UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

MAR 26 2004

REPLY TO THE ATTENTION OF

MEMORANDUM

From: Richard C. Karl, Acting Director
Superfund Division

R. Karl

To: JoAnn Griffith, Chair
National Remedy Review Board

This memo is in response to your October 8, 2003 letter which presents the recommendations of the National Remedy Review Board with respect to the Little Mississinewa River Site in Union City, Indiana (the Site). Region 5 will respond to the recommendations in the order that they appear in your letter. Following is our response:

Recommendation 1:

The board found the region's descriptions of Remedial Action Levels (RALs) as they relate to surface weighted average concentration (SWAG) to be confusing. The remedy decision documents and other information in the Administrative Record should clearly define the concepts of RAL and SWAC. For example, the region should explain the way in which sediments greater than ~ 4 mg/kg will be removed to produce a SWAC of 1 ppm over a one mile foraging reach.

Region 5 Response:

The Region agrees with this recommendation. This comment is addressed by assuring that this terminology is explained in the Feasibility Study (FS) Report and will be addressed in the Record of Decision (ROD) for the Site by including a description of the various terms and their relationship to each other, and providing an example directly from the risk tables for the Site.

Recommendation 2:

The region indicated that it calculated risks for recreational flood plain soils based on PCB concentrations. However, the risk reduction of additional PCB mass removal in the recreational flood plains was not clearly defined. The region should consider estimating the mass of PCBs present and the mass of PCBs removed under various alternatives to describe the reduction in risk. This calculation may facilitate distinctions between alternatives, e.g., between 4a and 4c. (Note from the Region-these alternatives have been renumbered to 3f and 3h)

Region 5 Response:

The Region agrees with this recommendation. Region 5 directed the Potentially Responsible Parties (PRPs) for the Site to perform PCB mass reduction calculations for various cleanup alternatives included in the Site Feasibility Study. These calculations have been completed and are included in the Proposed Plan and will be included in the ROD for the Site. This information is enclosed with this letter as Enclosure 1 and indicates that, for river sediments, Alternative 3f (formerly 4a) achieves a 90% PCB mass reduction; whereas, Alternative 3h (formerly 4c) achieves only a 70% PCB mass reduction. These calculations also indicate that, under Alternative 3h, average remaining PCB concentration in sediments exceeds 2 ppm in the first two river miles and exceeds 1 ppm for the third river mile. Conversely, under Alternative 3f, the average remaining PCB concentration is less than 1 ppm for all river miles (the Cleanup Goal for the top foot of river sediments is 1 ppm measured as an average over one river mile). Region 5 considers this difference to be significant and implementation of Alternative 3f will greatly reduce the potential for future releases of higher levels of PCBs in deeper sediments back into the river ecosystem, including potential deposition in residential flood plain areas which would present potential risks to humans. Alternative 3f provides further risk reduction and provides superior long-term effectiveness and permanence as compared to Alternative 3h. In fact, the only alternatives that are considered to have acceptable long-term effectiveness and permanence for the LMR Site are Alternatives 3b and 3f, and Alternative 3f achieves this criterion at a greatly reduced cost as compared to Alternative 3b (which costs about $60,000,000). For the contaminated flood plain soils, the difference in mass reduction is similar, 75 % for Alternative 3f and 55 % for Alternative 3h. However, the flood plain soils are not subject to the same level of scouring and redistribution as the channel sediments, and the cost differential for achieving the additional mass reduction in the flood plain soils is more pronounced due to the wider distribution of PCBs in the flood plain areas of the Site. Based on the mass reduction tables and further refinement of the calculations of ecological risk for the recreational flood plain areas, Region 5 has decided to use a not-to-exceed PCB cleanup level of 20 ppm for the recreational flood plain areas in the recommended alternative. This represents an estimated cost reduction of $ 3,700,000 from Alternative 3f as outlined in the FS Report, which included a 10 ppm PCB recreational flood plain cleanup level.

Additionally, one of the regional ecologists has written a stand-alone document that explains, in detail, the basis for the PCB cleanup level for the recreational flood plain areas in the recommended alternative for the Site. This document will be placed in the Site Administrative Record, will be discussed in the ROD for the Site, and is enclosed herein as Enclosure 2.

There are other considerations that were important in the Region’s remedy selection process. First, there is an existing institutional control, a 75-foot flood plain easement on both sides of the LMR, that is administered by the Randolph County Commissioners. This requires any entity that performs any potentially intrusive activity within 75 feet of the LMR to obtain a permit. This will assist EPA and the PRPs in tracking any such activities to properly address any PCB contamination that is disturbed via such activities. EPA will also require the establishment of a trust fund that can be utilized for sampling and proper disposal of any PCB-contaminated sediments and/or soils that are disturbed in the future in areas where PCBs are left in place above applicable cleanup levels. The LMR Site is a tremendous candidate for channel diversion and dry excavation due to its relatively small size and the presence of a nearly continuous thick, hard clay layer that forms the channel bottom (at depths ranging from 12-30 inches below the top of the sediment layer). As experienced during the 2001-2002 removal action at the LMR Site, this clay layer forms a visible barrier that greatly enhances the implementability of dry excavation and also serves as a barrier against vertical migration of PCBs in the river channel. Last, there are some residents that have had use restrictions placed on their land by the State of Indiana due to the PCB contamination. Any remedy that does not, in the State's view, adequately remediate the PCB contamination may result in the retention of these restrictions on certain residences, thus continuing to encumber innocent landowners at the LMR Site. The risks posed by the PCBs at the LMR Site, along with these additional considerations, led the Region to determine that Alternative 3f provides the most cost-effective, long-term remedy for the LMR Site.

Recommendation 3:

The need for action in recreational-use flood plains is driven by ecological risk that was not clearly explained in the board's review package, although the region did provide additional explanation during the meeting. The region should assure that ecological risks are clearly explained in the decision documents and Administrative Record. The board also recommends that the region define the term "recreational use" in the context of this site. For both residential and recreational-use flood plain areas, the region should include in the decision document an explanation of what areas are or are not available for unlimited human use, and where use is limited, include appropriate institutional controls.

Region 5 Response:

The Region agrees with this recommendation. One of the regional ecologists has written a standalone document that explains, in detail, the basis for the PCB cleanup level for the recreational flood plain areas in the recommended alternative for the Site. This document will be placed in the Site Administrative Record, will be discussed in the ROD for the Site, and is enclosed herein as Enclosure 2.

Regarding the delineation of areas of the Little Mississinewa River (LMR) as "residential flood plain" and "recreational flood plain", there are figures in the Site Feasibility Study which provide the requested delineation. These figures will be included in the ROD for the Site. The areas that will not be available for unlimited human use will be subject to the existing 75-foot easement that is managed by the Randolph County Commissioners. This institutional control requires notification and issuance of a permit for any intrusive activities that will occur within 75 feet of the river edge. Additionally, Region 5 will work with the PRPs to establish a trust fund to provide a mechanism for proper sampling and disposal of any soils that are excavated in the future in any area where wastes were left in place above the applicable cleanup levels. A physical barrier (e.g. orange snow fence, geotextile) will be placed prior to backfilling of any such areas to help indicate when action is required (sampling and removal, if necessary) and the trust fund is to be used.

Recommendation 4:

The information presented to the board did not include the region's conceptual site model (CSM) or specify remedial action objectives. Given the number of risk pathways at this site, the region's CSM would have made it easier to understand the site-wide risks and how the alternatives address those risks. The board recommends that the region include a discussion of its CSM in decision documents to better communicate the risk pathways and proposed remedies.

Region 5 Response:

The Region agrees with this recommendation. A figure presenting the Conceptual Site Model has been, developed and is enclosed with this letter as Enclosure 3. The Conceptual Site Model will be discussed, and this figure will be included in the ROD for the Site.

Recommendation 5:

As presented to the Board, risk in the residential flood plain appears to be within EPA's risk range for cancer and just exceeds a Hazard Index of 1.0 for non-cancer risk, yet PCB levels in some areas are elevated. The Board recommends that the decision documents better describe potential risks associated with higher concentrations in some exposure areas. For example, some exposure areas appear to have PCB concentrations in the hundreds of ppm, which may present greater risks in some areas than those portrayed in the review package.

Region 5 Response:

The Region agrees with this recommendation. The Region has added maximum concentration values to the Site figures so that it is clear that some of the residential flood plain areas have PCB concentrations well in excess of 100 ppm. The figures in the Feasibility Study indicated cutoffs of 1, 5, 10, and 20 ppm since we realized that it was unlikely that PCB concentrations in excess of 20 ppm would be allowed to remain on-site. These figures are useful for costing purposes but do not indicate that magnitude of some of the PCB contamination in the flood plain areas, most of which is at or near the ground surface. These figures are enclosed herein as Enclosure 4, and the region will include the new Site figures in the ROD and will fully describe the risks associated with exposure to PCBs at these levels. Also enclosed are the new human health risk tables (Enclosure 5) that were produced in response to the Region's comments on the draft Baseline Risk Assessment. When the Region attended the Remedy Review Board meeting in August 2003, these tables were not available.

Recommendation 6:

The region did not quantify the results that accrue from removing channel sediments at depth. The board recommends that the region perform a mass calculation to determine the volume of sediments removed and remaining at the three “not to exceed” levels in Alternative 4 (i.e., 5 ppm, 10 ppm, 20 ppm). This analysis may help illustrate the relative costs of the various cleanup criteria.

Region 5 Response:

The Region agrees with this recommendation. The Region has included mass calculation tables in the FS Report and will also include these tables in the ROD for the Site. These tables are useful in illustrating the potential benefits of the various alternatives relative to the costs and are enclosed with this letter as Enclosure 1. As the tables indicate, mass removal rates increase significantly as you go from a 20 ppm to 10 ppm and 5 ppm PCB cleanup level, and there is a commensurate reduction in the average post-excavation sediment PCB concentration, which relates directly to risk. The Region believes that the additional mass removal at the 5 ppm level greatly increases the effectiveness and long-term permanence of the sediment cleanup for the Site.

Recommendation 7:

The package provided little information on the affects that cleanup would have on existing habitat (e.g., vegetation and the stream channel). The board recommends that the region ensure that impacts from cleanup activities be kept to a minimum and/or ensure that actions are taken to return the stream channel to its present condition to the extent practicable. The region should clearly describe these activities in the decision documents and include associated monitoring and maintenance activities in the cost estimates.

Region 5 Response:

The Region agrees with this recommendation. Enclosed is a “Question and Answer” Fact Sheet that was produced to supplement the Proposed Plan for the Site (Enclosure 6). These issues are discussed in more detail in this Fact Sheet. The Region will clearly describe the river channel restoration goals in the ROD for the Site. The PRPs have indicated to the region that the Feasibility Study cost estimates for the various alternatives reflect aggressive river channel restoration activities. The actual engineering details of the river channel restoration activities will be finalized during remedial design for the Site, but it is the Region’s clearly stated intent to have the river channel restored in a way that prevents erosion and returns the channel to its preexcavation condition (minus the PCBs) as much as practicable.

In addition, the Region provided details to the NRRB during our meeting in August regarding the excavation depth limits that were placed on the flood plain remedies, including the recommended alternative. For the flood plain areas, a one-foot excavation depth limitation was placed on heavily-vegetated areas so that trees would not be destroyed by the remedial action. This limit is considered a maximum depth of excavation in the wooded areas- the actual depth of excavation would often be less in the immediate vicinity of the trees. The Remedial Project Manager for the LMR Site has extensive experience in removal of contaminated soil around trees. At the NL Industries Site in Granite City, Illinois, where 1600 residential yards were successfully cleaned up, less than 10 trees were lost due to the cleanup activities. The Site team will do whatever is necessary to ensure that trees are preserved in the LMR flood plain areas, due to the importance of the trees to the soil stability of the flood plains, to the aquatic life in the LMR, and to the residents and property owners along the LMR.

Recommendation 8:

Based on the information provided, the board noted that the Little Mississinewa River may be contaminated by both point and non-point discharges in addition to the PCB contamination. In order to ensure that the ecological benefits contemplated for the PCB cleanup are not compromised by other discharges, the board recommends that the region coordinate with other EPA and state programs to determine whether the appropriate water quality standards are in place, whether the river has been included on the Indiana 303(d) list, and whether a total maximum daily load has been or needs to be developed for the river. The region did not present the State of Indiana water quality classification or standards for this segment of the river. The board recommends that the region identify the appropriate water quality classification or standards, and establish cleanup goals that are consistent with them.

Region 5 Response:

The Region agrees with this recommendation. Enclosed are 1) a letter from the Indiana Department of Environmental Management that identifies the appropriate water quality classification and standards (Enclosure 7) and 2) a memo which was previously forwarded to the National Remedy Review Board regarding the use designations pertaining to ecological receptors for the LMR (Enclosure 8). The letter indicates that the LMR is on the 303(d) list because of the PCB contamination only, and that the LMR has not been adversely impacted by non-point discharges or other point source discharges. The LMR is subject to Indiana’s water quality standards at 327 IAC 2-1-3, which specifies that the LMR is designated for supporting a well-balanced warm water aquatic community. The Superfund program is not ultimately responsible for implementing all of these regulations; however, the region has considered these classifications, designations, and standards in establishing the Site cleanup goals.

Thank you for the useful recommendations pertaining to the Little Mississinewa River Site in Union City, Indiana. If you have any questions concerning this letter, please contact Brad Bradley, Site Project Manager, at (312) 886-4742.

