Health Consultation

SHIAWASSEE RIVER SUPERFUND SITE

HOWELL, LIVINGSTON COUNTY, MICHIGAN

EPA FACILITY ID: MID980794473

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U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

An ATSDR health consultation is a verbal or written response from ATSDR 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 which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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HEALTH CONSULTATION

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Prepared by:

Michigan Department of Community Health
Under Cooperative Agreement with the
U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry

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List of Acronyms

ATSDR	Agency for Toxic Substances and Disease Registry
CFC	Cast Forge Company
cfs	cubic feet per second
EPA	Environmental Protection Agency
GFMI	Gannett Fleming of Michigan, Inc.
MDCH	Michigan Department of Community Health
MDEQ	Michigan Department of Environmental Quality
mg/kg	milligrams per kilogram
nSA	new Study Area
PCB	polychlorinated biphenyl
PCDD	polychlorinated dibenzodioxins
PCDF	polychlorinated dibenzofurans
ppm	parts per million
ppt	parts per trillion
RME	Reasonable Maximum Exposure
ROD	Record of Decision
SA	Study Area
TEQ	Toxic Equivalency
UCL	Upper Confidence Limit

Summary

A health consultation was issued by the Michigan Department of Community Health (MDCH) and the Agency for Toxic Substances and Disease Registry (ATSDR) for the South Branch of the Shiawassee River (classified as a Superfund site, Facility Identification # MID980794473) in December 2003, following a 2001 request to do so from the Michigan Department of Environmental Quality (MDEQ).[1] The public health hazard surrounding the site was characterized as indeterminate, due to lack of residential and non-residential exposure data (MDCH 2003). The nature of the remaining hazard is from continued presence of polychlorinated biphenyl (PCB) "hotspots" in both river sediment and floodplain soil. One of the major conclusions of MDCH (2003) was that fish advisories should remain in effect and health education measures should be initiated to "ensure that all resident and non-resident recreational participants are informed of the potential health risks from PCB exposure."

In May 2004 and again in April 2005, MDEQ provided MDCH with updated environmental data from the South Branch of the Shiawassee River, which included analysis of samples taken from the river sediment and floodplain soil for PCBs as well as polychlorinated dibenzodioxins and dibenzofurans (PCDDs and PCDFs). Review of this new data (GFMI 2004 and GFMI 2005) is presented in this health consultation.

The most recent data reveals that residual hotspots of PCBs continue to be found in river sediment and floodplain soil in exceedance of MDEQ "action levels," hotspots in sediment and soil continue to exist in exceedance of pre-established EPA remediation goals and despite some limited soil remediation at the site. MDCH considers this site as posing a health hazard to those consuming fish from impacted parts of the South Branch. As such, fish advisories should remain in effect until fish tissue data from the Shiawassee River are updated and/or the site has been remediated sufficiently. The MDCH, in response to our former and current conclusions and in the absence of better fish tissue data, has initiated a demographics analysis to address data gaps for residential and non-residential recreational patterns of use for the South Branch of the Shiawassee River as well as to target health education efforts.

Background

Past Site Information

The South Branch of the Shiawassee River (hereafter referred to as South Branch) originates from Coon Lake near Marion Township just south of Howell, Michigan (Livingston County). It flows north for approximately 40 miles through Shiawassee County into the Shiawasseetown Reservoir (aka Shiawasseetown Pond). An aging dam is located at the reservoir (near Shiawasseetown) to regulate flow into the main stem of the Shiawassee River, which continues north through Saginaw and Bay Counties. The Shiawassee converges with the Tittabawassee and

[1] On April 1, 1996, the Michigan Department of Public Health (MDPH) Division of Health Risk Assessment was absorbed into the newly formed Michigan Department of Community Health (MDCH). On October 1, 1995, the environmental protection and regulation functions of the Michigan Department of Natural Resources (MDNR) were transferred to the newly formed Michigan Department of Environmental Quality (MDEQ).

Saginaw Rivers near the city of Saginaw and empties into Lake Huron via Saginaw Bay. See Figure 1 for an overview of this 40-mile stretch of river.

The South Branch is 20–45 feet in width, with a reported average width of 25 feet during normal periods of flow. Late summer (low) and peak flows in 1982 were reported to be 15 and 75 cubic feet per second (cfs), respectively (ENTACT 2003). Late summer depth of the water channel is 1–2 feet, with scour depths of up to 5 feet seen along the river banks. The adjacent 100-year floodplain is 50–300 feet wide during the first river mile (as measured from M-59; see Figure 1) and is heavily overgrown with mixed woodland and marsh-like areas. Land immediately adjacent to the South Branch is predominantly forested floodplain, agricultural, or undeveloped, with several residences located along the river channel. Presumably, river sediments contaminated by PCBs are deposited in the floodplain during periods of high flow in the river, which generally occurs seasonally (MDCH 2001).

The Cast Forge Company site (CFC, hereafter referred to as the "former CFC property") consists of the property located at 22440 W. Highland Road (M-59), Howell, Michigan (Livingston County) and the section of the South Branch between M-59 and Steinacker Road, comprising approximately 8 miles of the river (EPA 2001). See Figure 2 for an overview of the former CFC property. CFC manufactured aluminum wheel castings for the automobile industry starting in 1969. The former CFC property covers approximately 51 acres. It is bordered on the north and east by wetlands, on the west by the South Branch, and on the south by M-59. The developed portion of the property is fairly flat, draining predominantly to the wetlands on the eastern part of the property. An underground culvert drains these wetlands into the South Branch (ENTACT 2003). CFC is thought to be the source of the PCB contamination of river sediment and floodplain soil of South Branch.

In late September 2001, ATSDR received a request for a public health consultation from MDEQ relative to the Record of Decision (ROD) made in early September 2001 by the Environmental Protection Agency (EPA) for the Shiawassee River Superfund site. The ROD identified remedial goals at the site to be 5 milligrams per kilogram (mg/kg, or parts per million [ppm]) PCB for sediment and 10 ppm PCB for soil. This is significant as the MDEQ action levels are 0.33 and 4 ppm, respectively, such that the selected EPA clean-up goals exceed state-derived health-based standards.

To determine estimates of expected exposure point concentrations for both river sediment and floodplain soil hotspots, a data review was conducted through use of the combined data of Tetra Tech (2001) and ENTACT (2003). Estimates for "average" and "reasonable maximum exposure" (RME, analogous to the 95^{th} percentile upper confidence limit [UCL]) were calculated after combining the raw data from Tetra Tech (2001) and ENTACT (2003). These estimated exposure concentrations were compared to any existing and relevant health-based regulatory levels.

