Health Consultation

Exposure Investigation for Fish Dioxin Testing

FORMER KERR-MCGEE CHEMICAL CORPORATION

COLUMBUS, MISSISSIPPI

EPA FACILITY ID: MSD990866329

SEPTEMBER 22, 2008

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
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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 which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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Prepared by:

U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Exposure Investigation & Site Assessment Branch

Executive Summary

ATSDR was requested to conduct an exposure investigation to determine if fish in the Luxapalila Creek in Columbus, Mississippi contain concentrations of dioxins that pose a hazard to people who eat fish from the creek. Surface water runoff from the Kerr-McGee wood treatment plant, which is located about one-half mile west of the creek, may have carried dioxins into Luxapalila Creek. Kerr-McGee formerly treated wood products with pentachlorophenol and other wood preservatives. Technical grade pentachlorophenol contains trace quantities of dioxin-like compounds (chlorinated dibenzo-*p*-dioxins and chlorinated dibenzofurans).

Since dioxins can bioaccumulate in fish, ATSDR tested fish from Luxapalila Creek for dioxin contamination. ATSDR, with the assistance of the Mississippi Department of Environmental Quality, collected two species of fish: channel catfish, a bottom feeder, and spotted bass, a predator fish. The fish were collected from two locations: near the town of Steens, about 5-miles upstream of the site, and from a section of Luxapalila Creek that may have received surface water runoff from the site.

Composite samples of fish from each location were analyzed for 17 dioxin congeners. The concentrations of dioxin congeners in both species of fish from both locations were low. Measured concentrations of dioxin toxicity equivalents (TEQs) in the fish composite samples ranged from 0.005 to 0.150 parts per trillion (wet weight). ATSDR concluded that the levels of dioxins detected in fish from Luxapalila Creek do not pose a public health hazard.

Objectives and Rationale

ATSDR prepared an Initial Release Public Health Assessment for the former Kerr-McGee wood treatment plant in Columbus, Mississippi (ATSDR 2007). In this health assessment, ATSDR noted that surface water runoff from the facility may have discharged into the Luxapalila Creek, located about 0.5 miles east of the facility. Among the contaminants detected in drainage ditches that received surface water runoff from the facility were chlorinated dibenzo-*p*-dioxins (CDDs) and chlorinated dibenzofurans (CDFs). Dioxins are persistent in the environment because they are resistant to physical, chemical, and biological degradation. Furthermore, dioxins can bioaccumulate in fish and other aquatic species that come into contact with contaminated sediment. Residents of the area have reported that they eat fish that they catch in Luxapalila Creek. The purpose of this Exposure Investigation (EI) was to determine if fish in the Luxapalila Creek contain concentrations of CDDs and CDFs that pose a public health hazard to people who eat the fish.

Background

The site is located at 2300 N 14th Avenue in Columbus, Mississippi. A wood treatment plant operated at the site from 1928 to 2003. The Kerr-McGee Chemical Corporation operated the plant from 1968 until it closed in 2003. At this facility, Kerr-McGee produced pressure-treated railroad products such as wooden crossties, switch ties, and timbers. The production process at the site used creosote and creosote coal tar solutions to produce pressure-treated railroad products. The facility also used pentachlorophenol (PCP) for wood-treating from the 1950s until the mid-1970s. Technical grade PCP contains trace amounts of chlorinated dibenzo-*p*-dioxins and chlorinated dibenzofurans. These compounds are collectively referred to as “dioxins.”

The Kerr-McGee facility is located within the drainage basin of Luxapalila Creek, which is approximately 0.5 miles east of the facility. In the past when PCP was used at the facility, it is possible that PCP and dioxins washed into drainage ditches near the plant. Limited sampling has detected PCP and dioxins in sediment samples from the 14th Avenue ditch (ATSDR 2007). It is possible that surface water flowing through the ditch transported sediment-bound dioxins into the surrounding neighborhoods and the Luxapalila Creek.

Low concentrations of dioxin are ubiquitous in the environment as the result of releases from combustion processes, the chlorine bleaching of paper pulp, chemical manufacturing, and other industrial processes. Burning household trash in open barrels can be a significant source of dioxins (Lemieux 2000). Given the multiple and disparate sources of dioxin in an urban environment, this Exposure Investigation was not intended to identify the origin of any dioxins in fish that were detected in this study.