Enclosures:

1. Mass Calculations
2. Recreational Flood Plain Eco Risk Document
3. Conceptual Site Model
4. Figures showing maximum PCB concentrations
5. Final Human Health Risk Tables
6. Q&A Fact Sheet
7. IDEM letter regarding water quality standards
8. Region 5 memo regarding LMR ecological use designations

ENCLOSURE 1

Table 1
Little Mississinewa River Channel Sediment
Summary of Estimated PCB Mass Present/ Removed/ Residual
Remedial Alternatives 3a, 3b, 3f, 3g and 3h
Little Mississinewa River
Randolph County, IN

Estimated PCB Mass Removed from LMR Channel sediment (Surface and Depth)

Remedial Alternative	Depth Interval Below Channel Base(1)	Estimated PCB Mass In-Place (lbs)	Estimated PCB Mass Removed (lbs)	Estimated PCB Mass Remaining (lbs)	Estimated % of Total PCB Mass Removed	Estimated Project Cost (LMR Sediment)
3a	0 to 1 ft	722	160	562	22%	
3a*	1 ft to CB	436	0	436	0%	$ 1,882,744
3a TOTAL		1,158	160	998	14%	
3b	0 to 1 ft	722	681	41	94%	
3b	1 ft to CB	436	429	7	98%	$ 20,633,401
3b TOTAL		1,158	1,110	48	96%	
3f	0 to 1 ft	722	645	78	89%	
3f	1 ft to CB	436	398	38	91%	$ 14,554,101
3f TOTAL		1,224	1,042	116	90%	
3g	0 to 1 ft	722	591	131	82%	
3g	1 ft to CB	436	301	135	69%	$ 12,395,092
3g TOTAL		1,158	893	266	77%	
3h	0 to 1 ft	722	586	137	81%	
3h	1 ft to CB	436	221	215	51%	$ 10,668,118
3h TOTAL		1,158	807	352	70%	

(1) Channel bottom typically occurs at 2 feet below current riverbed; however, volume/mass calculations for the 1 foot to channel bottom interval include transects where channel bottom depths exceeded 2 feet

CB = Channel Bottom

* Remedial Alternative 3a had an excavation depth constraint of one foot, therefore, no PCBs were removed in the 1foot to CB interval

Estimated Post-Remedial Residual Sediment Concentration (Calculated by Exposure Area)

Mile Reach	Post-Remedial Area Weighted Average Residual Concentration (ppm)									
	Remedial Alternative 3a		Remedial Alternative 3b		Remedial Alternative 3f		Remedial Alternative 3g		Remedial Alternative 3h	
	0 to 1 ft	0 ft to CB	0 to 1 ft	0 ft to CB	0 to 1 ft	0 ft to CB	0 to 1 ft	0 ft to CB	0 to 1 ft	0 ft to CB
1	8.49	9.10	0.04	0.07	0.34	0.54	0.47	1.41	0.54	2.38
2	5.69	4.69	0.02	0.04	0.42	0.73	0.44	1.42	0.50	2.25
3	3.73	2.62	0.14	0.10	0.87	0.74	0.87	0.74	0.87	1.45
4	1.52	0.95	0.20	0.24	0.57	0.58	0.57	0.74	0.57	0.74
5	NA	NA	0.24	0.12	NA	NA	NA	NA	NA	NA
6	NA	NA	0.20	0.10	NA	NA	NA	NA	NA	NA
7	NA	NA	0.33	0.17	NA	NA	NA	NA	NA	NA

Mile reaches begin at Division Street and proceed northward

NA - Not Applicable to remedial Alternative

Table 2
Little Mississinewa River Floodplain Soil
Summary of estimated PCB Mass Present/Removed/Residential
Remedial Alternatives 3f, 3g, 3h
Little Mississinewa River
Randolph County, Indiana

Estimated PCB Mass Removal From Floodplain Soil

Remedial Alternative	Estimated Mass PCBs (Pounds)	Estimated Mass PCBs Removed (Pounds)	Estimated Mass PCBs Remaining (Pounds)	Estimated Percent of Total PCB Mass Removed	Estimated Total Project Cost (LMR Soil)
3a Totals	3674	1012	2662	28%	$ 8,288,908
3b Totals	3674	3635	39	99%	$ 42,265,499
3f Totals	3674	2751	924	75%	$ 16,485,019
3g Totals	3674	2328	1347	63%	$ 12,800,829
3h Totals	3674	2030	1645	55%	$ 12,023,012

Estimated Post-Remedial Residual Soil Concentration and Risk Exposures (Calculated by Exposure Area)

Floodplain Sample Area/Land Use	Maximum Post-Remedial Soil Concentration (ppm)	Post-Remedial Area Weighted Average Residual Concentration Assuming Uniform Excavation Depth of 1 foot or 2 feet in Individual Recreational Areas (ppm)		Post-Remedial Residual Risk Exposure for the 0-2 ft. Exposure Depth Intervals - Assuming Uniform Excavation Depth of 1 foot or 2 feet in Individual Recreational Areas (see notes 1, 2)	
		0 - 1 feet	0 - 2 feet	0 - 1 feet	0 - 2 feet
E - Residential 3a	8.3 (at 1-1.5 ft bgs)	0.50	NA	$< 1 \times 10^{-6}$	$< 1 \times 10^{-6}$
E - Residential 3b	1 (at 1.5-2 ft bgs)	0.40	0.40	$< 1 \times 10^{-8}$	$< 1 \times 10^{-8}$
E - Residential	4 (at 1-1.5 ft bgs)	0.87	0.52	$< 7 \times 10^{-7}$	$< 4 \times 10^{-7}$
F - Residential 3a	45 (at 1-1.5 ft bgs)	0.70	NA	$< 1 \times 10^{-6}$	$< 1 \times 10^{-6}$
F - Residential 3b	1 (at 2.5-3 ft bgs)	0.10	0.10	$< 1 \times 10^{-8}$	$< 1 \times 10^{-8}$
F - Residential	45 (at 1-1.5 ft bgs)	0.70	0.70	$< 6 \times 10^{-7}$	$< 6 \times 10^{-7}$
F - Recreational 3a	(at 1-1.5 ft bgs)	6.22	4.47	$< 1 \times 10^{-6}$	$< 1 \times 10^{-6}$
F - Recreational 3b	1 (at 2.5-3 ft bgs)	0.03	0.03	$< 1 \times 10^{-8}$	$< 1 \times 10^{-8}$
F - Recreational 3f	27 (at 2-3 ft bgs)	1.87	1.61	$< 1 \times 10^{-7}$	$< 1 \times 10^{-7}$
F - Recreational 3g	27 (at 2-3 ft bgs)	2.67	2.09	$< 2 \times 10^{-7}$	$< 2 \times 10^{-7}$
F - Recreational 3h	27 (at 2-3 ft bgs)	2.80	2.19	$< 2 \times 10^{-7}$	$< 2 \times 10^{-7}$
G - Residential 3a	44 (at 1-1.5 ft bgs)	1.20	NA	$< 1 \times 10^{-6}$	$< 1 \times 10^{-6}$
G - Residential 3b	1 (at 1.5-2 ft bgs)	0.10	0.10	$< 1 \times 10^{-8}$	$< 1 \times 10^{-8}$
G - Residential	4.6 at 1-1.5 ft bgs)	0.97	1.06	$< 9 \times 10^{-7}$	$< 8 \times 10^{-7}$
G - Recreational 3a	55 (at 0.5-1 ft bgs)	5.86	5.21	$< 1 \times 10^{-6}$	$< 1 \times 10^{-6}$
G - Recreational 3b	1 (at 1.5-2 ft bgs)	0.03	0.03	$< 1 \times 10^{-8}$	$< 1 \times 10^{-8}$
G - Recreational 3f	25 (at 2-3 ft bgs)	0.73	0.73	$< 5 \times 10^{-8}$	$< 5 \times 10^{-8}$
G - Recreational 3g	25 (at 2-3 ft bgs)	3.86	2.37	$< 3 \times 10^{-7}$	$< 2 \times 10^{-7}$
G - Recreational 3h	25 (at 2-3 ft bgs)	5.32	4.73	$< 2 \times 10^{-7}$	$< 2 \times 10^{-7}$
H - Recreational 3a	78 (at 1-1.5 ft bgs)	6.26	5.86	$< 1 \times 10^{-6}$	$< 1 \times 10^{-6}$
H - Recreational 3b	1 (at 1.5-2 ft bgs)	0.10	0.20	$< 1 \times 10^{-8}$	$< 1 \times 10^{-8}$
H - Recreational 3f	46 (at 1-1.5 ft bgs)^{3}	1.90	1.83	$< 1 \times 10^{-7}$	$< 1 \times 10^{-7}$
H - Recreational 3g	46 (at 1-1.5 ft bgs)^{3}	3.24	2.94	$< 2 \times 10^{-7}$	$< 2 \times 10^{-7}$
H - Recreational 3h	46 (at 1-1.5 ft bgs)^{3}	4.88	4.22	$< 4 \times 10^{-7}$	$< 3 \times 10^{-7}$
I - Recreational 3a	27 (at 1-1.5 ft bgs)	3.20	3.37	$< 1 \times 10^{-6}$	$< 1 \times 10^{-6}$
I - Recreational 3b	1 (at 1.5-2 ft bgs)	0.10	0.10	$< 1 \times 10^{-8}$	$< 1 \times 10^{-8}$
I - Recreational 3f	27 (at 1-1.5 ft bgs)	2.43	2.16	$< 2 \times 10^{-7}$	$< 2 \times 10^{-7}$
I - Recreational 3g	27 (at 1-1.5 ft bgs)	3.20	3.37	$< 3 \times 10^{-7}$	$< 3 \times 10^{-7}$
I - Recreational 3h	27 (at 1-1.5 ft bgs)	3.20	3.37	$< 3 \times 10^{-7}$	$< 3 \times 10^{-7}$
J - Residential 3a	8.8 (at 0.5-1 ft bgs)	0.90	NA	$< 1 \times 10^{-6}$	$< 1 \times 10^{-6}$
J - Residential 3b	1 (at 1.5-2 ft bgs)	0.20	0.40	$< 1 \times 10^{-8}$	$< 1 \times 10^{-8}$
J - Residential	4 (at 1-1.5 ft bgs)	0.90	0.90	$< 7 \times 10^{-7}$	$< 7 \times 10^{-7}$
J - Recreational 3a	52 (at 0.5-1 ft bgs)	1.61	1.43	$< 1 \times 10^{-6}$	$< 1 \times 10^{-6}$
J - Recreational 3b	1 (at 1.5-2 ft bgs)	0.16	0.16	$< 1 \times 10^{-8}$	$< 1 \times 10^{-8}$
J - Recreational 3f	10 (at 1-1.5 ft bgs)	0.92	0.97	$< 8 \times 10^{-8}$	$< 7 \times 10^{-8}$
J - Recreational 3g	11 (at 1-1.5 ft bgs)	1.05	1.08	$< 8 \times 10^{-8}$	$< 8 \times 10^{-8}$
J - Recreational 3h	11 (at 1-1.5 ft bgs)	1.05	1.08	$< 8 \times 10^{-8}$	$< 8 \times 10^{-8}$
K - Recreational 3a	17 (at 0-0.5 ft bgs)	5.46	3.92	$< 1 \times 10^{-6}$	$< 1 \times 10^{-6}$
K - Recreational 3b	1 (at 1.5-2 ft bgs)	0.04	0.04	$< 1 \times 10^{-8}$	$< 1 \times 10^{-8}$
K - Recreational 3f	9.3 (at 0-0.5 ft bgs)	2.21	1.84	$< 2 \times 10^{-7}$	$< 1 \times 10^{-7}$
K - Recreational 3g	17 (at 0-0.5 ft bgs)	5.46	3.92	$< 4 \times 10^{-7}$	$< 3 \times 10^{-7}$
K - Recreational 3h	17 (at 0-0.5 ft bgs)	5.46	3.92	$< 4 \times 10^{-7}$	$< 3 \times 10^{-7}$
L - Recreational 3a	22 (at 1-1.5 ft bgs)	5.83	9.10	$< 1 \times 10^{-6}$	$< 1 \times 10^{-6}$
L - Recreational 3b	1 (at 1.5-2 ft bgs)	0.02	0.02	$< 1 \times 10^{-8}$	$< 1 \times 10^{-8}$
L - Recreational 3f	22 (at 2-2.5 ft bgs)	2.24	4.42	$< 2 \times 10^{-7}$	$< 3 \times 10^{-7}$
L - Recreational 3g	22 (at 2-2.5 ft bgs)	2.24	6.26	$< 2 \times 10^{-7}$	$< 5 \times 10^{-7}$
L - Recreational 3h	22 (at 2-2.5 ft bgs)	6.47	10.06	$< 5 \times 10^{-7}$	$< 8 \times 10^{-7}$

Notes:

(1) The risk calculations contain the average area-weighted concentration risks for 0-1 foot and 0-2 feet depth soil in the Recreational Areas. All of these risks are below USEPA's acceptable risk range of 10-4 to 10-6 and IDEM's target risk of 10-5

2) All of these risks are within or below USEPA's acceptable risk range of 10-4 to 10-6 and below IDEM's target risk of 10-5

(3) Additional excavation in 2 Grids to depth of 3 feet

ENCLOSURE 2

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5

DATE: February 5, 2004

SUBJECT: Terrestrial Ecological Risk Addendum to the Baseline Risk Assessments, Little Mississinewa River, Randolf County, Indiana (Revision 1) Floodplain Risk Assessment, Sediment Risk Assessment, Sept. 22, 2003, prepared by Gradient Corp. for United Technologies Corp. and VIACOM Inc.

FROM: James Chapman, Ph.D., Ecologist

TO: Brad Bradley, RPM

Summary

This memo discusses the basis for the ecologically-protective soil PCB clean up goals (CUGs) for terrestrial wildlife in the recreational use areas in the floodplain of the Little Mississinewa River (LMR), and a revised analysis of the effectiveness of various alternative remedial action levels (RALs) in reducing ecological risks in the floodplain.

Table 1. Summary of the Effectiveness of Alternative Remedial Action Levels on Reduction of Risk in Robin Fledgling-stage Foraging Areas in Recreational Use Floodplains Along the Little Mississinewa River, Randolf County, IN

RAL (ppm)	LOAEL-based CUG (4 ppm)			NOAEL based CUG (1.5 ppm)		
	Post-action Number of Fledgling Areas ≥CUG	% Fledgling Areas at Risk Addressed by Action	Post-action % of Total Fledgling Areas<CUG	Post-action Number of Fledgling Areas >CUG	% Fledgling Areas at Risk Addressed by Action	Post-action % of Total Fledgling Areas ≤ CUG
no action	13	0	75	33	0	38
50	9	3	83	31	6	42
40	8	38	85	31	6	42
30	5	62	91	29	12	45
20	3	77	94	26	21	51
15	2	85	96	21	36	60
10	0	100	100	12	64	77
5				0	100	100

CUG - clean up goal
LOAEL - lowest observed adverse effect leve1
NOAEL - no observed adverse effect level
RAL - remedial action level

The effectiveness of different RAL selections in reducing terrestrial ecological risk in the recreational use LMR floodplain is summarized in Table 1. The first column under the LOAEL-based CUG shows the number of fledgling-stage areas that would exceed the CUG after remedial action at different RALs (including no action). The second column shows the percentage of the areas formerly at risk that would no longer represent a potential risk following remedial action, and the third column shows the percentage not at risk out of the total number of fledgling-stage foraging areas considered (53 areas total). The same information is given under the NOAEL-based CUG.

The data show that a RAL of 10 ppm is required to reduce potential risk to less than LOAEL levels in all of the areas under consideration, and a RAL of 5 ppm is necessary to reduce potential risk to NOAEL levels in all areas. Other RAL options are shown to assist in selection of an appropriate RAL that satisfies the nine criteria for remedy selection.

The CUGs are based on modeled reproductive effects in robins (*Turdus migratorius*) feeding on a mixed diet of earthworms, beetles, other soft-bodied insects, and fruit or seeds over the mean foraging area when the young have fledged. Robins serve as a proxy for a variety of birds, mammals, amphibians, reptiles, and invertebrates that feed on similar prey, and therefore share similar exposure pathways. Many species of birds include earthworms in their diets (vermivores). Mammalian vermivores include shrews, moles, skunk, opossum, raccoon, and, surprisingly, fox. Other important vermivores include species of salamanders, toads, frogs, snakes, ants, beetles, and centipedes. All of these animals would be expected to show elevated exposure to PCBs in areas with high soil PCB levels as a result of feeding on earthworm and other soil invertebrate prey that accumulate PCBs from the soil.

The RALs are calculated for robins feeding equally over the mean foraging area utilized after the young have fledged. Robins forage over a much smaller area during the nestling stage, less than one-fifth of the fledgling-stage foraging area. This means that the fledgling-stage-based RALs are probably not protective for robins while they are caring for nestlings. This would apply only to robins that build their nests near the LMR, because soil PCB concentrations decline with lateral distance from the river. However, the RALs are fully protective for robins that nest away from the river, but expand their foraging to include the area up to the river when their young have fledged.