The results from Gannett Fleming of Michigan Inc. (GFMI) (2003) were not included in the analysis because their sampling did not use the transect system used in most other recent

reports.[2] However, the unique aspects of this past data collection effort were that sediment samples were taken from *outside* the original 8-mile study area and that some samples were screened for polychlorinated dioxin (PCDD) and furan (PCDF) congeners. They created a new system whereby the 40-mile stretch of the South Branch were broken up into three "study areas" (SAs):

- SA1 consisted of the portion of the South Branch between the CFC property (near M-59 in Howell) and the Chase Lake Road crossing to the north, encompassing about eight (8) river miles downstream. SA1 corresponded roughly to transects 1 through 57 (see Figure 2).
- SA2 consisted of the portion of the South Branch between the Chase Lake Road crossing and the Shiawassee Pond and Dam (near Shiawasseetown), encompassing about 32 river miles downstream. SA2 included transects 57 through 61 and close to an additional 30 miles downstream beyond this (see Figure 2).
- SA3 consisted of the Shiawassee Pond (otherwise known as the Shiawasseetown Reservoir). There were no former transects that corresponded to this area.

Data collected during May and June 2003 and reported in GFMI (2003) revealed that twelve (12) of twenty (20) sediment samples collected from SA1 exceeded the MDEQ action level of 0.33 ppm.[3] In SA2, two (2) of twenty-three (23) sediment samples exceeded the MDEQ PCB standard. In SA3, no sediment samples exceed this standard. Random samples were sent off for "rapid screen" detection of PCDDs/PCDFs with a hit of 114.36 parts per trillion (ppt) found in SA2 and a hit of 615.5 ppt from SA3 (taken from the Shiawassee Pond). The conclusion of GFMI (2003) was that PCB contamination still extends from the former CFC property to the Steinacker Road crossing, approximately eight miles downstream.

Due to a lack of residential and non-residential exposure information for the South Branch of the Shiawassee River, the public health hazard was classified as indeterminate. At that time, need for more current fish tissue concentration data was identified. Multiple data reports preceeding MDCH (2003) have confirmed the presence of residual PCB hotspots in both the river sediment and the floodplain soil of the South Branch. At the time, it was advised that fish advisories should remain in effect, and health education measures should be initiated to ensure that all residents and non-resident recreational participants are informed of the potential health risks from PCB exposure. Finally, it was recommended that MDCH, MDEQ, and the regional EPA office should work together to address the lack of empirical data on natural attenuation processes as well as the disparity between the remediation goals of MDEQ and EPA for the South Branch. The full text containing the conclusions, recommendations, and public health action plan of the initial health consultation (MDCH 2003) can be found in Appendix A.

[2] Past data reports (Tetra Tech 2001, ENTACT 2003, etc.) used a shared numerical transect system, making it possible to combine data from similar transects. In addition, these data reports generally only focused on the first eight (8) river miles downstream from CFC, ending at the Steinacker Road crossing.

[3] According to personal communications with Linda Dykema (MDCH) and Janet (Sunny) Krajcovic (MDEQ), the "sediment contact standard" of 0.33 ppm for PCBs is the result of a back-calculation done by MDEQ and of comparison to the Test Method 8082 detection limit. The derived standard was slightly lower than the Test Method 8082 limit of detection and, therefore, was assumed as the standard.

New Site Information

GFMI (2004) reported the results of the second phase of the South Branch investigation, which was designed to continue to delineate the extent of PCB contamination in river sediment and floodplain soils. This particular data collection effort was focused on the six river miles between the Marr Road crossing and the Byron Road crossing, which partially overlaps SA1 and SA2 as defined by GFMI (2003). This new focus area includes a span roughly analogous to transects 46 through 61 (see Figure 2) plus the section of the South Branch that extends past Steinacker Road to the Byron Road crossing (just north of the intersection of Steinacker and Byron Roads – see Figure 1). This new focus area, which is comprised of about 6 river miles overall, was also split up into smaller groups for the purposes of data collection:

- New Study Area 1 (nSA1, to differentiate it from the past SA1) consists of the river area between the Marr Road crossing north to the Chase Lake Crossing. This roughly corresponds to sampling locations SA-1-5 through SA-2-1, as reported in GFMI (2003). Forty-eight (48) new sediment and thirty-two (32) new soil samples were proposed from nSA1.
- New Study Area 2 (nSA2) consists of the river area between the Chase Lake Road crossing north to the Byron Road crossing. This roughly corresponds to sampling locations SA-2-1 through SA-2-3, as reported in GFMI (2003). Fifty (50) new sediment and twenty-six (26) new soil samples were proposed from nSA2.

Samples of river sediment (roughly every 250 feet) and floodplain soil (roughly every 500 feet) were collected during the months of October and November 2003. Two samples were taken at each location, one from 0-3 feet in depth and one from 3-6 feet in depth. All floodplain soil samples were taken within 15 feet of the river channel. Almost 350 samples were submitted to BIO-CHEM Environmental Analytical Laboratories of Grand Rapids, MI, and analyzed via EPA SW-846 Method 8082 (GFMI 2004). This analytical method quantifies nine different PCB congeners (Aroclors 1216, 1221, 1232, 1242, 1248, 1254, 1260, 1262, and 1268). Similar to the first phase of investigation (GFMI 2003), a random set of samples were sent to Triangle Laboratories in Durham, North Carolina, for a rapid screen for PCDDs and PCDFs at a detection limit of 4 parts per trillion (ppt). Positive hits at this screening level were further processed by a confirmation scan employing the EPA SW-846 Method 8290. See Table 1 for a breakdown of sediment and soil samples from nSA1 and nSA2.

Table 1. Breakdown of sediment and soil samples collected during Oct-Nov 2003 and submitted for analysis by GFMI (2004).

Study Area Name	***Sent for PCB Analysis***		***Sent for PCDD/PCDF analysis***	
nSA1	**SEDIMENT** 108	**SOIL** 69	**SEDIMENT** 16	**SOIL** 9
nSA2	**SEDIMENT** 114	**SOIL** 58	**SEDIMENT** 18	**SOIL** 9

GFMI (2004) reported that 130 total samples had PCBs present above the MDEQ action level of 0.33 ppm. Seventy-seven (77) of these were from nSA1 (59 sediment and 18 soil) while fifty-three (53) were from nSA2 (45 sediment and 8 soil). The limit of detection for both sediment and soil samples was 0.33 ppm. See Table 2 for a summary of the sediment data, which lists the

number of samples that exceed the MDEQ action level of 0.33 ppm as well as the clean-up goal of 5 ppm selected by EPA. In addition, Table 2 lists the number of samples where the limit of detection was not sensitive enough to capture concentrations as low as 0.33 ppm.