METHODS

Sampling Locations

Fish were collected from two locations on the Luxapalila Creek. The control, up-river sampling location was near the town of Steens, Mississippi, which is located about 5 miles northeast of the Kerr-McGee facility. The second sampling area was located in Columbus, Mississippi, about one-half mile east of the former Kerr-McGee facility along a section of Luxapalila Creek where surface water runoff from the facility may have discharged into the creek. Fish were harvested from the creek from a point about 300 hundred yards below the Waterworks Road Bridge to below the Alabama Street Bridge, southeast of Propst Park. The fish sampling areas are indicated on the map in Figure 1.

Sample collection

ATSDR partnered with staff from the Mississippi Department of Environmental Quality (MDEQ) to collect fish from the sampling locations. MSDEQ staff launched a boat from shore to access the sampling locations. Fish were stunned using an electroshock device and collected with a fishing net. MSDEQ staff collected two species of fish: channel catfish (*Ictalurus punctatus*), a bottom feeding species, and spotted bass (*Micropterus punctulatus*), a predator species. MSDEQ conducted the sampling, so no collection permit was required.

Compositing samples

The fish were analyzed as composite samples. This was done for two reasons: (1) the average concentration of a contaminant in fish is the most appropriate measure of what a person who eats fish would be exposed to over a long period of time, rather the maximum or minimum concentration of a contaminant in an individual fish, and (2) the high cost of dioxin analyses precluded analyzing each individual fish.

EPA guidelines recommend that fish composite samples consist of 3 to10 fish of the same species and similar size (EPA 2000a). For this EI, the number of fish in the composite samples was determined by how many fish of each species that MSDEQ staff were able to capture at each sampling location. The composition of the composite samples is described in the results section below.

Sample handling and shipping

Each fish was logged in and its total length was recorded (distance in centimeters from tip of tail to tip of jaw). Each fish was individually wrapped in aluminum foil and a unique identification number was written on a piece of tape attached to the aluminum packet. The wrapped fish was placed in a zip-lock plastic bag, and the identification number was also written on the outside of the bag. The fish were stored on ice in a cooler until the following morning when they were transferred to an insulated cooler containing dry ice. The coolers and the chain-of-custody forms were shipped by overnight mail to the laboratory for analysis.

Lab processing and analysis

The SGS Environmental Services Laboratory, Inc. in Wilmington, North Carolina was the contract laboratory for this EI. SGS technicians skinned (catfish) or scaled (bass) the fish and filleted them to obtain portions of fish that are typically eaten. The fish were composited by location and species and analyzed using high resolution gas chromatography/high resolution mass spectrometry (EPA Method 8290). QA/QC procedures, including internal standards and method blanks, were implemented according to the EPA-approved methodology. The detection limit for all of the dioxin congeners in the tissue samples was less than 1 pg/gm (part per trillion). Results were reported as ppt dioxin congeners in wet weight of fish.

Data evaluation

ATSDR converted the concentrations of dioxin congeners to 2,3,7,8-tetrachloro dibenzo-*p*-dioxin (TCDD) toxicity equivalents (TEQs) using the 2005 WHO dioxin toxicity equivalent factors (TEFs) (Van den Berg et al. 2006). In calculating the total TEQs, non-detected congeners were computed both as zero and as one-half the analytical detection limit of the congener. ATSDR reported the dioxin concentrations as pg/gm of wet weight of fish.

Results

Composite fish samples

Composite samples were prepared for two species of fish (channel catfish and spotted bass) at each location. The composite samples consisted of 5 to 10 fish in each composite. In accordance with EPA guidelines, the length of each fish in the composite was 75 percent or more of the length of the largest fish in the composite. The size distribution of the fish in the composite samples is described in Table 1.