The toxicity reference values (TRVs) used for characterizing risk to robins are based on studies of chicken, which is the most sensitive species to the effects of PCBs of the relatively few bird species tested. This conservative approach is balanced by the non-conservative use of fledgling stage foraging area for calculating the RALs. Also, there are indications that the bioavailabilty of soil PCBs to earthworms and other soil invertebrates may be higher at LMR compared to the site from which the CUGs are derived.

CUG Source and Applicability to the LMR Site

Soil PCB CUGs developed at another Superfund site are applied to the LMR site because site specific investigations of terrestrial ecological risk were not performed at the LMR site (ecological risks were assessed at LMR for PCB-contaminated instream sediments, but not for contaminated floodplain soils). The rationale for not performing a terrestrial ecological risk assessment (TERA) at LMR was that soil PCB CUGs protective of human health (HH) would be protective for terrestrial ecological receptors as well. This is a reasonable assumption for residential scenarios with prolonged exposure durations, but not for recreational scenarios with intermittent exposures to humans. This issue was identified after the field sampling was completed for the remedial investigation (RI). To address the question whether the HH-based RALs developed for recreational scenarios are protective for terrestrial wildlife, ecological RALs are calculated for LMR by combining the wildlife soil PCB CUGs derived at Sheboygan with the soil PCB distribution data collected in the LMR floor for the RL.

A range of soil PCB CUGs of 1.5 ppm no observed adverse effect level (NOAEL) to 4 ppm lowest observed adverse effect level (LOAEL) are adopted from the Sheboygan River and Harbor Floodplain Terrestrial Ecological Risk Assessment, Sheboygan, Wisconsin, November 15, 1999, prepared by James Chapman for USEPA Region 5. The rationale for applying the Sheboygan soil PCB CUGs to the LMR floodplain is that the sites share the same contaminant of concern (PCBs), transport pathway (release of PCBs to rivers and deposition in floodplains during flood events), habitat types (mix of fields, shrubs, and deciduous woods), and potential key receptors (birds, mammals, and other animals that feed on earthworms and other terrestrial invertebrates that accumulate PCBs from contaminated soils). Another similarity between the sites, related to the transport pathway, is that soil PCB concentrations are highest near the respective rivers and decline significantly with distance away from the river.

A key assumption for applying the Sheboygan CUGs to LMR is that the soil-to-earthworm bioaccumulation factors (BAFs) measured at Sheboygan are reasonably representative for LMR, because the exposure and risk models are translated to soil CUGs via the soil-to earthworm BAFs. An important factor affecting bioaccumulation is the total organic carbon (TOC) of the soil. Bioaccumulation of PCBs in earthworms is inversely related to soil TOC (Connell and Markwell 1990). Based on a comparison of soil TOC at the two sites, earthworm PCB bioaccumulation may be higher from most of the LMR soils compared to Sheboygan soils, which means that the Sheboygan CUGs are not overprotective for LMR

The TOC of the soil samples used to determine the earthworm BAF for the Sheboygan TERA ranged from 3.6 to 5.4 % (mean = 4.4%, standard deviation = 0.6, n = 9). TOC was not reported for the LMR floodplain soil samples, but the likely range of values can be calculated based on the type of soils in the LMR floodplain. The soils at the LMR site include the Glynwood-Pewamo-Morley association and the Eel-Sloan-Fox association (Remedial Investigation Report, Revision 1, Sept 24, 2003, prepared by SECOR Intemat. Inc. for United Technologies Corp. and VIACOM, Inc.). The organic matter contents in approximately the upper foot of the soil profile range from 1 - 3 % in Eel, Fox, Glynwood, and Morley soils, 2 - 5 % in Sloan soil, to 3 - 10 % in Pewamo soil (USDA 1987). These values may be converted to approximate TOC by dividing the organic matter content by 1.724 (USDA 1996). The estimated TOC values are 0.6 - 2 % in Eel, Fox, Glynwood, and Morley soils, 1 - 3 % in Sloan soil, and 2 - 6 % in Pewamo soil. Most of the LMR soils have lower TOC compared to the Sheboygan soils, with the sole exception of Pewamo soil which has similar TOC as the Sheboygan soil samples. This indicates that the BAF for LMR earthworms may be higher than for Sheboygan earthworms, which would result in greater uptake of PCBs at LMR compared to Sheboygan (at the same soil PCBs concentrations).

The LMR soil TOC values are estimated, not measured, so firm conclusions regarding the relative bioavailability of soil PCBs between LMR and Sheboygan cannot be made with confidence. However, the available information indicates that bioavailability is likely to be higher for LMR soils than at Sheboygan, and the converse (LMR bioavailability less than at Sheboygan) is unlikely. This in turn indicates that the Sheboygan CUGs are unlikely to be overprotective when applied to LRM floodplain soils, but possibly might be underprotective. The Sheboygan CUGs are not adjusted downward to account for the potential difference in soil PCB bioavailability because the LMR TOC is estimated, not measured.

RAL Calculation

A CUG range corresponding to NOAEL- and LOAEL-based risk estimates consistent with USEPA Superfund guidance on ecological risk (Sect 7.3.1 in USEPA 1997). RALs are calculated for 53 robin fledgling-stage foraging areas, as delineated by Gradient Corp. for the responsibility parties (RPs). The RPs declined to perform RAL calculations for a NOAEL-based CUG, inconsistent with SF guidance, so the information is represented in this memo. The effectiveness of selected RAL options is shown in Table 1.

The LMR recreational-use floodplain areas were divided into 53 areas representing a foraging range of approximately 295 ft on a side by adult robins and their young during the fledgling stage (the nestling-stage foraging area is much smaller, about 126 ft on a side). Existing LMR floodplain data were used to calculate surface-weighted average concentrations (SWAG) for each of the fledgling stage foraging areas. Since soil samples were not collected as far as 295 ft from the LMR in the recreational-use areas, the unsampled portion of the fledgling stage foraging areas were assumed to not have detectable PCBs, as was observed in agricultural fields at equivalent distances from the LMR. Accordingly, the unsampled portions were assigned a soil PCB concentration of 0.165 ppm (½ detection limit). The SWAC calculations are shown in Table 4.

RAL calculations are shown in Table 5 for the 13 fledgling-stage foraging areas with SWACs that equaled or exceeded the LOAEL-based CUG of 4 ppm, and in Table 6 for the 33 areas with SWACs that exceeded the NOAEL-based CUG of 1.5 ppm. The LOAEL-based RALs differ somewhat from those calculated by Gradient Corp. for two reasons: Gradient started with the highest of three LOAEL-based CUGs calculated through three approaches, while the central value is used in this memo (consistent with the selection at the Sheboygan River and Harbor Superfund site from which the CUGs are borrowed), and Gradient used a rounded value for the size of a robin fledgling-stage foraging area, but the unrounded value is used in this memo.

Summary of <u>Sheboygan River and Harbor Floodplain Terrestrial Ecological Risk Assessment</u>, November 15, 1999, prepared by James Chapman, USEPA Ecologist, for USEPA Region 5.

Only the portions of the Sheboygan risk assessment directly related to the soil PCB clean tip goals (CUGs) are included in this summary. In addition to the approaches described in this summary (robin egg PCB and congener models), other risk assessment approaches were also performed (adult robin PCB and dioxin toxic equivalent (TEQ) doses, and robin egg TEQ models), but were not used for calculating Sheboygan soil CUGs. Most approaches gave broadly similar results, but variability was less for the robin egg PCB and congeners models, which, for that reason, were selected for calculation of the soil PCB CUGs.

Site Background

The Sheboygan River and Harbor Superfund site, Wisconsin, includes about 14 river miles from above Sheboygan Falls Dam to the harbor at Lake Michigan. Elevated PCB concentrations were detected in floodplain soils along the Sheboygan River, deposited in portions of the floodplain by episodes of flooding. Discrete sampling revealed a pattern of elevated soil PCB concentrations within approximately 100 ft of the nearest river bank, and much diminished levels at greater distances, along about a 2-mile section of the river. The riparian habitat includes a mix of deciduous woods, scrub-shrub, and grassy fields.

Terrestrial Wildlife PCB Exposure and Ecological Risk Assessment

A terrestrial ecological risk assessment (TERA) was performed to assess the potential risks to terrestrial ecological receptors associated with PCB contamination in floodplain soils, and to calculate ecologically-protective preliminary soil clean up goals (CUGs). The assessment endpoint for the TERA was reproductive performance in terrestrial vermivorous and insectivorous species (feed on earthworms and insects, respectively). The measurement endpoint was modeled reproductive performance in robins. Robins feed predominantly on insects, earthworms and other invertebrates during the breeding and nesting season, and therefore serve as a proxy for a variety of birds, mammals, amphibians, reptiles, and invertebrates that feed on similar prey. While no other species would have exactly the same level of risk as robins-because of differences in dietary composition, foraging behavior, metabolism, susceptibility, and so forth-a finding of risk to robins indicates that other vermivorous species may be potentially at risk as well.

The basis of the TERA was reproductive effects in robins extrapolated from site-specific earthworm contaminant data. Reproductive effects were assessed by modeled uptake of PCBs in robin eggs, which were compared to the results of egg injection studies or to feeding studies in which egg concentrations were measured The results of the risk assessment were translated to soil ecologically-protective preliminary clean up goals (CUGs) by use of site-specific soil-earthworm bioaccumulation factors (BAFs).

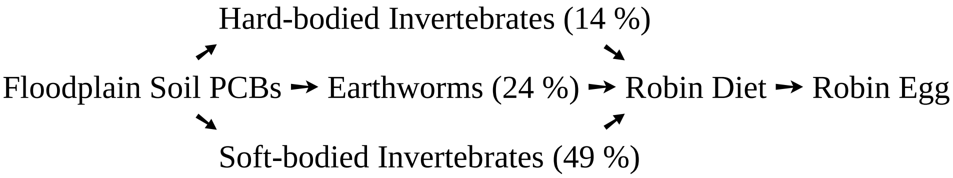
Co-located earthworm and soil samples were collected in the sections of the Sheboygan River floodplain previously shown to have high levels of PCB contamination. Earthworm samples were not depurated, that is, gut contents were not expelled. Undepurated worm data may be considered more realistic for estimating exposure to higher trophic levels because vermivores consume undepurated worms (Beyer and Stafford 1993). An uncertainty with this approach is the bioavailability of the gut content contaminants is usually unknown. In contrast, depurated worm data is useful for estimating the bioavailable component, under the simplifying assumptions that tissue absorbed contaminants are bioavailable and gut content contaminants are unavailable (Stafford and McGrath 1986). Neither assumption holds in all cases-absorbed contaminants may be sequestered in an unavailable form, and some studies have shown increased bioavailability of contaminants in earthworm casts, that is, following excretion from the worms (Ireland 1983).

PCB congeners were analyzed by Axys Analytical Services by two methods: high resolution for 3 non-*ortho*-substituted congeners (77, 126 and 169), 8 mono-*ortho*-substituted congeners (105, 114, 118, 123, 156, 157, 167, and 189), and 2 di-*ortho*-substituted congeners (170 and 180) (draft EPA Method 1668, 10/4/95, high resolution gas chromatography/high resolution mass spectrometry); and low resolution for 101 congeners, singly or in combination. Total PCBs were calculated as the sum of detected PCB congeners.

The robin dietary composition presented in the Wildlife Exposure Factors Handbook (USEPA 1993) was based on young (3 - 35 d) robin gut content analyses reported by Howell (1942). It included 19.5 % grass, which is probably not a food item (the author stated “its presence is accidental”). If grass is indigestible by robins, it should not be included in the dietary composition (unless the ingestion rate derivation includes non-food components). The robin ingestion value described below was based on laboratory feeding studies that did not include extraneous non-food items (Levey and Karasov 1989). So the grass component was subtracted from Howell’s Table 8, and the percentage composition of the remaining dietary items were recalculated “Traces of animal matter” (5 %) were added to the earthworm category (18.6 %) to partially compensate for the likely under representation of soft-bodied worms in gut analysis, far a final earthworm value of 23.6 % of the diet excluding grass. Similarly, the beetles category became 14.4 %. The percentage soft-bodied invertebrates (other than earthworms) was calculated by subtracting the earthworm and beetle values from the total animal matter (87.2 % excluding grass), for a value of 49.2 % (all wet weight percentages).

PCB dietary exposure to robins feeding in the contaminated floodplain was calculated for consumption of three broad categories of prey: earthworms, hard-bodied invertebrates (beetles), and soft-bodied invertebrates (other than earthworms) (Figure 1). Several other potential exposure pathways were not included in the model as discussed below.

Figure 1. Robin PCB Exposure Model, Sheboygan River Floodplain, WI.



Measured values: soil and earthworm PCB concentrations (congener-specific and total PCBs).
Modeled values: PCB concentrations in hard- and soft-bodied invertebrates, and in robin eggs.
Contribution to robin diet in parentheses (percentage of total food mass).

“Incidental” soil ingestion, the soil consumed along with prey, was not separately estimated because the earthworms were not depurated (gut contents were not emptied before performing chemical analyses). Earthworm gut contents account for roughly 30 % of the total undepurated dry weight (Stafford and McGrath 1986). The estimated dry-weight faction of soil in the diets of birds that feed on soil invertebrates ranges from 10 % in the highly vermivorous woodcock to 7 - 30 % in insectivorous sandpipers (Beyer, et al. 1994). Since these values are not higher than the gut content fraction of the earthworms analyzed for PCBs, the “incidental” soil term is likely included in the undepurated earthworm data and therefore was not separately (and redundantly) estimated.

The 13 % contribution of fruit and vegetable matter in the robin diet was not included in the PCB exposure model. Plants do not as a rule absorb PCBs directly from soil or translocate PCBs from roots to aboveground tissues. This does not mean that aboveground plant parts have no exposure to soil PCBs. The exposure pathways include volatilization of soil PCBs to the air followed by absorption or adherence on plant surfaces, and direct transfer of PCB-containing soil particles to plant surfaces through wind-borne dust (Puri, et al. 1997). PCB concentrations in plants are usually orders of magnitude lower compared to the PCB concentrations in animals. This is reflected in large differences in PCB accumulation in animals that feed on plants (herbivorous) or seeds (granivorous) versus animals that prey on other animals for part (omnivorous) or all of their diet. For example, omnivorous mammals accumulated about 20 times more PCBs in their fat tissue compared to herbivorous mammals in the same area, and omnivorous or predaceous birds accumulated 90 to 1000 times more PCBs in their livers compared to granivorous birds (Hoshi, et al. 1998). This demonstrates that terrestrial PCB exposures through feeding on plants are minor compared to the exposures associated with animal prey.

Three potential exposure pathways were excluded from the dose model because they are expected to account for only a small fraction of the total dose: water ingestion, dermal uptake and inhalation.