The floodplain soils data from GFMI (2004) is reported in Table 3, which lists the number of samples that exceed the MDEQ action level of 4 ppm as well as those that equal or exceed the clean-up goal of 10 ppm selected by EPA. In no cases was the detection limit higher than the MDEQ action level of 4 ppm. It should be noted that GFMI (2004) *incorrectly* listed the MDEQ "direct contact criterion" for PCBs in residential soil exposure settings as 5 ppm, when in actuality it is 4 ppm. This has very minor impacts on GFMI's analysis as well as this health consultation. GFMI's mistake excludes two soil concentrations from nSA2, located at SA-2-FP3 and SA-2-FP9 (4.6 and 4.9 ppm, respectively).

Table 2. Summary of sediment data from GFMI (2004) for nSA1 and nSA2.

Study Area Name	*# hits > 0.33 ppm PCBs*	*# hits > 5 ppm PCBs*	*# hits MDL > 0.33 ppm PCBs*
nSA1	69	11	19
nSA2	45	10	15

The random samples that were screened for the presence of PCDDs and PCDFs revealed that just eight (8) of fifty-two (52) samples were positive upon initial rapid screen (which, again, revealed that there may be concentrations of PCDDs and/or PCDFs above 4 ppt). The vast majority of the positive screening results were from nSA2, with only one of eight positives coming from nSA1 GFMI 2004). These congener-specific concentrations were converted to total dioxin equivalency units (TEQs) and the eight (8) samples undergoing confirmatory scan showed a range of 0.67 to 17.46 ppt TEQ.

Table 3. Summary of soils data from GFMI (2004) for nSA1 and nSA2.

Study Area Name	*# hits > 4 ppm PCBs*	*# of hits =/> 10 ppm PCBs*
nSA1	19	10
nSA2	9	4

GFMI (2005) was conducted as part of the "third phase" of remedial investigation activities at the South Branch site and contained additional river sediment and floodplain soils data. At the time of the preparation of this report, a final report had not been finalized by GFMI, there is some uncertainty as to methodology, etc. In general, the data of GFMI (2005), collected in November and December of 2004, agreed with the data of GFMI (2004) in that there are remaining hotspots in both sediments and soils. GFMI (2005) reported the results of collecting river sediment data from 57 different sampling locations, all located between Marr and Chase Lake Roads. Thirty-two (32) of these sampling locations had positive PCB hits that exceeded the MDEQ standard of 0.33 ppm while 7 of these locations exceeded the chosen EPA remediation goal of 5 ppm. Similar to previous GFMI reports (GFMI 2003 and 2004), several rapid screens for PCDDs and PCDFs were done on river sediments. Two (2) of 31 rapid screens came back "positive" and were sent on for laboratory analysis, yielding 1.2 and 1.3 ppt TEQ.

Following some limited floodplain soil remediation both on the original CFC property and near former EPA transects 9 and 37 (two previously identified floodplain soil hotspots), GFMI (2005)

collected some "post-excavation" samples, including 14 on-site samples and 12 floodplain samples. GFMI (2005) also incorrectly applied the 5 ppm soil criterion when reporting that 7 on-site samples and 7 floodplain samples exceed the MDEQ action level of 5 ppm. Applying the proper MDEQ standard of 4 ppm only excludes one additional floodplain soil sample from transect 9. Finally, water samples taken from areas of the river near transects 9 and 37 indicated fairly significant PCB concentrations (see Discussion section for more details). It is unclear how, when or why these samples were taken as part of the excavation process given the lack of a final report at the time of this report's preparation.

Discussion

Human Exposure Pathways

To determine whether nearby residents are, have been, or are likely to be exposed to contaminants associated with a property, ATSDR and MDCH evaluate the environmental and human components that could lead to human exposure. Actual exposure to a contaminant occurs through an exposure pathway. An exposure pathway contains five elements: (1) a source of contamination, (2) contaminant transport through an environmental medium, (3) a point of exposure, (4) a route of human exposure, and (5) a receptor population. An exposure pathway is considered *complete* if there is evidence that all five of these elements are, have been, or will be present at the property. Alternatively, an exposure pathway is considered complete if there is a high probability of exposure. It is considered a *potential* exposure pathway if at least once of the elements is missing but could be found present at some point. An *incomplete* pathway exists if at least one element is missing and will never be present. Table 4 shows the PCB exposure pathways expected for the South Branch.

The main exposure pathway of concern identified from MDCH (2003) was the consumption of fish from the river and/or wild game from the floodplain. Given the moderately high concentrations found in the past at certain hotspots and the reasonable assumption that other, still undetected hotspots in soil and sediment existed, people living in the vicinity of the South Branch were considered to have possibly been exposed to harmful levels of PCBs through incidental ingestion of soil and sediment. To a lesser extent, exposure was considered possible via ingestion of river water as well as dermal exposure to soil and sediment hotspots. Three pathways of greatest concern from MDCH (2003) are discussed briefly below.

River Sediment: Any individual engaging in water-based recreation (swimming, boating, canoeing, angling, etc.) within the South Branch may come into contact with PCB-bearing sediments. In addition, it is likely that the sediments closer to the former CFC property are migrating downstream over time and with scour events within the river channel. The implications of this "off-site migration" is such that individuals much further downstream could be exposed in the future to transported PCB-bearing sediment that is not detected and remediated. This could the case near the town of Byron, Michigan, which has a millpond fed by the South Branch that supports water-based recreation by local residents. (Personal communication with J. Krajcovic [MDEQ], May 2003)

Floodplain soil: It is a reasonable assumption that those properties along the river are occasionally contaminated with PCB-bearing sediment during flooding events in which the water overflows the river banks. In addition, significant (but unquantified) numbers of residential and otherwise private properties are within the 100-year floodplain; therefore, it is assumed that potential exposure to PCBs in soils exists.