Table 1 – Fish Composite samples. Total length of fish in centimeters

Steens (control) Channel catfish	Steens (control) Spotted bass	Columbus (site) Channel catfish	Columbus (site) Spotted bass
30	30	36	30
31	27	32	28
29	33	33	26
33	27	35	26
31	25	32	24
33	26	34	
31	30		
30	27		
31			
31			

Analytical test results

The composite fish tissue samples were analyzed using EPA Method 8290. Most of the congeners were below the analytical detection limit, and only a few congeners were detected in tissue samples at low concentrations. When most of the dioxin congeners in a sample are at detectable concentrations, the total dioxin TEQ concentration is not sensitive to how non-detected congeners are quantitated. However, when most of the dioxin congeners are not at detectable concentrations, the total dioxin concentration is very sensitive to how the non-detected congeners are quantitated. For this EI, non-detected congeners were quantitated both as zero and as one-half of the detection limit. Because most of the congeners were non-detected, this results in significant differences in the TEQ total between the two methods.

The dioxin TEQ concentrations in the composite fish samples are presented in Table 2. When a non-detected congener was quantified as zero, the dioxin TEQ concentrations ranged from 0.005 ppt to 0.150 ppt. When the non-detected congeners were set to one-half the detection limit, the dioxin TEQ concentrations ranged from 0.490 to 0.627 ppt.

Table 2 – Dioxin TEQ concentrations in pg/gm (ppt) of wet weight of fish composite sample.

Sample	**Dioxin TEQ with ND = 0**	**Dioxin TEQ with ND = DL/2**
Control – catfish	0.0414	0.526
Control – bass	0.150	0.490
Site - catfish	0.0240	0.589
Site - bass	0.005	0.627

ND = not detected
TEQ = TCDD toxicity equivalents
DL = detection limit

Discussion

Fish move upstream and downstream depending on the availability of food, water level, season of year (spawning), etc. Skains (1992) reported that the home range of flathead catfish in the Big Black River, Mississippi, and the Tallahatchie River, Mississippi, ranged from 0.5 – 1.9 km (0.3 – 1.2 miles). In two Missouri streams, the median linear range of flathead catfish was 3.5 km (2.2 miles) (Vokoun 2005). Various species of bass were reported to have similar ranges. In the Savannah River in South Carolina, largemouth bass had a home range of about 0.5 km (0.3 miles), but sometimes travelled longer distances (Paller et al. 2005). Except during the spawning season, smallmouth bass typically stay within a 1 km range (0.6 miles) (Bunt et al. 2002).

Catfish and bass from the Luxapalila Creek would be expected to have similar home ranges. The body burdens of dioxins found in fish reflect their cumulative, lifetime exposure to dioxins in their home range. In this EI, the control area of the Luxapalila River and the site area are more than 5-miles apart, so it is unlikely that fish in the control area were exposed to contaminants in the site area and *vice versa.*

An examination of the data in Table 2 indicates that the concentrations of dioxin TEQs in fish from the site are similar to those from fish from the control area. If the dioxin TEQ values with ND=0 are used, the dioxin concentrations in fish from the site are less than those from the control area. These data support the conclusion that dioxin from the former Kerr-McGee site has not impacted fish in Luxapalila Creek.

Risk assessment of dioxin contamination in fish

The MSDEQ has established a fish tissue criterion for dioxins of 5 ppt (MSDEQ 1990). When the 5 ppt level is exceeded, MSDEQ recommends limiting consumption to no more than eight ¼-pound meals per year for the species of concern. All of the dioxin concentrations detected in fish in this EI were well below this criterion.

Based on national surveys, the US EPA has estimated that the 90th percentile value for freshwater and estuarine fish eaten by the public is 17.5 grams of uncooked fish per day (EPA 2000b). Using this fish consumption rate and the highest concentration of dioxin (0.63 pg/gm) detected in a fish sample, this equates to a daily dose of 0.16 pg/kg/day for an adult with a bodyweight of 70 kg. This estimated exposure dose is well below ATSDR's chronic Minimal Risk Level (MRL) of 1 pg/kg/day and does not pose a health hazard. It should be noted that this estimated dose is based on the assumption that the non-detected dioxin congeners were present at one-half the detection limit. If the maximum concentration of dioxin in fish that was actually measured (with non-detected congeners equal to zero) were used instead, the estimated ingestion dose would only be 0.0375 pg/kg/day.