The ingestion rate was based on laboratory studies that determined robin ingestion rates separately for frugivory and insectivory, feeding on fruit and insects, respectively (Levey and Karasov 1989). The normalized ingestion rate for a diet of crickets (0.31 g/g_{bw}-d) is much lower than the frugivorous ingestion rates given in the Wildlife Expose Factors Handbook (089-1.52 g/g_{bw}-d) (USEPA 1993). An uncertainty associated with 1aboratory studies is that the ingestion rate may be lower than in wild birds because laboratory birds are less active. However, the ingestion rate in the Levey/Karasov study for a banana mash diet (0.99 g/g_{bw}-d) falls within the lower range of the other frugivorous studies (all wet weights), which lends credence to the approach and results of the Levey/Karasov study.

The details of Levey and Karasov (1989) were as follows: n =10, initial robin bodyweight = 77.8 g_o feeding period = 3 d (after acclimation), cricket ingestion = 6.8 g_{dw}/d, cricket moisture content (mc) =72 %, banana mash ingestion = 11.6 g_{dw}/d, banana mash mc = 85 % (ingestion values are dry weight (dw)). On a ww basis, the ingestion values were: cricket = 24.3 $g_{ww/}$d and banana mash = 77.3g_{ww}/d. The corresponding bodyweight-normalized ingestion rates were 0.31 and 0.99 g_{ww}/g_{bw}-d, respectively.

After removing the grass component from the robin dietary composition (Howell 1942), the overall diet was 13 % fruit and seeds, and 87 % animal matter. The overall ingestion rate based on Levy and Karasov (1989) was calculated as:

$$IR = (IR_a * fd_a) + (IR_{fr} * fd_{fr}) \qquad [1]$$

where IR is the ingestion rate and fd the fraction of the diet for animals (a) and fruit (fr).

Equation 2 was solved as (0.31 g_{ww}/g_{bw}-d) (0.87) + (0.99 $g_{ww/}g_{bw}$-d) (0.13) = 0.398 g_{ww}/g_{bw}-d, which should be reasonably representative for the breeding/nesting period.

Concentrations of PCB congeners in soft-bodied invertebrates (other than earthworms) were estimated from the measured earthworm values using the ratio of soft-bodied invertebrate/earthworm concentrations of dioxin measured in field studies of paper sludge applications in pine plantations (equation 2). Martin, et al. (1987) reported undepurated earthworm concentration (mean 35.8 ppt), and Thiel, et al. (1988) reported undepurated soft-bodied invertebrate concentration (mean 2.7 ppt). The soft-bodied invertebrates included crickets, cockroaches, tent and other caterpillars, larvae, and spiders. Based on these studies, soft-bodied invertebrates were assumed to have 0.08 of the PCB concentration in earthworms at any particular sample location.

$$C_{si} = C_{ew} * CR_{si} \qquad [2]$$

where C is the ww PCB or congener concentration in soft-bodied invertebrates (si) and earthworms (ew), and CR_{si}, is the concentration ratio between earthworms and soft bodied invertebrates (0.08).

The same approach was followed for estimating concentrations in hard-bodied invertebrates (beetles) (mean undepurated dioxin concentration of 6.2 ppt) (Thiel, et al. 1988). Based on these studies, hard-bodied invertebrates were assumed to have 0.17 of the PCB concentration in earthworms.

$C_{hi} = C_{ew} * CR_{hi}$ [3]

where C is the ww PCB or congener concentration in had-bodied invertebrates (hi) and earthworms (ew), and CR_{hi} is the concentration ratio betweens and hard-bodied invertebrates (0.17).

These equations were applied to earthworms data for total PCBs an individual congeners to derive the respective soft- and hard-bodied invertebrate concentrations. The main uncertainty is to what degree relative dioxin bioaccumulation among different categories of terrestrial invertebrates reflects relative PCB bioaccumulation among the same groups. The estimates were based on dioxin studies because studies of relative PCB bioaccumulation were not located for terrestrial invertebrate exposures.

The overall concentration of PCBs in the robin diet was calculated as:

$C_{diet} = (C_{ew} * fd_{ew}) + (C_{hi} * fd_{hi}) + (C_{si} * fd_{si})$ [4]

where C is ww PCB or congener concentration and fd the fraction of diet for earthworms (ew), hard-bodied invertebrates (hi) and soft-bodied invertebrates (si).

An empirical approach was used to estimate concentrations of PCBs in robin eggs. PCB diet-to-egg BMFs were taken from two sets of studies of piscivorous (fish-eating) birds and their prey in the Great Lakes: spottail shiner (*Notropis hudsonius*) to Forster's tem (*Sterna fosteri*) eggs (Kubiak, et al. 1989), and alewife (*Alosa pseudoharengus*) to herring gull (*Larus argentatus*) eggs (Braun and Norstrom 1989; Norstrom pers. comm. in Hoffman, et al. 1996). The values are listed in Table 2.

Table 2. PCB Diet-to-Egg Biomagnification Factors (BMF) (wet weight basis).

PCB Congener	Alewife to Gull Egg[a]	Spottail Shiner to Tem Egg[b]
77	1.8	0.17
105	20	-
126	29	64
Total PCBs	31.7	-

a) Braune and Norstrom (1989); Norstrom pers. comm in Hoffman, et al. (1996)

b) Kubiak, et al (1989)

Modeling of dioxin-like congener egg uptake was limited by the availability of congener-specific diet-to-egg BMFs and congener-specific egg toxicity values. Although only 3 of the 12 PCB congeners with dioxin-like toxicity we modeled, the selected congeners accounted for most of the dioxin-like toxicity due to the PCBs. For example, just congeners 77 and 126 contributed 98 % of the total dioxin toxic equivalents (TEQ) in the worm samples.

The toxicity reference value (TRV) for total PCBs was based on a study of chicken (*Gallus domesticus*) fed field-contaminated common carp (*Ciprinus carpio*) collected from the Saginaw River, Lake Huron, MI (Summer, et al.

1996a, b). Different treatment doses were obtained by diluting the carp with chicken feed. Egg TRVs were selected on the basis of reproductive effects reported in Summer, et al. (1996b). Hatchability decreased by 18 % in the high-dose treatment relative to the control (weeks 4 - 8 post-exposure), and total embryo/chick deformities increased 2.3 times (over the entire experimental period including the 2-week acclimation). deformities increased 1.4 times in the low-dose treatment relative to the control, but hatchability was unaffected. The overall deformity rates were 17, 24, and 40 % for the control, low-, and high-doses, respectively. The data were not statistically analyzed by the authors, but the increases in deformity rates were statistically discernible for both the low- and high-dose treatments (Kathy Patnode, WDNR, pers, comm.). For the purposes of the risk assessment, the high-dose treatment was selected as the lowest observed adverse effect level (LOAEL), that is, the lowest dose in which a toxic effect was detected. This was based on the decrease in hatchability and the large increase in deformities. The low-dose treatment was selected as the no observed adverse effect level (NOAEL), the highest dose in which toxic effects were not detected. This was based on the lack of effect on hatchability and the comparatively low increase in deformities. In other words, despite the statistical “significance” of the low-dose deformity rate compared with controls, the effect was not considered to be biologically significant, especially since hatchability was unaffected. In contrast, the more than doubling of deformity rates accompanied by decreased hatchability in the high dose treatment was considered a biologically significant effect. Eggs were analyzed weekly for total PCBs (sum of Aroclors 1242, 1248, 1254 and 1260) for each treatment (Summer, et al. 1996b). The highest egg concentration of the last 3 weeks of the experiment (when levels appear to have reached a plateau) was selected for the no observed adverse effect concentration (NOAEC): 5 mg PCB/kg egg in the low-dose treatment. The lowest egg concentration of the last 3 weeks of the experiment was selected for the lowest observed adverse effect concentration (LOAEC): 24 mg PCB/kg egg in the high-dose treatment. Both concentrations are wet weight (ww).

The apparent toxicity of PCB congener 126 injected into chicken egg yolks was shown to be inversely related to the injection volume. The lethal concentration to 50 % of the embryos ($LC_{50,}$) was 0.6 µg 126/kg egg (ww) for an injection volume of 1 µL/g egg (Powell, et al. 1996a), but was 2.3 µg 126/kg egg (less toxic) for an injection volume of 0.1 µL/g egg (Powell, et al. 1996b). The latter study was used for deriving the egg TRV. Nine doses were injected from 0 to 12.8 µg 126/kg egg. Statistically discernible increases in developmental abnormalities and in embryo mortalities occurred at 3.2 µg 126/kg egg (22 % abnormalities vs. 0 in controls, and 92 % mortality vs. 6 - 9 % in controls), which was selected for the LOAEC. The next lowest dose was selected for the NOAEC (3% abnormalities and 22% mortality).

Powell, et al. (1996a) also investigated the effects of PCB congener 77 in chicken eggs at the higher injection volume, but did not repeat the study with the lower injection volume. Six doses were injected from 0 to 81 µg 77/kg egg (ww). Embryo abnormalities increased 3-fold at 9 µg 77/kg egg, but were not statistically discernible from controls. Abnormalities increased 4-fold at 27 µg 77/kg egg compared with controls (a statistically discernible increase). Mortality was statistically elevated for doses 9 µg 77/kg egg (67 % mortality) and 27 µg 77/kg egg (100 %) compared with the vehicle control[1] (40 %). Under the assumption that the toxicity of congener 77 would have been lower if the study have been repeated with a smaller injection volume, as was shown for congener 126, the LOAEC was set at 27 µg 77/kg egg and the NOAEC at 9 µg 77/kg egg (shifted one dose level upwards from the results based on mortality).

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[1] Vehicle control refers to eggs injected with the solvent (the vehicle) by itself, that is without the addition of the chemical under investigation.

The PCB congener 105 egg TRVs were based on the same study used for congener 77 (Powell, et al. 1996a). Six doses were injected from 0 to 8100 µg 105/kg egg (ww). Embryo abnormalities increased 4- to 7-fold at 8100 µg 105/kg egg, but were not statistically discernible from controls. Mortality was statistically elevated at 8100 µg 105/kg egg (84 %) compared with the vehicle control (40 %). The LOAEC was set at 8100 µg 105/kg egg and the NOAEC at 2700 µg 105/kg egg. The results were not shifted to account for the injection volume effect because the LOAEC was the highest dose in the study.

Risk to robins was evaluated by calculating hazard quotients (HQs):

$$HQ = \text{Modeled egg concentration} / TRV \qquad [5]$$

where TRV is the toxicity reference value for either the NOAEC or LOAEC in eggs for the chemical under consideration (total PCBs or specific congeners). HQs less than 1 indicate that modeled egg concentrations are below levels of concern, therefore adverse effects are considered unlikely. HQs equal to or greater than 1 indicate that modeled egg concentrations are at or above levels of concern, therefore robins are at risk of adverse effects.

Three congener-specific risk estimates were made (congeners 77, 126, and 105) for eggs. Under the assumption that the congener-specific effects are additive, the congener-specific HQs were summed to an overall hazard index (HI):

$$HI = HQ_{77} + HQ_{126} + HQ_{105} \qquad [6]$$

Clean Up Goals

Egg-based risk estimates were less variable than oral dose-based estimates (not described in this summary), so the egg models were used to back-calculate soil ecologically protective clean up goals (CUGs). CUGs were calculated on the basis of total PCBs, and two congener-specific models that differed in the biomagnification factors used to estimate egg congener concentration from the robin dietary concentration.

The procedure for calculating ecologically protective soil CUGs on the basis of total PCBs began with the total PCB TRVs for eggs corresponding to the NOAEC and LOAEC. Ecologically protective robin dietary concentrations were calculated by dividing the egg PCB TRVs by the diet-to-egg biomagnification factor (BMF). Ecologically protective earthworm concentration were calculated by combining and rearranging equations 2 through 4:

$$EPC_{ew} = EPC_{diet} / [fd_{ew} + (CR_{si} * fd_{si}) + (CR_{hi} * fd_{hi})] \qquad [7]$$

where EPC is ecologically protective concentration, fd is fraction of robin diet, and CR is the concentration ratio between earthworms and other invertebrates, for earthworms (ew), robin diet (diet), soft-bodied invertebrates (si), and hard-bodied invertebrates (hi).

Ecologically protective soil CUGs were back-calculated from protective earthworm concentrations by dividing the earthworm concentration by the soil-earthworm bioaccumulation factor (BAF) (equation 8). The BAF, calculated from site-specific data, represents the ratio of earthworm wet weight concentration to soil dry weight concentration.

$$BAF = C_{ew}\ (ww) / C_s\ (dw) \qquad [8]$$

where C is the concentration of total PCBs or specific congeners in earthworm (ew) (wet weight) and soil (s) (dry weight).

Soil CUGs were also back-calculated on a congener-specific basis. The procedure was similar to the one described for total PCBs with two modifications. First, the TRV of a designated congener had to be adjusted so that, after calculating the soil CUG, the sum of congener-specific HQs would equal a HI of 1. Three congeners were included in the congener-specific HI (congeners 77,126, and 105). If the TRV of one congener was used to back-calculate the soil CUG, the HQ for that congener would then equal 1, but the HI would be greater than 1 because of the contribution of the other two congener-specific HQs to the overall HI. To avoid this problem, the TRV of the congener making the greatest contribution to the HI was adjusted by multiplying the TRV by the ratio of that congener's HQ to the HI:

$$TRV_{adj} = TRV_i * (HQ_l / HI) \qquad [9]$$

where TRV_{adj} is the adjusted toxicity reference value of the individual congener (I) making the greatest contribution to the HI. For example, if the congener 126 HQ accounted for 80 % of the HI, the adjusted TRV would be 0.8 times the TRV for congener 126. The adjusted TRV would then be used to back-calculate the soil CUG.

The second modification was to add an additional step to convert the back-calculated soil CUG from a congener concentration to a total PCB concentration. This was accomplished by dividing the back-calculated congener CUG by the site-specific ratio of that congener to the total PCB concentration in soil:

$$\text{Congener:PCB Ratio} = \text{Congener concentration} / \text{Total PCB concentration} \qquad [10]$$

The results were checked by calculating the soil concentrations of the other two congeners corresponding to the total PCB CUG by use of their respective congener:PCB ratios, rerunning the egg bioaccumulation model, recalculating the three congener-specific HQs, and verifying that the HI (sum of the congener-specific HQs) equals 1.

The calculated soil PCB clean up goals are shown in Table 3. The CUGs are similar for the 3 approaches (total PCBs, and two congener-specific approaches with different congener-specific diet-to-egg BMFs for the modeled congener uptake to eggs). The central values (shown in bold-NOAEC-based CUG of 1.5 ppm, and LOAEC-based CUG of 4 ppm) were selected as best representing the soil CUG at Sheboygan. The central values were the basis for additional calculations to account for site-specific area use at Sheboygan (foraging over both heavily contaminated areas bordering the river and less contaminated land farther from the river), which served a similar purpose as the remedial action level (RAL) calculations at LMR.

Table 3. Ecologically Protective Soil Clean Up Goals (CUGs), Sheboygan River Floodplain, WI.

Toxicity Basis	NOAEC-based CUG	LOAEC-based CUG
	(ppm total PCBs)	
Total PCBs [a]	1	**4**
Congener-specific [b]	**1.5**	3
Congener-specific [c]	2	5

a) Modeled with gull diet-to-egg BMF (Braune and Norstrom 1989).
b) Modeled with tem BMF (Kubiak, et al. 1989).
c) Modeled with gull BMF (Norstrom pers. Comm. in Hoffman. et al. 1996).