Biota: Although fish advisories have been and are warning against consumption of fish taken from the South Branch, several instances of anecdotal evidence during site visits imply that fishing (and possibly other water-based recreation) still occurs along the river. Therefore, it is assumed that exposure to PCBs via ingestion of fish and/or turtles taken from the South Branch occurs, as it could with the ingestion of any game (i.e., white-tailed deer, cottontail rabbit) or livestock (i.e. cattle, chickens, pigs) species that graze within the 100-year floodplain.

River Sediment Data

See Table 2 for a summary of the sediment data, which lists the number of samples that exceed the MDEQ action level for PCBs of 0.33 ppm as well as the clean-up goal of 5 ppm selected by EPA. In addition, Table 2 lists the number of samples where the limit of detection was not

Table 4. Exposure Pathways of Concern at the South Branch of the Shiawassee River.

Source	Environmental Medium and Transport	Exposure Point(s)	Exposure Route(s)	Exposed Population	Time Frame	Status
Release of PCBs from the former CFC facility	Air	Ambient Air	Inhalation	Residents, swimmers, boaters, anglers	Past	Incomplete
					Present	Incomplete
					Future	Incomplete
	Water	South Branch, Shaw Lake, Shiawasseetown Reservoir	Ingestion, dermal absorption, inhalation	Residents, swimmers, boaters, anglers	Past	Potential
					Present	Potential
					Future	Potential
	River Sediment	South Branch	Ingestion, dermal absorption, inhalation	Residents, swimmers, anglers	Past	Potential
					Present	Potential
					Future	Potential
	Floodplain Soil	100-year floodplain of South Branch	Ingestion, dermal absorption, inhalation	Residents, others recreating in floodplain	Past	Potential
					Present	Potential
					Future	Potential
	Biota	Fish, turtles caught from South Branch; game species grazing in the floodplain	Ingestion	Local anglers and hunters	Past	Complete
					Present	Complete
					Future	Potential

sensitive enough to capture concentrations as low as 0.33 ppm. There are still a significant number of sampled locations that exceed the MDEQ action level of 0.33 ppm in both new study areas (nSA1 and nSA2). Similarly, there are many spots that exceed the selected remedial goal

for the site of 5 ppm. For nSA1, these hits extend from the Marr Road crossing to the Chase Lake Road crossing, but tend to be concentrated among the wetland areas south of the Howell Township boundary. The highest reported concentration for nSA1 was 27 ppm. For nSA2, the hits are mainly concentrated in between the Chase Lake Road crossing and the Steinacker Road crossing. The highest reported PCB concentration for nSA2 was 58 ppm.

River sediment data reported in GFMI (2005) were all collected from nSA1, as defined from GFMI (2004). These newer data showed that PCB concentrations in sediment from GFMI (2005) ranged from 0.35 to 80 ppm. Not only did this data surpass the previously reported highest concentration from nSA1 (27 ppm), but showed many areas north of the Howell Township boundary where residual sediment contamination remains in exceedance of the MDEQ action level of 0.33 ppm.

Floodplain Soils Data

The floodplain soils data from GFMI (2004) is reported in Table 3, which lists the number of samples that exceed the MDEQ action level of 4 ppm for PCBs as well as the clean-up goal of 10 ppm selected by EPA. In no cases was the detection limit higher than the MDEQ action level of 4 ppm. Similar to the sediment data, there are still many sampling locations that not only exceed the state health-based standard but the selected clean-up goal as well. In nSA1, the hits were confined for the most part between the Chase Lake Road crossing and the Howell Township boundary to the north. The highest reported concentration for nSA1 was 29 ppm. For nSA2, the hits extended from the Chase Lake Road crossing to the Byron Road crossing. The highest reported concentration for nSA2 was 18 ppm.

Whereas GFMI (2003) reported that the only PCB congener present was 1242, GFMI (2004) reported that the only congener present was 1232. This seems a little strange as the time between the two rounds of sampling was only a few months, hardly enough time for all the Aroclor 1242 to degrade to 1232 via reductive chlorination. Although it is recognized that microbial breakdown may be the ultimate degradation pathway for PCBs in sediment and soil, the persistence of PCBs generally increases as degree of chlorination increases such that tetrachlorinated Aroclors (like 1242 and 1248) degrade slower than di- and trichlorinated Aroclors (like 1221 and 1232) (HSDB 2003). This "reductive dechlorination" process can produce congeners with lower weight (such as the transformation from 1242 to 1232) but the rate at which this process occurs at concentrations under 50 ppm has been reported as "very slow or non-measurable" (Tiedje et al. 1993). If there is indeed some sort of anaerobic dechlorination process occurring, then there should be an increase in the detection of "lesser" chlorinated species, like mono- and dichlorobiphenyls (which does not appear to be the case at this site). Furthermore, HSDB (2003) reported that it took seven (7) months for 30-53% of PCBs in two different river sediments to degrade. The same SW-846 method was used for both sets of GFMI samples.

Post-excavation sampling performed on floodplain soils (and reported in GFMI 2005) revealed that 5 of 7 samples from transect 9 exceeded the MDEQ action level of 4 ppm while 3 of 5 samples from transect 37 exceeded this standard. PCB soil concentrations at transect 9 ranged from 4.8 to 60 ppm while they ranged from 6.3 to 31 ppm at transect 37 (GFMI 2005). [Water

samples taken in conjunction with post-excavation activities were also found to exceed MDEQ criteria for drinking water (0.5 ug/L) and direct contact (3.3 ug/L). At transect 9, PCB concentration in water was measured at 5.6 ug/L (or ppb) and at 25 ug/L at transect 37.]

Dioxin/Furan Data

The eight (8) samples undergoing a confirmatory scan showed a range of 0.67 to 17.46 ppt toxic equivalency (TEQ). Many of these were co-located with floodplain soil sampling locations where PCBs were found in excess of either the 4 ppm or 10 ppm level. In fact, the three highest concentrations (12.87, 13.60, and 17.46 ppt TEQ) were found at soil sampling locations sited between Chase Lake Road and Steinacker Road and associated with PCB concentrations of 18, 8.5, and 10 ppm, respectively.

The MDEQ direct contact criterion for chlorinated dioxins and furans is 90 ppt and, in fact, all of the dioxin/furan concentrations found in the South Branch study areas were below this limit. All but the three hits listed above were consistent with what Nestrick et al (1986) characterized as "background" for the Midwest. They reported that this background in the Midwest is 0-10 ppt TEQ.