Even if the MRL dose of dioxin were to be exceeded, it does not mean that health effects would occur, because the MRL incorporates uncertainty (or safety) factors. Although an MRL is derived for non-cancer toxic effects, ATSDR's MRL is also below a level that would pose a significant risk of cancer. Experimental studies have shown that high doses of dioxin cause cancer in animals, but there is considerable uncertainty regarding the cancer risk from exposure to low doses of dioxin (NRC 2006). ATSDR has stated that its MRL of 1 pg/kg/day is about one to two orders of magnitude below any effect levels demonstrated either experimentally or in epidemiologic studies for both cancer and non-cancer health endpoints (Pohl 2002).

Background concentrations of dioxins in fish

It is difficult to define normal or background concentrations of dioxin in fish, because dioxins are widespread environmental contaminants, especially in urban environments. Furthermore, most monitoring for dioxins in fish is done in bodies of water thought to be contaminated, resulting in test results that are biased toward higher values. The following references are representative of dioxin concentrations detected in fish from various surveys. In the data presented below, the dioxin TEQ concentrations were calculated by setting non-detected congeners equal to one-half the detection limit unless otherwise specified.

In 1987, the EPA conducted the National Study of Chemical Residues in Fish (EPA 1992). In this study, the EPA analyzed composite samples of fish from 388 locations nationwide. Many of the sites were selected because they were near potential point and nonpoint pollution sources. The average concentration of dioxin TEQs in all fish across all sites was 11.1 ppt with a median concentration of 2.80 ppt. However, at background sites with no known pollution, the average dioxin TEQ was 0.59 ppt with a median of 0.21 ppt.

In 1994, catfish nuggets from farm-raised catfish were purchased from local stores and markets in southern Mississippi (Cooper 1995). The dioxin TEQ concentrations in the catfish ranged from 1.19 to 2.64 ppt. It was later discovered that ball clay, an ingredient in catfish feed, was contaminated with dioxins, which contributed to the body burden of dioxins in the catfish (Rappe 1998).

In 1995, food items, including freshwater fish, were purchased from supermarkets in five regions of the United States (Schecter 2001). The dioxin TEQ concentration in pooled samples of freshwater fish (catfish, trout, perch, whitefish, and farm-raised salmon) was 0.810 ppt.

In 1995/1996, the U.S. FDA tested for dioxins in a market basket survey of food items collected from across the country (Jensen 2001). Dioxin concentrations in catfish were arbitrarily separated into two groups: “catfish with elevated levels of dioxin” and “background catfish.” Catfish with elevated levels of dioxin had an average dioxin TEQ concentration of 3.27 ppt, whereas background catfish had an average dioxin TEQ of 0.31 ppt. In this survey, test results were very similar when non-detected congener concentrations were calculated as being equal to zero: 3.26 ppt and 0.29 ppt, respectively.

As indicated by the data in Table 2, all of the dioxin TEQ concentrations in fish from the Luxapalila River were less than 0.63 ppt (or less than 0.15 ppt if calculated as ND = 0). The concentrations of dioxins in fish from the Luxapalila River are below concentrations detected in national market basket surveys, and are similar to dioxin concentrations detected in fish from uncontaminated background areas in two of the surveys.

The dioxin concentrations in the fish from the EI were calculated using the WHO 2005 dioxin TEFs, whereas the dioxin concentrations in the referenced studies were calculated using earlier TEFs. The revisions in the TEF values would not change interpretation of the results. For example, using the previous TEFs, the highest fish TEF concentration in fish from this EI would be 0.68 ppt, rather than 0.63 ppt, and the 0.15 ppt concentration would be unchanged. Thus, the conclusions would be the same regardless of which TEFs were used.

Child Health Considerations

In communities with environmental contamination, children can be at greater risk than adults for exposure to hazardous substances. A child’s behavior and lifestyle influence exposure. Children crawl on floors, put things in their mouths, play close to the ground, and spend more time outdoors. 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.

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 (NRC, 2006).

It is prudent public health policy to minimize dioxin exposures in children. Neonates and infants are not likely to eat large 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 (AAP, 2002).

Conclusions

(1) Low concentrations of dioxin were detected in fish collected from the Luxapalila Creek. Consumption of these fish would not pose a public health hazard.

(2) The concentrations of dioxins in fish from the Luxapalila Creek near the site were similar to those detected in fish from an upstream control area. These results support the conclusion that fish in Luxapalila Creek have not been impacted by dioxin contamination from the site.