Robin Foraging Areas

The foraging range of robins varies according to the life stage. Parental robins forage over a smaller area while feeding nestling (1472 m^2) than while caring for fledglings (8080 m^2) (mean values, n = 24 pairs) (Weatherhead and McRae 1990).[2] For the purposes of the risk assessment, the foraging range was assumed to be square (compare with Figure 3 of Weatherhead and McRae 1990). Converted to feet, the nestling and fledgling foraging ranges are 15,845 and 86,972 ft^2, respectively. For square ranges, this is equivalent to 126 x 126 ft for a nestling-stage range, and 295 x 295 ft for a fledgling-stage range. Note: the nestling-stage range refers solely to the adult foraging area, the fledgling-stage range refers to both adult and fledgling foraging area

The nestling-stage and fledgling-stage foraging areas of a single breeding pair have been shown to overlap, that is, the fledgling-stage area is an expansion of nestling-stage area, not displaced to a different location (Weatherhead and McRae 1990). Robins have been reported to utilize different portions of their foraging area “on a fairly regimented schedule”, roughly every hour in one example (Swihart and Johnson 1986). The investigators speculated that cyclic use of territory may be related to renewal of prey items. The main point for risk assessment purposes is that robins are expected to receive integrated exposures from throughout their foraging area (except for differences in habitat quality that markedly alter prey availability).

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[2] Several studies of robin foraging and territory size were considered. Weatherhead and McRae (1990) was selected because it provided information on foraging and not just territory, showed changes in foraging areas as development of young progresses, and showed the geometry of the areas. All adult robins in the study area were caught and color-banded. Foraging observations were made by researchers who “regularly walked through the study area and mapped the location and identity of every robin they saw”. These observations were made “nearly every day of the study”, which ran from late April to mid-August in 1987 and 1988, and were collected “over all daylight hours”. Home ranges were calculated for 24 parents with sufficient observations for both nestling and fledgling stages. The resulting estimates have high precision: mean nestling-stage foraging area of 1472 ± 205 m^2, of, and mean fledgling-stage foraging area of 8080 ± 13 19 m^2 (± SE). Nearly 90 % (21 out of 24) of the individual comparisons showed a consistent difference between the nestling-and fledgling-stage foraging areas. The territory sizes given in four other robin studies summarized in USEPA (1993) are 0.11, 0.12, 0.21, 0.21 and 0.42 ha, compared with 0.15 ha for nestling-stage foraging area and 0.81 ha for fledgling-stage foraging area based on Weatherhead and McRae.

There are several uncertainties associated with the foraging area assumptions. Much smaller robin foraging areas (7900 ft^2) have been reported (Howell 1942) than the ones used in the ERA (about one-half and one-tenth of the aforementioned nestling-stage and fledgling-stage foraging areas, respectively), which, if applicable to the site, would increase exposure and risk estimates. The assumptions of square foraging geometry and equal use of all portions of the foraging area are also of uncertain applicability to the site if robins preferentially forage closer to the river. Preferential foraging in floodplain areas closer to the river might occur because of differences in soil moisture, overstory vegetation, and/or soil organic matter accumulations that favor earthworms in comparison with more distant floodplain habitats, for example, under a tree line new the river bank compared with open fields further from the river.

Uncertainty

All risk assessments require that judgements be made on the choice of exposure pathways and species to evaluate, the studies to utilize, and the additional parameter values and extrapolations needed to calculate exposures and risks. The alternative would be to pursue open-ended investigations to reduce all uncertainties. At some point, cost, time, and manpower constraints limit all such efforts. All risk assessments (and field investigations) therefore unavoidably have uncertainties, that is, unresolved questions that could be addressed with feather research

Several factors may have resulted in overestimation of risk. One is that the TRVs were derived from studies of chickens. Chickens are the most sensitive to the reproductive effects of PCBs of the relatively few species of birds investigated. The sensitivity of robins, or other likely vermivorous species, relative to chicken is unknown, but is presumably less than for chickens. However, the egg LOAEC based on chicken used in the TERA is higher than those reported for bald eagles and several species of terns in field studies.

Another issue is the Summer, et al. (1966) study relied on naturally contaminated Saginaw Bay carp for dosing chickens with PCBs. This means that other contaminants may have contributed to the observed toxicity in addition to PCBs. Again, the total PCB TRV from this study is higher than those reported from field studies, but other contaminants may have also contributed to the effects observed in the field studies. However, this is not an issue for the studies used for the TRVs for PCB congeners 77, 105, and 126, because the congeners were injected into the eggs (Powell, et al. 1996 a and b). Since both approaches resulted in similar risk estimates, this indicates that other contaminants did not significantly contribute to the observed toxicity in the Summer, et al. (1996) study.

The insectivorous robin ingestion value used in the TERA is much lower than the frugivorous ones reported in the Wildlife Exposures Factor Handbook (USEPA 1993). The decrease is expected because insects are more nutritious than fruit, but part of the decrement may also be due to the fact that the study used for the insectivorous value was performed in a laboratory setting. Captive birds are less active than wild birds, and do not have to cope with weather extremes, and therefore require less food than wild birds to maintain bodyweight. However, captive birds might eat more than wild counterparts because of easy food availability and boredom. In any case, the frugivorous ingestion rate estimate from the same laboratory study used for the insectivorous ingestion rate corresponds to the lower range of the frugivorous rates given in USEPA (1993), which increases confidence in the insectivorous rate derived from the same study.

Some potential exposure pathways were omitted: incidental soil ingestion, water consumption, inhalation, and fruits and seeds. The latter three were considered insignificant. The former was not modeled separately because the earthworm data were for undepurated worms. If any of these assumptions are incorrect, the exposure would be underestimated.

The TRVs were not always the lowest values reported in the literature, based on judgements regarding the quality or applicability of the studies. Also, no uncertainty or conversion factors were used. These factors are often applied to decrease the TRVs to account for possible differences in species sensitivities, or to compensate for study limitation. Such factors were not applied in the TERA because the toxicological studies were performed with a species known to be highly sensitive to PCBs.

The size of the robin fledgling-stage foraging area used for the RAL calculations is substantially larger than other robin foraging areas reported in the literature (USEPA 1993). If robins utilize smaller foraging areas, their exposure and risk levels would be higher than estimated in the TERA. RAL calculations were not performed for robin nestling-stage foraging area, which is less than one-fifth of the fledgling-stage foraging area. This means that the RALs are probably not protective for robins that nest close to the river (during the nestling stage). However, the RALs are fully protective for robins that nest away from the river, but expand their foraging to include the area by the river when their young have fledged.

The lower TOC of most of the LMR soils compared to the Sheboygan soils indicates that bioaccumulation of PCBs from soil to earthworms and other soil invertebrates may be higher at LMR than at Sheboygan. If so, the Sheboygan CUGs would be underprotective when applied to the LMR floodplain. This is uncertain because TOC was estimated for LMR soils (not measured), and earthworm bioaccumulation studies have not been performed at LMR

References

Beyer, W. and C. Stafford. 1993. Survey and evaluation of contaminants in earthworms and in soils derived from dredged material at confined disposal facilities in the Great Lakes region. Environ Monit Assessm 24: 151-165.

Beyer, W.N., E. Connor and S. Gerould. 1994. Estimates of soil ingestion by wildlife. J Wildl Manage 58: 375-382.

Braune, B. and R. Norstrom. 1989. Dynamics of organochlorine compounds in herring gulls: III. Tissue distribution and bioaccumulation in Lake Ontario gulls. Environ Toxicol Chem 8: 957-968.

Connell, D. and R. Markwell. 1990. Bioaccumulation in the soil to earthworm system. Chemosphere 20: 91-100.

Hoffman, D., C. Rice and T. Kubiak. 1996. PCBs and Dioxins in Birds. *In* Environmental Contaminants in Wildlife, Interpreting Tissue Concentrations. (W. Beyer, G. Heinz and A. Redmon-Norwood, eds.). Lewis, Boca Raton. pp. 165-207.

Hoshi, H., N. Minamoto, H. Iwata, K. Shiraki, R. Tatsukawa, S. Tanabe, S. Fujita, K. Hirai, and T. Kinjo. 1998. Organochlorine pesticides and polychlorinated biphenyl congeners in wild terrestrial mammals and birds from Chubu Region, Japan: interspecies comparison of the residue levels and compositions. Chemosphere 15: 3211-3221.

Howell, J. 1942. Notes on the nesting habits of the American robin (*turdus migratorius* L.). Am Midl Nat 28:529-603.

Ireland, M. 1983. Heavy metal uptake and tissue distribution in earthworm. *In*: Earthworm Ecology, From Darwin to Vermiculture. (J. Satchell, ed.). Chapman & Hall, New York. pp. 247-265.

Kubiak, T., H. Harris, L. Smith, T. Schwartz, D. Stalling J. Trick, L. Sileo, D. Docherty and T. Erdman. 1989. Microcontaminants and reproductive impairment of the Forster's tem on Green Bay, Lake Michigan - 1983. Arch Environ Contam Toxicol 18: 706-727.

Levey, D. and W. Karasov. 1989. Digestive responses of temperate birds switched to fruit or insect diets. Auk 106: 675-686.

Martin, S., D. Thiel, J. Duncan and W. Lance. 1987. Effects of a paper industry sludge containing dioxin on wildlife in red pine plantations. TAPPI Proceedings, 1987 Environmental Conference. TAPPI Press, Atlanta. pp. 363-377.

Powell, D., R. Aulerich, K. Stromborg and S. Bursian. 1996a. Effects of 3,3',4,4'-tetrachlorobiphenyl, 2,3,3',4,4'-pentachlorobiphenyl, and 3,3',4,4',5-pentachlorobiphenyl on the developing chicken embryo when injected prior to incubation. J Toxicol Environ Health 49: 319-338.

Powell, D., R. Aulerich, J. Meadows, D. Tillitt, J. Giesy, K. Stromborg and S. Bursian. 1996b. Effects of 3,3',4,4',5-pentachlorobiphenyl (PCB 126) and 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD) injected into the yolks of chicken (*Gallus domesticus*) eggs prior to incubation. Arch Environ Contam Toxicol 31: 404-409.

Puri, R, Q. Ye, S. Kapila, W. Lower and V. Puri. 1997. Plant uptake and metabolism of polychlorinated biphenyls (PCBs). *In* Wang, W., J. Gorsuch and J. Hughes (eds.). Plants for Environmental Studies. CRC Lewis Publ., Boca Raton. pp. 481-513.

Stafford, E. and S. McGrath. 1986. The use of acid insoluble residue to correct for the presence of soil-derived metals in the gut of earthworms used as bio-indicator organisms. Environ Pollut (Series A) 42: 233-246.

Summer, C., J. Giesy, S. Bursian, J. Render, T. Kubiak, P. Jones, D. Verbrugge, and R Aulerich. 1996a Effects induced by feeding organochlorine-contaminated carp from Saginaw Bay, Lake Huron, to laying white leghom hens. I. Effects on health of adult hens, egg production, and fertility. J Toxicol Environ Health 49: 389-407.

Summer, C., J. Giesy, S. Bursian, J. Render, T. Kubiak, P. Jones, D. Verbrugge, and R. Aulerich. 1996b. Effects induced by feeding organochlorine-contaminated carp from Saginaw Bay, Lake Huron, to laying white leghom hens. II. Embryotoxic and teratogenic effects. J Toxicol Environ Health 49: 409-438.

Swihart, R. and S. Johnson. 1986. Foraging decisions of American Robins: somatic and reproductive tradeoffs. Behav Ecol Sociobiol 19: 275-282.

Thiel, D., S. Martin, J. Duncan, M. Lemke, W. Lance and R. Peterson. 1988. Evaluation of the effects of dioxin-contaminated sludges on wild bird. TAPPI Proceeding, 1988 Environmental Conference. TAPPI Press, Atlanta. pp. 487-506.

USDA. 1987. Soil Survey of Randolf County, Indiana. USDA Soil Conservations Service, Purdue University Agricultural Experiment Station, and Indiana Dept. Natural Resources Soil and Water Conservation committee.

USDA. 1996. Soil Survey Laboratory Methods Manual. Natural Resources Conservation service, National Soil Survey Center. Soil Survey investigation Report No. 42 Version 3.0. http://soils.usda.gov/technical/1mm/

USEPA. 1993. Wildlife Exposure Factors Handbook. vol. I and II. Office of Research and Development. EPA/600/R-93/187a and b. http://cfpub.epa.gov/ncea/cfm/wefh.cfm?ActType=default

USEPA. 1997. Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments, Interim Final. Environmental Response Team, Edison, NJ, EPA 540-R-97-006. http://www.epa.gov/superfund/programs/risk/ecorisk/ecorisk.htm

Weatherhead, P. and S. McRae. 1990. Brood care in American robins: implications for mixed reproductive strategies by females. Anim Behav 39: 1179-1188.

Little Mississinewa River Floodplain PCB Surface-weighted Area Concentration in Recreation Land and Remedial Action Level (RAL) Calculations

Table 4. Robin Fledgling-stage Foraging Area-based Surface-weighted Area Concentration (SWAC) in Recreational Land Along the Little Mississinewa River, Randolf County, IN

SOIL SAMPLE ID	FORAGING AREA ID	SOIL PCB	AREA PER SAMPLE	SAMPLE PCB * AREA	PARTIAL SWAC SOIL PCB	FULL SWAC SOIL PCB
		ppm	ft^2	ppm * ft^2	ppm	ppm
FEG13-S	1	13	1268	16484		Fledgling stage foraging area – 86972 ft^2
FEG14-S	1	24	1268	30432		
FEG15-S	1	36	1268	45648		
FEG16-S	1	54	1174	63396		Unsampled PCB – 0.165 ppm
FEG17-S	1	84	1174	98616		
FEG18-S	1	61	1174	71614		
FEG38-S	1	47	1184	55648		
FEHSA2-S	1	35	9386	328510		
FEHSA3-S	1	0.17	14608	2483.36		
FEHSA4-S	1	10	26267	262670		
Total or *Mean*	1	*36.42*	58771	975501.36	16.60	11.27
% Foraging area	1		**67.57**			
FEHSA5-S	2	2.9	17750	51475	2.90	0.72
% Foraging area	2		**20.41**			
FEHSA6-S	3	1.4	16840	23576	1.40	0.40
% Foraging area	3		**19.36**			
FEG19-S	4	53	1252	66356		
FEG20-S	4	68	1252	85136		
FEG21-S	4	91	1252	113932		
FEG22-S	4	150	1252	187800		
FEG23-S	4	15	1076	16140		
FEG24-S	4	31	1076	33356		
FEG25-S	4	110	1076	118360		
FEG26-S	4	17	1076	18292		
FEHSA7-S	4	66	8015	528990		
FEHSA8-S	4	39	20261	790179		
Total or *Mean*	4	*64.00*	37588	1958541	52.11	22.61
% Foraging area	4		**43.22**			
FEHSA9-S	5	8.2	23775	194955	8.20	2.36
% Foraging area	5		**27.34**			
FEHSA10-S	6	1.6	22440	35904	1.60	0.54
% Foraging area	6		**25.80**			
FWG12-S	7	4.2	1334	5602.8		

Table 4. Robin Fledgling-stage Foraging Area-based Surface-weighted Area Concentration (SWAC) in Recreational Land Along the Little Mississinewa River, Randolf County, IN