Although there is no exceedance of health-based standards for chlorinated dioxins and furans, there is the possibility that synergistic effects between PCBs and PCDDs/PCDFs could happen at those sampling locations where both types of compounds are found. This is most likely to occur when exposure is to both dioxins/furans and the "dioxin-like" PCB congeners. Since the various Aroclor are mixtures of differently chlorinated individual congeners, there are varying amounts of these "dioxin-like" species within different mixtures. The mixture known as Aroclor 1248 contains almost 20% by weight of PCB-126 (which is the "most toxic" of all the "dioxin-like" congeners in that it is roughly one-tenth [10%] less toxic than the most toxic PCDD congener, 2,3,7,8-tetrachlorodibenzo-d-dioxin); Aroclor 1232 contains roughly 10% by weight of PCB-126 (ATSDR 2000).

Fish Tissue Data and Dose Estimation

Fish tissue concentrations reported by the Fox River Group (FRG 1999) were previously identified by MDCH (2003) as the most useful for estimating PCB dose from the fish consumption exposure pathway. On the basis of the data from FRG (1999), doses through the fish consumption exposure pathway were estimated through use of standard EPA methodology and exposure factors. Appendix B presents an overview of methods and assumptions used, in addition to presenting the dose estimates. The estimated doses were assumed to result from eating white sucker at the FRG (1999) contamination levels (i.e., from the 1994 site conditions of the Bowen Road bridge crossing on the South Branch). Adults from the general population could be expected to take in a dose ranging from 0.00022 to 0.00066 milligrams (mg) of PCBs per kilogram (kg) of body weight (BW) per day. [The former estimate is an average, or central tendency, while the latter estimate is an RME estimate, roughly analogous to the 95th percentile.] Adults from the recreational fisher population could be expected to take in a dose ranging from 0.0014 to 0.00044 mg/kg-day. Children of the general population (consumption

rates for children of recreational fishers in Michigan could not be identified) could be expected to take in a dose ranging from 0.00061 to 0.000084 mg/kg-day.

Assuming a meal is 8 ounces of fish and that meal-sized portion contains 2.56 mg PCB per kg of fish tissue, this would translate to 0.00829 mg PCB per meal, or 0.000118 mg PCB per kg human body weight per meal (as consumed by the "average" adult from the general population).

All the estimated doses for both adult and children consumption scenarios exceed both the intermediate (0.00003 mg/kg-day) and the chronic (0.00002 mg/kg-day) oral MRLs, as defined by ATSDR for Aroclor 1254. In addition, the estimated amount of PCBs that would be ingested per 8 oz portion of fish (assuming it is contaminated at 2.56 mg PCB per kg fish tissue) is 0.000118, which is also in exceedance of both the chronic and intermediate MRL values. This chronic oral MRL is based on feeding studies done with Aroclor 1254 and Rhesus monkeys (ATSDR 2000). A low-observed adverse effect level (LOAEL) of 0.005 mg/kg-day was identified from these studies, based on an immunologic endpoint of decreased antibody response. A total uncertainty factor of 300 was applied to this LOAEL to derive the chronic MRL (and coincidently, the EPA oral reference dose as well). All the estimated doses for both adult and children consumption scenarios exceed the LOAEL identified from the critical study that defined the chronic oral MRL.

According to FDA and EPA fish consumption guidance, even fish concentrations of 1.7 to 2.56 ppm (as seen in the FRG data from 1999) are 1 to 2 orders of magnitude above "do not eat" concentrations. Furthermore, this range of 1.7 to 2.56 ppm in fish tissue is related to sediment concentrations of 0.59 to 0.72 ppm, as these fish and sediment samples were taken at the same time and place [see FRG (1999) or MDCH (2003) for more information]. Data from GFMI (2004) and GFMI (2005) reflect existing sediment concentrations well in exceedance of the 0.59 to 0.72 ppm range. In fact, a value of 80 ppm was reported in GFMI (2005) as recently as November/December 2004, which is two orders of magnitude higher than the concentration (0.72 ppm) associated with fish tissue concentrations of 2.56 ppm. Consumption of fish from these areas and consistent with the assumptions used to derive these estimated doses (see Appendix B) could, therefore, cause health effects upon long-term exposure.

Children's Health Considerations

In general, children may be at greater risk than adults from exposure to hazardous substances at sites of environmental contamination. Children engage in activities such as playing outdoors and hand-to-mouth behaviors that could increase their intake of these hazardous substances. They are shorter than most adults and, therefore, breathe dust, soil and vapors closer to the ground. Their lower body weight and higher intake results in a greater dose of hazardous substance per unit of body weight. The developing body systems of children can sustain permanent damage if toxic exposures are high enough during critical growth stages. Even before birth, children are forming the body organs they need to last a lifetime. Injury during key periods of growth and development could lead to malformation of organs (teratogenesis), disruption of function, and premature death. Exposure of the mother could lead to exposure of the fetus, via the placenta, or could affect the fetus because of injury or illness sustained by the mother (ATSDR 1998). The

obvious implication for environmental health is that children can experience substantially greater exposures than adults to toxicants that are present in soil, water, or air.

Children living on or near the South Branch of the Shiawassee River and its adjacent 100-year floodplain may have access to both the floodplain and the river channel. Residences are located along the river at several locations, and more public access points to the floodplain of the river likely exist. Young children were identified at one residence located on the river during the May 2003 site visit. Because the former CFC facility is an NPL hazardous waste site, children living nearby are at increased risk of exposure to PCBs in soil (ATSDR 2000). Residential housing located in the floodplain may have detectable levels of PCBs in house dust, so that children living there may be at even greater risk of exposure. Children and teenagers with exposed skin playing in the floodplain were also identified during the May 2003 site visit. Finally, infants and small children can be exposed to PCBs both prenatally and through consumption of breast milk, for PCBs have been shown to accumulate in breast milk and to be transferable to babies and breast-feeding small children.

Conclusions

The most recent data reveal that residual hotspots of PCBs continue to be found in river sediment and floodplain soil in exceedance of MDEQ "action levels," hotspots in sediment and soil continue to exist in exceedance of pre-established EPA remediation goals, and that fish advisories should remain in effect until fish tissue data from the Shiawassee River are updated. Even despite limited remediation, there is residual PCB contamination of floodplain soil. Since fishing and/or hunting likely continues to occur at this site, a public health hazard exists due to exposure via ingestion PCB-contaminated fish. As part of the public health action plan described in MDCH (2003), a request was made to the MDEQ for additional fish sampling. As of the writing of this updated version (February 2006), no additional fish sampling has been received. Efforts will be ongoing to incorporate any additional fish sampling data into future estimates of PCB dose from consumption of fish from the South Branch.