Recommendations

None

Public Health Action Plan

ATSDR's Health Promotion and Community Involvement Branch will develop appropriate materials to inform the community of the findings of this Exposure Investigation.

ATSDR staff will present the findings of this Exposure Investigation to the community at a public meeting.

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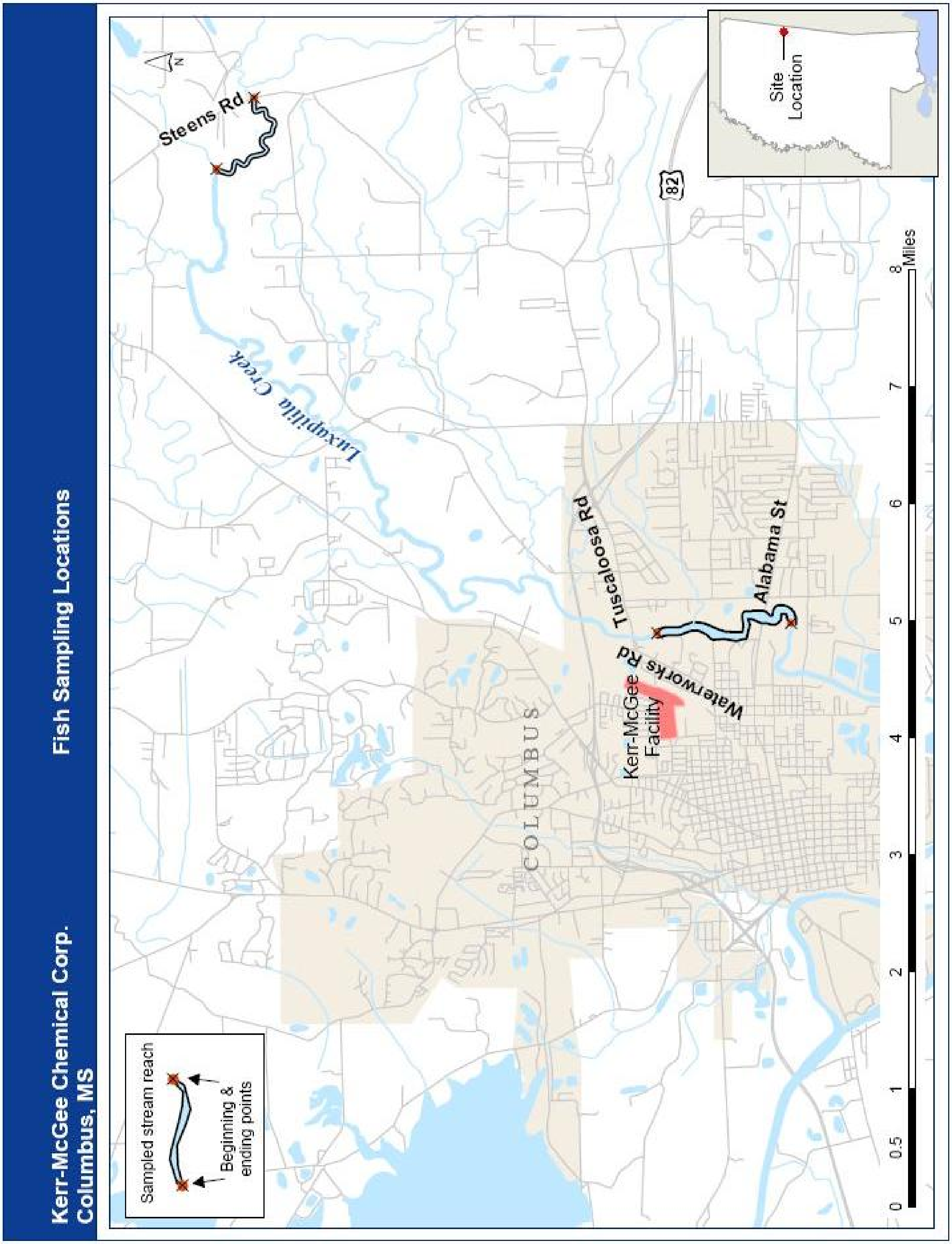

Figure 1. Fish Sampling Locations