SOIL SAMPLE ID	FORAGING AREA ID	SOIL PCB	AREA PER SAMPLE	SAMPLE PCB * AREA	PARTIAL SWAC SOIL PCB	FULL SWAC SOIL PCB
		ppm	ft^2	ppm * ft^2	ppm	ppm
FWG13-S	7	16	1334	21344		
FWG14-S	7	16	1334	21344		
FWG15-S	7	31	1143	35433		
FWG16-S	7	15	1143	17145		
FWG40-S	7	4.1	1360	5576		
FWG41-S	7	22	1360	29920		
FWG42-S	7	57	1360	77520		
FWHSA5-S	7	2.6	18288	47548.8		
Total or *Mean*	7	*18.66*	28656	261433.6	9.12	3.12
% Foraging area	7		**32.95**			
FWHSA6-S	8	5.4	24966	134816.4	5.40	1.67
% Foraging area	8		**28.71**			
FWHSA7-S	9	7.9	23639	186748.1		
FWG17-S	9	18	1239	22302		
FWG18-S	9	21	1239	26019		
FWG19-S	9	9.5	1239	11770.5		
Total or *Mean*	9	*14.10*	27356	246839.6	9.02	2.95
% Foraging area	9		**31.45**			
FWG20-S	10	60	1089	65340		
FWG21-S	10	59	1089	64251		
FWHSA8-S	10	50	23788	1189400		
Total or *Mean*	10	*56.33*	25966	1318991	50.80	15.28
% Foraging area	10		**29.86**			
FWHSA10-S	11	1.6	21939	35102.4		
FWHSA9-S	11	37	18989	702593		
Total or *Mean*	11	*19.30*	40928	737695.4	18.02	8.57
% Foraging area	11		**47.06**			
GEHSA1-S	12	2.1	8287	17402.7	2.10	0.35
% Foraging area	12		**9.53**			
GEHSA2-S	13	10	23344	233440	10.00	2.80
% Foraging area	13		**26.84**			
GEHSA3-S*	14	12	24168	290016	12.00	3.45
% Foraging area	14		**27.79**			
GEHSA4-S	15	11	21854	240394	11.00	2.89

Table 4. Robin Fledgling-stage Foraging Area-based Surface-weighted Area Concentration (SWAC) in Recreational Land Along the Little Mississinewa River, Randolf County, IN

SOIL SAMPLE ID	FORAGING AREA ID	SOIL PCB	AREA PER SAMPLE	SAMPLE PCB * AREA	PARTIAL SWAC SOIL PCB	FULL SWAC SOIL PCB
		ppm	ft^2	ppm * ft^2	ppm	ppm
% Foraging area	15		**25.13**			
GEG1-S	16	5.4	1209	6528.6		
GEG2-S	16	11	1209	13299		
GEG3-S	16	13	1209	15717		
GEG4-S	16	19	1209	22971		
GEHSA5-S	16	2.1	17784	37346.4		
Total or *Mean*	16	*10.10*	22620	95862	4.24	1.22
% Foraging area	16		**26.01**			
GEG17-S	17	11	1268	13948		
GEG18-S	17	16	1268	20288		
GEG19-S	17	19	1268	24092		
GEG20-S	17	140	1475	206500		
GEG22-S	17	7.1	1367	9705.7		
GEG5-S	17	13	1267	16471		
GEG6-S	17	20	1267	25340		
GEG7-S	17	23	1267	29141		
GEG8-S	17	20	1267	25340		
GEHSA6-S	17	2.5	24840	62100		
Total or *Mean*	17	*27.16*	36554	432925.7	11.84	5.07
% Foraging area	17		**42.03**			
GWG17-S	18	19	1227	23313		
GWG18-S	18	62	1227	76074		
GWG19-S	18	52	1227	63804		
GWG1-S	18	18	1251	22518		
GWG20-S	18	13	1136	14768		
GWG21-S	18	11	1136	12496		
GWG2-S	18	13	1251	16263		
GWG3-S	18	15	1251	18765		
GWG4-S	18	*25*	1251	31275		
GWG5-S	18	39	1242	48438		
GWG6-S	18	47	1242	58374		
GWHSA4-S	18	1.6	13856	22169.6		
Total or *Mean*	18	*26.30*	27297	408257.6	14.96	4.81
% Foraging area	18		**31.39**			
GWHSA3-S	19	0.15	15998	2399.7	0.15	0.16
% Foraging area	19		**18.39**			
GWHSA2-S	20	0.058	17055	989.19	0.06	0.14

Table 4. Robin Fledgling-stage Foraging Area-based Surface-weighted Area Concentration (SWAC) in Recreational Land Along the Little Mississinewa River, Randolf County, IN

SOIL SAMPLE ID	FORAGING AREA ID	SOIL PCB	AREA PER SAMPLE	SAMPLE PCB * AREA	PARTIAL SWAC SOIL PCB	FULL SWAC SOIL PCB
		ppm	ft^2	ppm * ft^2	ppm	ppm
% Foraging area	20		**19.61**			
GWHSA1-S	21	15	15405	231075	15.00	2.79
% Foraging area	21		**17.71**			
HEG1-S	22	14	5692	79688		
HEG25-S	22	4.3	8637	37139.1		
HEG2-S	22	3.3	5692	18783.6		
HEG3-S	22	3.1	4903	15199.3		
HEG4-S	22	7.9	4903	38733.7		
HEG5-S	22	1.2	7660	9192		
HEG6-S	22	5.4	7660	41364		
Total or *Mean*	22	*5.60*	45147	240099.7	5.32	2.84
% Foraging area	22		**51.91**			
HEG10-S	23	5.4	5843	31552.2		
HEG11-S	23	11	8145	89595		
HEG26-S	23	2.4	6455	15492		
HEG27-S	23	2.5	6455	16137.5		
HEG28-S	23	5.9	9028	53265.2		
HEG38-8	23	0.023	4670	107.41		
HEG7-S	23	4.8	6253	30014.4		
HEG8-S	23	11	6253	68783		
HEG9-S	23	7.1	5843	41485.3		
Total or *Mean*	23	*5.57*	58945	346432.01	5.88	4.04
% Foraging area	23		**67.77**			
HEG12-S	24	10	8145	81450		
HEG13-S	24	10	8705	87050		
HEG29-S	24	0.3	9028	2708.4		
HEG30-S	24	1.1	8804	9684.4		
Total or *Mean*	24	*5.35*	34682	180892.8	5.22	2.18
% Foraging area	24		**39.88**			
HEG14-S	25	40	8705	348200		
HEG15-S	25	2.2	6606	14533.2		
HEG16-S	25	4.3	6606	28405.8		
HEG17-S	25	1.6	8237	13179.2		
HEG18-S	25	3.5	8237	28829.5		
HEG31-S	25	6.7	8804	58986.8		
HEG32-S*	25	6.6	6710	44286		

Table 4. Robin Fledgling-stage Foraging Area-based Surface-weighted Area Concentration (SWAC) in Recreational Land Along the Little Mississinewa River, Randolf County, IN

SOIL SAMPLE ID	FORAGING AREA ID	SOIL PCB	AREA PER SAMPLE	SAMPLE PCB * AREA	PARTIAL SWAC SOIL PCB	FULL SWAC SOIL PCB
		ppm	ft^2	ppm * ft^2	ppm	ppm
Total or *Mean*	25	*9.27*	53905	536420.5	9.95	6.23
% Foraging area	25		**61.98**			
HEG19-S	26	1.2	8576	10291.2		
HEG20-S	26	3.7	8576	31731.2		
HEG21-S	26	7.3	4951	36142.3		
HEG22-S	26	8.7	9164	79726.8		
HEG33-S	26	1.9	7154	13592.6		
HEG34-S	26	1.5	7154	10731		
HEG35-S	26	5.7	8193	46700.1		
HEG39-S	26	1.3	7427	9655.1		
HEG40-S	26	1.9	7127	14111.3		
Total or *Mean*	26	*3.69*	68622	252681.6	3.68	2.94
% Foraging area	26		**78.90**			
HEG23-S	27	7.6	9164	69646.4		
HEG24-S*	27	5.3	6870	36411		
HEG36-S	27	6.7	8193	54893.1		
HEG37-S	27	7.9	7999	63192.1		
HEHSA3-S	27	10	15424	154240		
Total or *Mean*	27	*7.50*	47650	378382.6	7.94	4.43
% Foraging area	27		**54.79**			
HEHSA1-SSUB*	28	31	18978	588318		
HEHSA2-S	28	18	19200	345600		
HEHSA4-S	28	21	9030	189630		
Total or *Mean*	28	*23.33*	47208	1123548	23.80	12.99
% Foraging area	28		**54.28**			
HWHSA11-SSUB*	29	54	37199	2008746		
HWHSA13-S	29	.02	59507	11901.4		
Total or *Mean*	29	*27.10*	96706	2020647.4	20.89	20.89
% Foraging area	29		**111.19**			
HWHSA10-S	30	21	22563	473823		
HWHSA12-S	30	6.2	18077	112077.4		
Total or *Mean*	30	*13.60*	40640	585900.4	14.42	6.82
% Foraging area	30		**46.73**			
HWG30-S	31	9.3	7479	69554.4		
HWG31-S	31	4	8698	34792		

Table 4. Robin Fledgling-stage Foraging Area-based Surface-weighted Area Concentration (SWAC) in Recreational Land Along the Little Mississinewa River, Randolf County, IN

SOIL SAMPLE ID	FORAGING AREA ID	SOIL PCB	AREA PER SAMPLE	SAMPLE PCB * AREA	PARTIAL SWAC SOIL PCB	FULL SWAC SOIL PCB
		ppm	ft^2	ppm * ft^2	ppm	ppm
HWHSA9-S	31	2.8	18967	53107.6		
Total or *Mean*	31	*5.37*	35144	157454.3	4.48	1.91
% Foraging area	31		**40.41**			
HWG27-S	32	4.7	7102	33379.4		
HWG28-S	32	6.8	7102	48293.6		
HWG29-S	32	15	7479	112185		
HWHSA8-S	32	0.97	27406	26583.82		
Total or *Mean*	32	*6.87*	49089	220441.82	4.49	2.61
% Foraging area	32		**56.44**			
HWHSA7-S	33	1.8	15099	27178.2	1.80	0.45
% Foraging area	33		**17.36**			
HWG24-S	34	5.4	7582	40942.8		
HWG25-S	34	9.7	7582	73545.4		
HWG26-S*	34	3	3935	11805		
HWHSA6-S	34	3.5	22340	78190		
Total or *Mean*	34	*5.40*	41439	204483.2	4.93	2.44
% Foraging area	34		**47.65**			
HWG20-S	35	7.6	6682	50783.2		
HWG21-S	35	8	6682	53456		
HWG22-S	35	3.2	7216	23091.2		
HWG23-S	35	5.5	7747	42608.5		
HWHSA4-S	35	0.83	26436	21941.88		
HWHSA5-S	35	21	16865	354165		
Total or *Mean*	35	*7.69*	71628	546045.78	7.62	6.31
% Foraging area	35		**82.36**			
HWG18-S	36	1.4	7040	9856		
HWG19-S	36	2	7040	14080		
HWHSA3-S	36	0.19	19930	3786.7		
Total or *Mean*	36	*1.20*	34010	27722.7	0.82	0.42
% Foraging area	36		**39.10**			
HWG14-S	37	16	6359	101744		
HWG15-S	37	6.9	5033	34727.7		
HWG16-S	37	10	5033	50330		
HWG17-S	37	3.3	7397	24410.1		
HWHSA1-S	37	0.042	18041	757.722		

Table 4. Robin Fledgling-stage Foraging Area-based Surface-weighted Area Concentration (SWAC) in Recreational Land Along the Little Mississinewa River, Randolf County, IN

SOIL SAMPLE ID	FORAGING AREA ID	SOIL PCB	AREA PER SAMPLE	SAMPLE PCB * AREA	PARTIAL SWAC SOIL PCB	FULL SWAC SOIL PCB
		ppm	ft^2	ppm * ft^2	ppm	ppm
HWHSA2-S	37	1.6	9553	15284.8		
Total or *Mean*	37	*6.31*	51416	227254.322	4.42	2.68
% Foraging area	37		**59.12**			
HWG10-S	38	18	6305	113490		
HWG11-S	38	10	7373	73730		
HWG12-S	38	0.85	7373	6267.05		
HWG13-S	38	1.5	6359	9538.5		
HWG9-S	38	12	6305	75660		
Total or *Mean*	38	*8.47*	33715	278685.55	8.27	3.31
% Foraging area	38		**38.77**			
HWG5-S	39	10	7835	78350		
HWG6-S	39	0.019	7835	148.865		
HWG7-S	39	2.9	7272	21088.8		
HWG8-S	39	14	7272	101808		
Total or *Mean*	39	*6.73*	30214	201395.665	6.67	2.42
% Foraging area	39		**34.74**			
HWG1-S	40	2.4	6664	15993.6		
HWG2-S	40	2.9	6664	19325.6		
HWG3-S	40	0.69	6585	4543.65		
HWG4-S	40	0.69	6585	4543.65		
Total or *Mean*	40	*1.67*	26498	44406.5	1.68	0.63
% Foraging area	40		**30.47**			
IEG11-S	41	1.2	10064	12076.8		
IEG12-S	41	0.51	10064	5132.64		
IEG1-S	41	2.3	8029	18466.7		
IEG2-S	41	3.8	8029	30510.2		
IEG3-S	41	1.3	5278	6861.4		
IEG4-S	41	1.1	5278	5805.8		
IEG5-S	41	1.6	8870	14192		
IEG6-S	41	9.9	8870	87813		
Total or *Mean*	41	*2.71*	64482	180858.54	2.80	2.12
% Foraging area	41		**74.14**			
IEG7-S	42	0.97	5910	5732.7		
IEG8-S	42	2.1	5910	12411		
IEG9-S	42	2.1	7251	15227.1		
Total or *Mean*	42	*1.72*	19071	33370.8	1.75	0.51

Table 4. Robin Fledgling-stage Foraging Area-based Surface-weighted Area Concentration (SWAC) in Recreational Land Along the Little Mississinewa River, Randolf County, IN