The MDCH, in response to our former and current conclusions and in the absence of better fish tissue data, has initiated a demographics analysis to address data gaps for residential and non-residential recreational patterns of use for the South Branch of the Shiawassee River. In addition, MDCH will investigate the possibility of adapting current health education initiatives involving fish consumption from other areas of the Saginaw River watershed to include the South Branch. This is mainly intended to close any data gaps regarding consumption of fish from the river or game from the floodplain as well as to target future site-related health education initiatives.

Recommendations

1. The fish contaminant monitoring data for South Branch should be updated to include more recent tissue data for this area and prioritized based on the recent and ongoing environmental characterization of the river sediment. Fish consumption advisories should then be reviewed in

light of this new data. MDCH will be available to work with the MDEQ to review existing data and provide priority sampling areas.

2. MDCH will initiate health education measures designed to alert people living within the 100-year floodplain of their potential risks from PCB exposure from consumption of game and livestock species from the river channel and/or floodplain. In addition, MDCH will also target non-resident recreational anglers and hunters who may collect fish and game species from the river channel and/or floodplain. These initiatives will be driven by the results of the ongoing demographics analysis, which will seek to generate information about site-specific usage of the site by residents and non-residents. MDCH will also investigate adapting current health education data collection efforts in other areas of the Saginaw River watershed to the South Branch.

Public Health Action Plan

MDCH proposes the following action items relative to our conclusions:

- MDCH will still request site-specific data on natural attenuation processes from the MDEQ and/or EPA in order to verify that this is a valid option to reduce sediment and soil contamination to below acceptable health-based standards.
- MDCH will continue to be available to MDEQ and EPA to address issues related to the natural attenuation of PCBs in sediment and soil as well as for technical review of future environmental data, including post-remediation sampling results.
- MDCH will continue the demographics analysis for the areas along the river and in the floodplain to help target health education measures and materials to residents living in the floodplain and/or near the river channel as well as resident and non-resident recreational participants who may hunt, catch and/or consume fish from the river or wild game from the floodplain. It is hoped that site-specific exposure patterns may be ascertained through this process, which will help better characterize the hazard for those exposed.
- MDCH will investigate adoption of health education efforts in other areas of the Saginaw River watershed towards health education initiatives at the South Branch.

Any citizen with additional information or health concerns regarding this health consultation should contact the Michigan Department of Community Health, Environmental and Occupational Epidemiology Division, at 1-800-648-6942.

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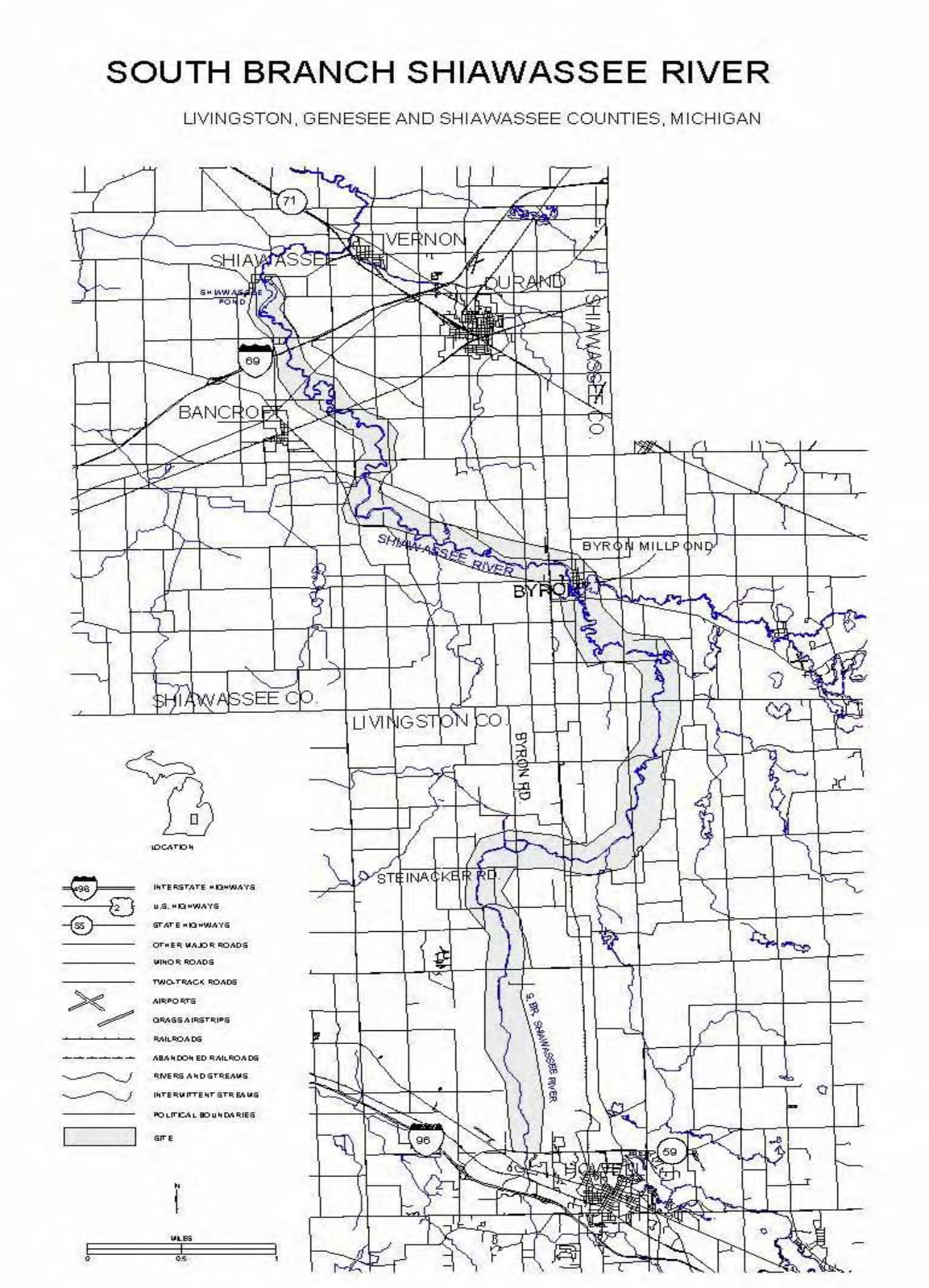
SOUTH BRANCH SHIAWASSEE RIVER
LIVINGSTON, GENESEE AND SHIAWASSEE COUNTIES, MICHIGAN
71
VERNON
SHIAWASSEE
OURAND
SHIAWASSEE POND
SHIAWASSEE CO.
69
BANCROFT
SHIAWASSEE RIVER
BYRON MILLPOND
BYRON
SHIAWASSEE CO.
LIVINGSTON CO.
BYRON RD.
STEINACKER RD.
S. BR. SHIAWASSEE RIVER
96
59
HOWELL
LOCATION
INTERSTATE HIGHWAYS
U.S. HIGHWAYS
STATE HIGHWAYS
OTHER MAJOR ROADS
MINOR ROADS
TWO-TRACK ROADS
AIRPORTS
GRASS AIRSTRIPS
RAILROADS
ABANDONED RAILROADS
RIVERS AND STREAMS
INTERMITTENT STREAMS
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Figure 1

STUDY AREA PORTION OF SHIAWASSEE RIVER

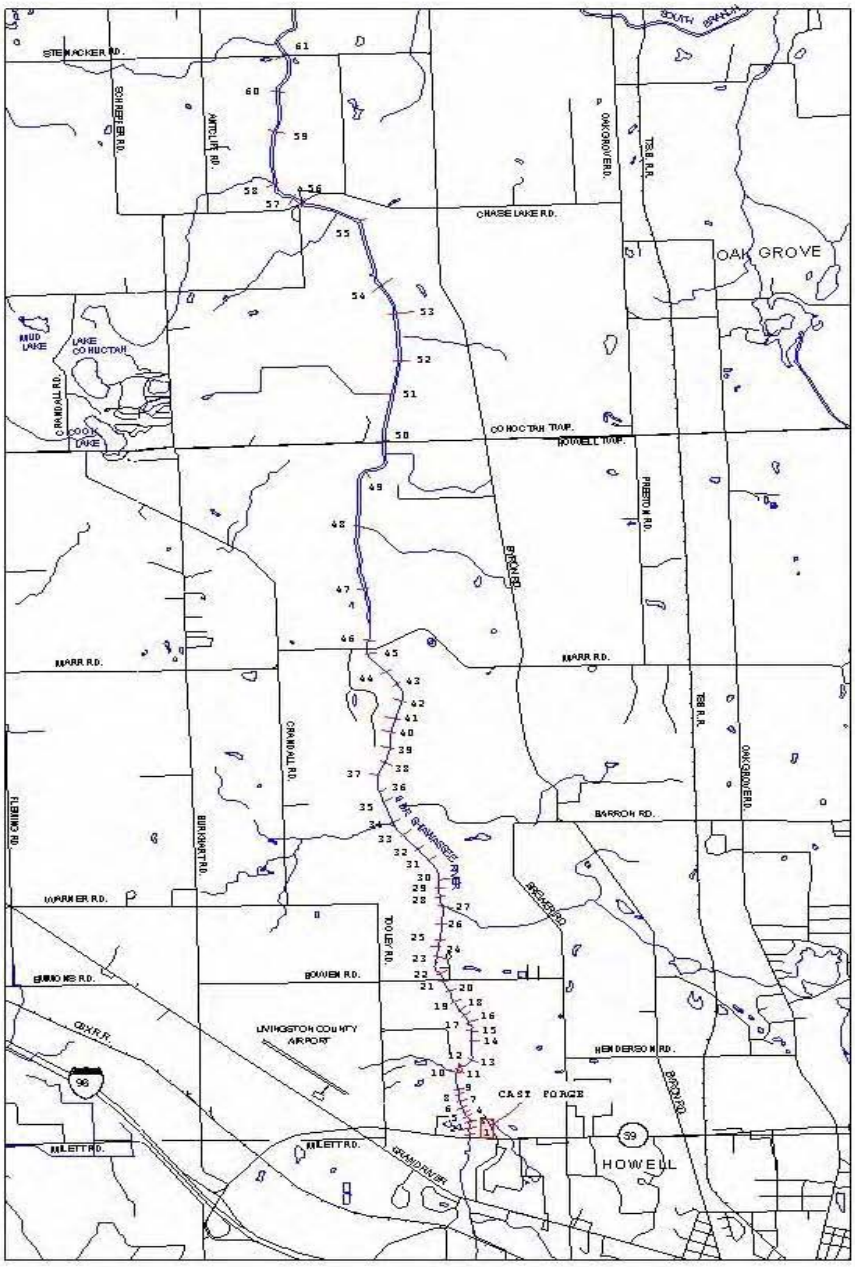

Figure 2

CERTIFICATION

This Shiawassee River Superfund Site Cleaners Health Consultation was prepared by the Michigan Department of Community 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 begun. Editorial Review was completed by the Cooperative Agreement Partner.

Technical Project Officer, Cooperative Agreement Team (CAT), Superfund and Program Assessment Branch (SPAB), Division of Health Assessment and Promotion (DHAC), ATSDR

The Division of Health Assessment and Consultation, ATSDR, has reviewed this public health consultation and concurs with the findings.

for Team Leader, Cooperative Agreement Team, SPAB, DHAC, ATSDR

Appendix A

Conclusions, Recommendations, and Public Health Action Plan from December 2003 health consultation for Shiawassee River Superfund Site

Conclusions

Assuming standard residential exposure patterns exist along the South Branch, a public health hazard exists, mainly through the consumption of game or livestock species from the river channel and/or floodplain. There is a need, however, for more up-to-date fish tissue concentration data, because the most recent data are from 1994. Multiple data reports from the last few years have all confirmed the presence of residual PCB hotspots in both the river sediment and the floodplain soil of the South Branch of the Shiawassee River. Given the moderately high concentrations still found at certain hotspots and the reasonable assumption that other undetected hotspots in soil and sediment exist, people living in the vicinity of the South Branch could also be exposed to harmful levels of PCBs through incidental ingestion of soil and sediment from hotspots. To a lesser extent, exposure is possible via ingestion of river water and dermal exposure to soil and sediment hotspots.

The soil and sediment remediation standards selected by MDEQ and EPA for this Superfund Site are generally separated by an order of magnitude, with the EPA remediation goals being higher in both cases. The EPA standards do not appear to be protective of human health and, if implemented, would likely leave many hotpots untouched and in violation of state clean-up goals. The SWAC methodology also appears problematic because it is based on "average" remaining contamination levels. Inherent in the SWAC methodology is the assumption that spots will remain that are either below or above this "average" remaining concentration.