SOIL SAMPLE ID	FORAGING AREA ID	SOIL PCB	AREA PER SAMPLE	SAMPLE PCB * AREA	PARTIAL SWAC SOIL PCB	FULL SWAC SOIL PCB
		ppm	ft^2	ppm * ft^2	ppm	ppm
% Foraging area	42		**21.93**			
IEG10-S	43	1.3	4764	6193.2		
IEHSA1-S	43	4.3	15223	65458.9		
IEHSA2-S	43	1.4	17254	24155.6		
Total or *Mean*	43	*2.33*	27241	95807.7	2.57	1.20
% Foraging area	43		**42.82**			
IEHSA3-S	44	4.9	26955	132079.5	4.90	1.63
% Foraging area	44		**30.99**			
IWG15-S	45	1.1	9255	10180.5		
IWG16-S	45	1.3	9255	12031.5		
Total or *Mean*	45	*1.20*	18510	22212	1.20	0.39
% Foraging area	45		**21.28**			
IWG11-S	46	1.9	8640	16416		
IWG12-S	46	1.9	8640	16416		
IWG13-S	46	2.8	6746	18888.8		
IWG14-S	46	3.2	6746	21587.2		
IWHSA2-S	46	1.9	16127	30641.3		
IWHSA3-S	46	1.1	15804	17384.4		
Total or *Mean*	46	*2.13*	62703	121333.7	1.94	1.44
% Foraging area	46		**72.10**			
IWG10-S	47	6.9	5541	38232.9		
IWG6-S	47	1.4	8512	11496.8		
IWG7-S	47	1.5	8212	12318		
IWG8-S	47	1.6	6126	9801.6		
IWG9-S	47	1.1	6126	6738.6		
IWHSA1-S	47	9	22684	204156		
Total or *Mean*	47	*3.58*	56901	282743.9	4.97	3.31
% Foraging area	47		**65.42**			
IWG1-S	48	0.31	7340	2275.4		
IWG2-S	48	0.31	7340	2275.4		
IWG3-S	48	3.1	4885	15143.5		
IWG4-S	48	6.1	4885	29798.5		
IWG5-S	48	0.92	5536	5093.12		
Total or *Mean*	48	*2.15*	29986	54585.92	1.82	0.74
% Foraging area	48		**34.48**			

Table 4. Robin Fledgling-stage Foraging Area-based Surface-weighted Area Concentration (SWAC) in Recreational Land Along the Little Mississinewa River, Randolf County, IN

SOIL SAMPLE ID	FORAGING AREA ID	SOIL PCB	AREA PER SAMPLE	SAMPLE PCB * AREA	PARTIAL SWAC SOIL PCB	FULL SWAC SOIL PCB
		ppm	ft^2	ppm * ft^2	ppm	ppm
JWG21-S	49	2.6	1245	3237		
JWG22-S	49	2.9	1245	3610.5		
JWG23-S	49	2.9	1245	3610.5		
JWG24-S	49	4.3	1245	5353.5		
JWG25-S	49	4.6	1294	5952.4		
JWG26-S	49	3.4	1294	4399.6		
JWG27-S	49	4.2	1294	5434.8		
JWHSA4-S	49	2.6	15252	39655.2		
JWHSA5-S	49	1.4	15761	22065.4		
JWHSA6-S	49	0.48	18842	9044.16		
JWHSA7-S	49	0.75	17903	13427.25		
JWHSA8-S	49	0.13	22019	2862.47		
Total or *Mean*	49	*2.52*	98639	118652.78	1.20	1.20
% Foraging area	49		**113.41**			
JWG15-S	50	2.4	1263	3031.2		
JWG16-S	50	1.3	1263	1641.9		
JWG17-S	50	2.5	1274	3185		
JWG18-S	50	0.96	1274	1223.04		
JWG19-S	50	2	1274	2548		
JWG20-S	50	1.5	1274	1911		
JWHSA3-S	50	1.1	14971	16468.1		
Total or *Mean*	50	*1.68*	22593	30008.24	1.33	0.47
% Foraging area	50		**25.98**			
JWG9-S	51	3.2	1338	4281.6		
JWG10-S	51	5.1	1338	6823.8		
JWG11-S	51	3.3	1338	4415.4		
JWG12-S	51	6.3	1338	8429.4		
JWG13-S	51	1.8	1263	2273.4		
JWG14-S	51	2.9	1263	3662.7		
Total or *Mean*	51	*3.77*	7878	29886.3	3.79	0.49
% Foraging area	51		**9.06**			
JWG1-S	52	8.9	1211	10777.9		
JWG2-S	52	8.1	1211	9809.1		
JWG3-S	52	9.4	1211	11383.4		
JWG4-S	52	3.9	1211	4722.9		
JWG5-S	52	0.03	1348	40.44		
JWG6-S	52	0.46	1348	620.08		

Table 4. Robin Fledgling-stage Foraging Area-based Surface-weighted Area Concentration (SWAC) in Recreational Land Along the Little Mississinewa River, Randolf County, IN

SOIL SAMPLE ID	FORAGING AREA ID	SOIL PCB	AREA PER SAMPLE	SAMPLE PCB * AREA	PARTIAL SWAC SOIL PCB	FULL SWAC SOIL PCB
		ppm	ft^2	ppm * ft^2	ppm	ppm
JWG7-S	52	0.97	1348	1307.56		
JWG8-S	52	4.2	1348	5661.6		
JWHSA2-S	52	0.022	21637	476.014		
Total or *Mean*	52	*4.00*	31873	44798.994	1.41	0.62
% Foraging area	52		**36.65**			
JWHSA1-S	53	0.085	17906	1522.01	0.08	0.15
% Foraging area	53		**20.59**			

Robin fledgling-stage foraging area is the area over which adult robins and their fledged young search for food (8080 m^2, equivalent to 86,972 ft^2) based on Weatherhead and McRae (1990). The dimensions of a square-shaped fledgling-stage foraging area are about 295 ft on a side.

Unsampled PCB concentration (0.165 ppm) is set equal to one-half of the detection limit for soil PCB sampling the LMR under the assumption that PCBs are not at detectable levels beyond the areas sampled for the site investigations.

Total or Mean - total values are given for AREA PER SAMPLE and SAMPLE PCB*AREA, and mean (average) values for SOIL PCB.

% Foraging area = (Total AREA PER SAMPLE/ Fledgling-Stage Foraging Area) * 100. It represents the percentage of a robin fledgling-stage foraging area in which soil PCB data are available.

PARTIAL SWAC = SAMPLE PCB* AREA / Total AREA PER SAMPLE. It represents the surface-weighted average concentration of soil PCB solely in the portion of a robin fledgling-stage foraging area in which soil PCB data are available.

FULL SWAC = (PARTIAL SWAC * (Total AREA PER SAMPLE / Fledgling-stage Foraging Area)) + (Unsampled PCB * ((Fledgling-stage Foraging Area -Total AREA PER SAMPLE) / (Fledgling-sage Foraging Area)). It represents an estimated surface-weighted average concentration of soil PCB over an entire robin fledgling-stage foraging area assuming soil PCB concentrations are below detection limits in unsampled portions of the foraging area. This is accomplished by weighting the PARTIAL SWAC by the fraction the Total AREA PER SAMPLE represents out of the total foraging area, and adding the Unsampled PCB concentration weighted by the fraction the unsampled area represents out of the total foraging area.

Table 5. Lowest Observed Adverse Effect Level (LOAEL)-based Remedial Action Levels (RAL) for Robin Fledgling-stage Foraging Areas in Recreational Land Along the Little Mississinewa River, Randolf Conty, IN

SOIL SAMPLE ID	FORAGING AREA ID	SOIL PCB AND RAL	POST-ACTION SOIL PCB	AREA PER SAMPLE	SAMPLE PCB * AREA	PARTIAL SWAC SOIL PCB	FULL SWAC SOIL PCB
		ppm	ppm	ft^2	ppm * ft^2	ppm	ppm
FEG13-S	1	13	13	1268	16848		Fledgling stage foraging area – 86972 ft^2
FEG14-S	1	24	24	1268	30432		
FEG15-S	1	36	**0.02**	1268	25.36		
FEG16-S	1	54	**0.02**	1174	23.48		Unsamplde PCB 0.165 ppm
FEG17-S	1	84	**0.02**	1174	23.48		
FEG18-S	1	61	**0.02**	1174	23.48		
FEG38-S	1	47	**0.02**	1184	23.68		Soil LOAEL Clean Up. Goal – 4 ppm
FEHSA2-S	1	35	**0.02**	9386	187.72		
FEHSA3-S	1	0.17	0.17	14608	2483.36		
FEHSA4-S	1	10	10	26267	262670		
Total or *Mean*	1	*36.42*	*4.73*	58771	312376.56	5.32	3.65
FEG19-S	4	53	**0.02**	1252	25.04		
FEG20-S	4	68	**0.02**	1252	25.04		
FEG21-S	4	91	**0.02**	1252	25.04		
FEG22-S	4	150	**0.02**	1252	25.04		
FEG23-S	4	15	15	1076	16140		
FEG24-S	4	31	31	1076	33356		
FEG25-S	4	110	**0.02**	1076	21.52		
FEG26-S	4	17	17	1076	18292		
FEHSA7-S	4	66	**0.02**	8015	160.3		
FEHSA8-S	4	39	**0.02**	20261	405.22		
Total or *Mean*	4	*64.00*	*6.31*	37588	68475.2	1.82	0.88
FWG20-S	10	60	**0.02**	1089	21.78		
FWG21-S	10	59	**0.02**	1089	21.78		
FWHSA8-S	10	**50**	**0.02**	23788	475.76		
Total or *Mean*	10	*56.33*	*0.02*	25966	519.32	0.02	0.12
FWHSA10-S	11	1.6	1.6	21939	35102.4		
FWHSA9-S	11	**37**	**0.02**	18989	379.78		
Total or *Mean*	11	*19.30*	*0.81*	40928	35482.18	0.87	0.50
GEG17-S	17	11	11	1268	13948		
GEG18-S	17	16	16	1268	20288		
GEG19-S	17	19	19	1268	24092		
GEG20-S	17	**140**	**0.02**	1475	29.5		
GEG22-S	17	7.1	7.1	1367	9705.7		
GEG5-S	17	13	13	1267	16471		
GEG6-S	17	20	20	1267	25340		
GEG7-S	17	23	23	1267	29141		
GEG8-S	17	20	20	1267	25340		
GEHSA6-S	17	2.5	2.5	24840	62100		
Total or *Mean*	17	*27.16*	*13.16*	36554	226455.2	6.20	2.70

Table 5. Lowest Observed Adverse Effect Level (LOAEL)-based Remedial Action Levels (RAL) for Robin Fledgling-stage Foraging Areas in Recreational Land Along the Little Mississinewa River, Randolf Conty, IN

SOIL SAMPLE ID	FORAGING AREA ID	SOIL PCB AND RAL	POST-ACTION SOIL PCB	AREA PER SAMPLE	SAMPLE PCB * AREA	PARTIAL SWAC SOIL PCB	FULL SWAC SOIL PCB
		ppm	ppm	ft^2	ppm * ft^2	ppm	ppm
GWG17-S	18	19	19	1227	23313		
GWG18-S	18	**62**	**0.02**	1227	24.54		
GWG19-S	18	52	52	1227	63804		
GWG1-S	18	18	18	1251	22518		
GWG20-S	18	13	13	1136	14768		
GWG21-S	18	11	11	1136	12496		
GWG2-S	18	13	13	1251	16263		
GWG3-S	18	15	15	1251	18765		
GWG4-S	18	25	25	1251	31275		
GWG5-S	18	39	39	1242	48438		
GWG6-S	18	47	47	1242	58374		
GWHSA4-S	18	1.6	1.6	13856	22169.6		
Total or *Mean*	18	*26.30*	*21.14*	27297	332208.14	12.17	3.93
HEG10-S	23	5.4	5.4	5843	31552.2		
HEG11-S	23	**11**	**0.02**	8145	162.9		
HEG26-S	23	2.4	2.4	6455	15492		
HEG27-S	23	2.5	2.5	6455	16137.5		
HEG28-S	23	5.9	5.9	9028	53265.2		
HEG38-8	23	0.02	0.023	4670	107.41		
HEG7-S	23	4.8	4.8	6253	30014.4		
HEG8-S	23	11	**0.02**	6253	125.06		
HEG9-S	23	7.1	7.1	5843	41485.3		
Total or *Mean*	23	*5.57*	*3.13*	58945	188341.97	3.20	2.22
% Fledgling area	23				**67.77**		
HEG14-S	25	**40**	**0.02**	8705	174.1		
HEG15-S	25	2.2	2.2	6606	14533.2		
HEG16-S	25	4.3	4.3	6606	28405.8		
HEG17-S	25	1.6	1.6	8237	13179.2		
HEG18-S	25	3.5	3.5	8237	28829.5		
HEG31-S	25	6.7	6.7	8804	58986.8		
HEG32-S *	25	6.6	6.6	6710	44286		
Total or *Mean*	25	*9.27*	*356*	53905	188394.6	3.49	2.23
HEG23-S	27	7.6	7.6	9164	69646.4		
HEG24-S *	27	5.3	5.3	6870	36411		
HEG36-S	27	6.7	6.7	8193	54893.1		
HEG37-S	27	7.9	7.9	7999	63192.1		
HEHSA3-S	27	**10**	**0.02**	15424	308.48		
Total or *Mean*	27	*7.50*	*5.50*	47650	224451.08	4.71	2.66
HEHSA1-SSUB *	28	31	**0.02**	18978	379.56		
HEHSA2-S	28	**18**	**0.02**	19200	384		
HEHSA4-S	28	21	**0.02**	9030	180.6		
Total or *Mean*	28	*23.33*	*6.01*	47208	944.16	0.02	0.09

Table 5. Lowest Observed Adverse Effect Level (LOAEL)-based Remedial Action Levels (RAL) for Robin Fledgling-stage Foraging Areas in Recreational Land Along the Little Mississinewa River, Randolf Conty, IN

SOIL SAMPLE ID	FORAGING AREA ID29	SOIL PCB AND RAL	POST-ACTION SOIL PCB	AREA PER SAMPLE	SAMPLE PCB * AREA	PARTIAL SWAC SOIL PCB	FULL SWAC SOIL PCB
		ppm	ppm	ft^2	ppm * ft^2	ppm	ppm
HWHSA11-SSUB *	29	**54**	**0.02**	37199	743.98		
HWHSA13-S	29	0.2	0.2	59507	11901.4		
Total or *Mean*	29	*27.10*	*0.11*	96706	12645.38	0.13	0.13
HWHSA10-S	30	**21**	**0.02**	22563	451.26		
HWHSA12-S	30	6.2	6.2	18077	112077.4		
Total or *Mean*	30	*13.60*	*3.11*	40640	112528.66	2.77	1.38
HWG20-S	35	7.6	7.6	6682	50783.2		
HWG21-S	35	8	8	6682	53456		
HWG22-S	35	3.2	3.2	7216	23091.2		
HWG23-S	35	5.5	5.5	7747	42608.5		
HWHSA4-S	35	0.83	0.83	26436	21941.88		
HWHSA5-S	35	**21**	**0.02**	16865	337.3		
Total or *Mean*	35	*7.69*	*4.19*	71628	192218.08	2.68	2.24

POST-ACTION SOIL PCB – The PCB concentration of fill brought into remediated areas is assumed to be 0.02 ppm. Areas to be remediated are shown in gray.

RAI. – The remediation action level for each foraging area is shown in bold type. It represents the lowest PCB concentration that needs to be remediated in a particular foraging area so that the surface-weighted average concentration over the entire foraging area (FULL SWAC SOIL PCB) is less than the LOAEL-based clean up goal (CUG) of 4 ppm.