Recommendations

1. MDCH should suggest to MDEQ that the fish contaminant monitoring data for South Branch be updated and possibly expanded to incorporate data to inform advisories on the entire 40-mile stretch of river. Fish consumption advisories should then be reviewed in light of this new data.

2. MDCH should initiate health education measures designed to alert people living within the 100-year floodplain of their risks from PCB exposure from consumption of game and livestock species from the river channel and/or floodplain. These health education initiatives should include sensitive subpopulations (such as children, the elderly, pregnant women, and the immuno-compromised). In addition, non-resident recreational anglers and hunters who may collect fish and game species from the river channel and the 100-year floodplain should be targeted for health education strategies.

3. MDCH suggests that the regional EPA office and MDEQ work more collaboratively to decide upon mutually acceptable and fiscally responsible remediation goals, in addition

to coordinating sampling events within the South Branch watershed. In addition, state agencies and EPA should work collaboratively to address the lack of empirical data on natural attenuation of PCBs in the sediments of the South Branch and to validate natural attenuation as part of the overall remediation strategy.

4. MDCH should initiate health education measures designed to alert people living within the 100-year floodplain of their risks from PCB exposure from incidental ingestion and direct contact with surface and subsurface soils. In addition, these health education initiatives should include sensitive subpopulations (such as children, the elderly, pregnant women, and the immuno-compromised).

5. MDCH should initiate an exposure survey to ascertain the site-specific exposure patterns associated with the 40-mile stretch of the South Branch, including collecting information on sensitive subpopulation demographics and non-resident recreation habits.

Public Health Action Plan

- MDCH will request that MDEQ continue the Fish Contaminant Monitoring Program, with particular attention paid to updating the PCB fish tissue data from the South Branch (to include possible expansion to the entire 40-mile stretch). These data should be provided to MDCH so that fish advisories for this river can be updated where necessary.

- MDCH will suggest a collaborative process to the regional EPA office and MDEQ to address the lack of information on natural attenuation as well as the difference between state and federal remediation goals.

- MDCH will provide educational materials (such as the health consultation, fact sheets, etc.) and learning opportunities (such as public information sessions) to residents of the 100-year floodplain. MDCH will attempt to identify non-resident recreational users of the South Branch and provide them with educational materials and learning opportunities.

- MDCH will investigate funding opportunities to conduct an exposure survey to characterize site-specific exposure patterns, especially among children and people recreating along and in the South Branch and its associated floodplain as well as those residents living near known sediment and floodplain soil hotspots.

Appendix B–Estimation of PCB dose through fish consumption

All algorithms used to estimate dose through the fish consumption pathway were adapted from the EPA's 1998 guidance titled *Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities.*

Table B-1. Estimated consumption rates for freshwater fish for adults and children of Michigan.

Age	*CT (mean)*	*RME (95th p'tile)*	*Reference*
Adult–general	6 g/day (0.000084)	19 g/day (0.00026)	EPA 1997
Adult–rec. fisher	12 g/day (0.00017)	39 g/day (0.00054)	EPA 1997[A]
Child–general	1.88 g/day (0.000033)	13.9 g/day (0.00024)	EPA 2002

[A] This data appears in a 1989 study of Michigan freshwater anglers as cited in EPA 1997.

The estimated consumption rates for freshwater fish in the table (CR_{fish}) were used as input into the algorithm below to calculate total intake of PCBs through fish consumption (I_{fish}, in mg/kg-day). First, the given consumption rates had to be converted to kilograms of fish tissue consumed per kilogram body weight (BW) per day. Body weights were assumed to be 71.8 kg for adults and 57.1 kg for children (here defined as no older than 14 years of age). These converted values are listed in Table B-1 in parentheses in units of kg of PCB per kg BW per day.

$$I_{fish} = C_{fish} \times CR_{fish} \times F_{fish}$$

where C_{fish} = concentration in fish tissue (mg/kg)

CR_{fish} = consumption rate of fish (kg/kg-day)

F_{fish} = fraction of fish that are contaminated

Fish concentration data were taken from FRG (1999), which reported 2.56 ppm in the white sucker. For the sake of conservatism, 100% of all fish are considered to be contaminated, so that F_{fish} is assumed to be 1.

Table B-2. Estimated PCB intake rates from consumption of freshwater fish for adults and children of Michigan. All intakes/standards are in mg/kg-day.

Age	*CT (mean)*	*RME (95th p'tile)*	*Risk-Based Standard*[A]
Adult – general	0.00022	0.00066	0.00002
Adult – rec. fisher	0.00044	0.0014	0.00002
Child – general	0.000084	0.00061	0.00002

[A] The PCB intakes here are compared to ATSDR's chronic oral Minimum Risk Level (MRL). The intermediate oral standard is 0.00003 mg/kg-day.

Uncertainties related to this dose estimation are as follows:

- The assumption that 100% of fish consumed are contaminated may not adequately reflect site-specific conditions.
- Site-specific fish consumption rates for adult and children of both the general population and the recreational angler population may not be identical to the assumption.
- The fish concentration used (white sucker sampled in 1994) may not necessarily reflect current site conditions with regard to fish contamination or preferred species consumed from the site.
- 100% gastrointestinal absorption is assumed, for the sake of conservatism. Actual absorption values are likely to be between 50 and 100%, with the co-planar PCB congeners tending to be more completely absorbed.

From the estimated doses from fish consumption alone (consideration of other pathways would serve only to increase total daily dose, dependent on site-specific exposure patterns) from Table B-2, all adult and child consumption scenarios exceed both the ATSDR chronic oral MRL and the intermediate oral MRL of 0.00003 mg-kg-day.

This chronic oral MRL is based on feeding studies done with Aroclor 1254 and Rhesus monkeys. A low-observed adverse effect level (LOAEL) of 0.005 mg/kg-day was identified from these studies, based on an immunologic endpoint of decreased antibody response. A total uncertainty factor of 300 was applied to this LOAEL to derive the chronic MRL (and coincidently, the EPA oral reference dose as well). From consulting Table B-2, one sees that all intake scenarios exceed the LOAEL from the Rhesus monkey feeding studies.

Given that the white sucker data used to generate the dose estimations are associated with a sediment concentration of 0.72 ppm (see FRG 1999), it is quite probable that much higher sediment concentrations (as seen at hotpots 7 and 25, Table 3) are associated with higher doses than those reported in Table B-2, assuming the same exposure patterns.