Table 6. No Observed Adverse Effect Level (NOAEL)-based Remedial Action Levels (RAL) for Robin Fledgling-stage Foraging Areas in Recreational Land Along the Little Mississinewa River, Randolf Conty, IN

SOIL SAMPLE ID	FORAGING AREA ID	SOIL PCB AND RAL	POST-ACTION SOIL PCB	AREA PER SAMPLE	SAMPLE PCB * AREA	PARTIAL SWAC SOIL PCB	FULL SWAC SOIL PCB
		ppm	ppm	ft^2	ppm * ft^2	ppm	ppm
FEG13-S	1	13	**0.02**	1268	25.36		Fledgling stage foraging area – 86972 ft^2
FEG14-S	1	24	**0.02**	1268	25.36		
FEG15-S	1	36	**0.02**	1268	25.36		
FEG16-S	1	54	**0.02**	1174	23.48		Unsamplde PCB 0.165 ppm
FEG17-S	1	84	**0.02**	1174	23.48		
FEG18-S	1	61	**0.02**	1174	23.48		
FEG38-S	1	47	**0.02**	1184	23.68		Soil NOAEL Clean Up. Goal – 4 ppm
FEHSA2-S	1	35	**0.02**	9386	187.72		
FEHSA3-S	1	0.17	0.17	14608	2483.36		
FEHSA4-S	1	10	**0.02**	26267	525.34		
Total or *Mean*	1	*36.42*	*0.04*	58771	3366.62	0.06	0.09
FEG19-S	4	53	**0.02**	1252	25.04		
FEG20-S	4	68	**0.02**	1252	25.04		
FEG21-S	4	91	**0.02**	1252	25.04		
FEG22-S	4	150	**0.02**	1252	25.04		
FEG23-S	4	15	15	1076	16140		
FEG24-S	4	31	31	1076	33356		
FEG25-S	4	110	**0.02**	1076	21.52		
FEG26-S	4	17	17	1076	18292		
FEHSA7-S	4	66	**0.02**	8015	160.3		
FEHSA8-S	4	**39**	**0.02**	20261	405.22		
Total or *Mean*	4	*64.00*	*6.31*	37588	68475.2	1.82	0.88
FEHSA9-S	5	**8.2**	**0.02**	23775	475.5	0.02	0.13
FWG12-S	7	4.2	4.2	1334	5602.8		
FWG13-S	7	16	16	1334	21344		
FWG14-S	7	16	16	1334	21344		
FWG15-S	7	31	**0.02**	1143	22.86		
FWG16-S	7	15	15	1143	17145		
FWG40-S	7	4.1	4.1	1360	5576		
FWG41-S	7	**22**	**0.02**	1360	27.2		
FWG42-S	7	57	**0.02**	1360	27.2		
FWHSA5-S	7	2.6	2.6	18288	47548.8		
Total or *Mean*	7	*18.66*	*6.44*	28656	118637.86	4.14	1.47
FWHSA6-S	8	**5.4**	**0.02**	24966	499.32	0.02	0.12
FWHSA7-S	9	7.9	**0.02**	23639	472.78		
FWG17-S	9	18	**0.02**	1239	24.78		
FWG18-S	9	21	**0.02**	1239	24.78		
FWG19-S	9	**9.5**	**0.02**	1239	24.78		
Total or *Mean*	9	*14.10*	*0.02*	27356	547.12	0.02	0.12

Table 6. No Observed Adverse Effect Level (NOAEL)-based Remedial Action Levels (RAL) for Robin Fledgling-stage Foraging Areas in Recreational Land Along the Little Mississinewa River, Randolf County, IN

SOIL SAMPLE ID	FORAGING AREA ID	SOIL PCB and **RAL**	POST-ACTION SOIL PCB	AREA PER SAMPLE	SAMPLE PCB * AREA	PARTIAL SWAC SOIL PCB	FULL SWAC SOIL PCB
		ppm	ppm	ft2	ppm * ft2	ppm	ppm
FWG20-S	10	60	**0.02**	1089	21.78		
FWG21-S	10	59	**0.02**	1089	21.78		
FWHSA8-S	10	**50**	**0.02**	23788	475.76		
Total or *Mean*	10	*56.33*	*0.02*	25966	519.32	0.02	0.12
FWHSA10-S	11	1.6	1.6	21939	35102.4		
FWHSA9-S	11	**37**	**0.02**	18989	379.78		
Total or *Mean*	11	*19.30*	*0.81*	40928	35482.18	0.87	0.50
GEHSA2-S	13	**10**	**0.02**	23344	466.88	0.02	0.13
GEHSA3-S *	14	**12**	**0.02**	24168	483.36	0.02	0.12
GEHSA4-S	15	**11**	**0.02**	21854	437.08	0.02	0.13
GEG17-S	17	11	11	1268	13948		
GEG18-S	17	16	16	1268	20288		
GEG19-S	17	19		1268	25.36		
GEG20-S	17	140		1475	29.5		
GEG22-S	17	7.1	7.1	1367	9705.7		
GEG5-S	17	13	13	1267	16471		
GEG6-S	17	**20**	**0.02**	1267	25.34		
GEG7-S	17	23	**0.02**	1267	25.34		
GEG8-S	17	20	**0.02**	1267	25.34		
GEHSA6-S	17	2.5	2.5	24840	62100		
Total or *Mean*	17	*27.16*	*4.97*	36554	122643.58	3.36	1.51
GWG17-S	18	**19**	**0.02**	1227	24.54		
GWG18-S	18	62	**0.02**	1227	24.54		
GWG19-S	18	52	**0.02**	1227	24.54		
GWG1-S	18	18	18	1251	22518		
GWG20-S	18	13	13	1136	14768		
GWG21-S	18	11	11	1136	12496		
GWG2-S	18	13	13	1251	16263		
GWG3-S	18	15	15	1251	18765		
GWG4-S	18	25	**0.02**	1251	25.02		
GWG5-S	18	39	**0.02**	1242	24.84		
GWG6-S	18	47	**0.02**	1242	24.84		
GWHSA4-S	18	1.6	1.6	13856	22169.6		
Total or *Mean*	18	*26.30*	*5.98*	27297	107127.92	3.92	1.35
GWHSA1-S	21	**15**	**0.02**	15405	308.1	0.02	0.14
HEG1-S	22	14	**0.02**	5692	113.84		
HEG25-S	22	4.3	4.3	8637	37139.1		
HEG2-S	22	3.3	3.3	5692	18783.6		

Table 6. No Observed Adverse Effect Level (NOAEL)-based Remedial Action Levels (RAL) for Robin Fledgling-stage Foraging Areas in Recreational Land Along the Little Mississinewa River, Randolf County, IN

SOIL SAMPLE ID	FORAGING AREA ID	SOIL PCB and **RAL**	POST-ACTION SOIL PCB	AREA PER SAMPLE	SAMPLE PCB * AREA	PARTIAL SWAC SOIL PCB	FULL SWAC SOIL PCB
		ppm	ppm	ft2	ppm * ft2	ppm	ppm
HEG3-S	22	3.1	3.1	4903	15199.3		
HEG4-S	22	**7.9**	**0.02**	4903	98.06		
HEG5-S	22	1.2	1.2	7660	9192		
HEG6-S	22	5.4	5.4	7660	41364		
Total or *Mean*	22	*5.60*	*2.48*	45147	121889.9	2.70	1.48
HEG10-S	23	**5.4**	5.4	5843	31552.2		
HEG11-S	23	11	**0.02**	8145	162.9		
HEG26-S	23	2.4	2.4	6455	15492		
HEG27-S	23	2.5	2.5	6455	16137.5		
HEG28-S	23	**5.9**	**0.02**	9028	180.56		
HEG38-8	23	0.023	0.023	4670	107.41		
HEG7-S	23	4.8	4.8	6253	30014.4		
HEG8-S	23	11	**0.02**	6253	125.06		
HEG9-S	23	7.1	**0.02**	5843	116.86		
Total or *Mean*	23	*5.57*	*1.69*	58945	93888.89	1.59	1.13
HEG12-S	24	**10**	**0.02**	8145	162.9		
HEG13-S	24	10	**0.02**	8705	174.1		
HEG29-S	24	0.3	0.3	9028	2708.4		
HEG30-S	24	1.1	1.1	8804	9684.4		
Total or *Mean*	24	*5.35*	*0.36*	34682	12729.8	0.37	0.25
HEG14-S	25	40	**0.02**	8705	174.1		
HEG15-S	25	2.2	2.2	6606	14533.2		
HEG16-S	25	4.3	4.3	6606	28405.8		
HEG17-S	25	1.6	1.6	8237	13179.2		
HEG18-S	25	3.5	3.5	8237	28829.5		
HEG31-S	25	6.7	**0.02**	8804	176.08		
HEG32-S *	25	**6.6**	**0.02**	6710	134.2		
Total or *Mean*	25	*9.27*	*1.67*	53905	85432.08	1.58	1.05
HEG19-S	26	1.2	1.2	8576	10291.2		
HEG20-S	26	3.7	3.7	8576	31731.2		
HEG21-S	26	7.3	**0.02**	4951	99.02		
HEG22-S	26	8.7	**0.02**	9164	183.28		
HEG33-S	26	1.9	1.9	7154	13592.6		
HEG34-S	26	1.5	1.5	7154	10731		
HEG35-S	26	**5.7**	**0.02**	8193	163.86		
HEG39-S	26	1.3	1.3	7427	9655.1		
HEG40-S	26	1.9	1.9	7427	14111.3		
Total or *Mean*	26	*3.69*	*1.28*	68622	90558.56	1.32	1.08
HEG23-S	27	**7.6**	**0.02**	9164	183.28		
HEG24-S *	27	5.3	5.3	6870	36411		
HEG36-S	27	6.7	6.7	8193	54893.1		

Table 6. No Observed Adverse Effect Level (NOAEL)-based Remedial Action Levels (RAL) for Robin Fledgling-stage Foraging Areas in Recreational Land Along the Little Mississinewa River, Randolf County, IN

SOIL SAMPLE ID	FORAGING AREA ID	SOIL PCB and **RAL**	POST-ACTION SOIL PCB	AREA PER SAMPLE	SAMPLE PCB * AREA	PARTIAL SWAC SOIL PCB	FULL SWAC SOIL PCB
		ppm	ppm	ft2	ppm * ft2	ppm	ppm
HEG37-S	27	7.9	**0.02**	7999	159.98		
HEHSA3-S	27	10	**0.02**	15424	308.48		
Total or *Mean*	27	*7.50*	*2.41*	47650	91955.84	1.93	1.13
HEHSA1-SSUB *	28	31	**0.02**	18978	379.56		
HEHSA2-S	28	**18**	**0.02**	19200	384		
HEHSA4-S	28	21	**0.02**	9030	180.6		
Total or *Mean*	28	*23.33*	*0.02*	47208	944.16	0.02	0.09
HWHSA11-SSUB *	29	**54**	**0.02**	37199	743.98		
HWHSA13-S	29	0.2	0.2	59507	11901.4		
Total or *Mean*	29	*27.10*	*0.11*	96706	12645.38	0.13	0.13
HWHSA10-S	30	**21**	**0.02**	22563	451.26		
HWHSA12-S	30	6.2	6.2	18077	112077.4		
Total or *Mean*	30	*13.60*	*3.11*	40640	112528.66	2.77	1.38
HWG30-S	31	**9.3**	**0.02**	7479	149.58		
HWG31-S	31	4	4	8698	34792		
HWHSA9-S	31	2.8	2.8	18967	53107.6		
Total or *Mean*	31	*5.37*	*2.27*	35144	88049.18	2.51	1.11
HWG27-S	32	4.7	4.7	7102	33379.4		
HWG28-S	32	6.8	6.8	7102	48293.6		
HWG29-S	32	**15**	**0.02**	7479	149.58		
HWHSA8-S	32	0.97	0.97	27406	26583.82		
Total or *Mean*	32	*6.87*	*3.12*	49089	108406.4	2.21	1.32
HWG24-S	34	**5.4**	**0.02**	7582	151.64		
HWG25-S	34	9.7	**0.02**	7582	151.64		
HWG26-S *	34	3	3	3935	11805		
HWHSA6-S	34	3.5	3.5	22340	78190		
Total or *Mean*	34	*5.40*	*1.64*	41439	90298.28	2.18	1.12
HWG20-S	35	**7.6**	**0.02**	6682	133.64		
HWG21-S	35	8	**0.02**	6682	133.64		
HWG22-S	35	3.2	3.2	7216	23091.2		
HWG23-S	35	5.5	5.5	7747	42608.5		
HWHSA4-S	35	0.83	0.83	26436	21941.88		
HWHSA5-S	35	21	0.02	16865	337.3		
Total or *Mean*	35	*7.69*	*1.60*	71628	88246.16	1.23	1.04
HWG14-S	37	**16**	**0.02**	6359	127.18		
HWG15-S	37	6.9	6.9	5033	34727.7		
HWG16-S	37	10	10	5033	50330		
HWG17-S	37	3.3	3.3	7397	24410.1		

Table 6. No Observed Adverse Effect Level (NOAEL)-based Remedial Action Levels (RAL) for Robin Fledgling-stage Foraging Areas in Recreational Land Along the Little Mississinewa River, Randolf County, IN

SOIL SAMPLE ID	FORAGING AREA ID	SOIL PCB and **RAL**	POST-ACTION SOIL PCB	AREA PER SAMPLE	SAMPLE PCB * AREA	PARTIAL SWAC SOIL PCB	FULL SWAC SOIL PCB
		ppm	ppm	ft2	ppm * ft2	ppm	ppm
HWHSA1-S	37	0.042	0.042	18041	757.722		
HWHSA2-S	37	1.6	1.6	9553	15284.8		
Total or *Mean*	37	*6.31*	*3.64*	51416	125637.502	2.44	1.51
HWG10-S	38	18	**0.02**	6305	126.1		
HWG11-S	38	10	10	7373	73730		
HWG12-S	38	0.85	0.85	7373	6267.05		
HWG13-S	38	1.5	1.5	6359	9538.5		
HWG9-S	38	**12**	**0.02**	6305	126.1		
Total or *Mean*	38	*8.47*	*2.48*	33715	89787.75	2.66	1.13
HWG5-S	39	10	10	7835	783.50		
HWG6-S	39	0.019	0.019	7835	148.865		
HWG7-S	39	2.9	2.9	7272	21088.8		
HWG8-S	39	**14**	**0.02**	7272	145.44		
Total or *Mean*	39	*6.73*	*3.23*	30214	99733.105	3.30	1.25
IEG11-S	41	1.2	1.2	10064	12076.8		
IEG12-S	41	0.51	0.51	10064	5132.64		
IEG1-S	41	2.3	2.3	8029	18466.7		
IEG2-S	41	3.8	3.8	8029	30510.2		
IEG3-S	41	1.3	1.3	5278	6861.4		
IEG4-S	41	1.1	1.1	5278	5805.8		
IEG5-S	41	1.6	1.6	8870	14192		
IEG6-S	41	**9.9**	**0.02**	8870	177.4		
Total or *Mean*	41	*2.71*	*1.48*	64482	93222.94	1.45	1.11
IEHSA3-S	44	**4.9**	**0.02**	26955	539.1	0.02	0.12
IWG10-S	47	6.9	6.9	5541	38232.9		
IWG6-S	47	1.4	1.4	8212	11496.8		
IWG7-S	47	1.5	1.5	8212	12318		
IWG8-S	47	1.6	1.6	6126	9801.6		
IWG9-S	47	1.1	1.1	6126	6738.6		
IWHSA1-S	47	**9**	**0.02**	22684	453.68		
Total or *Mean*	47	*3.58*	*2.09*	56901	79041.58	1.39	0.97

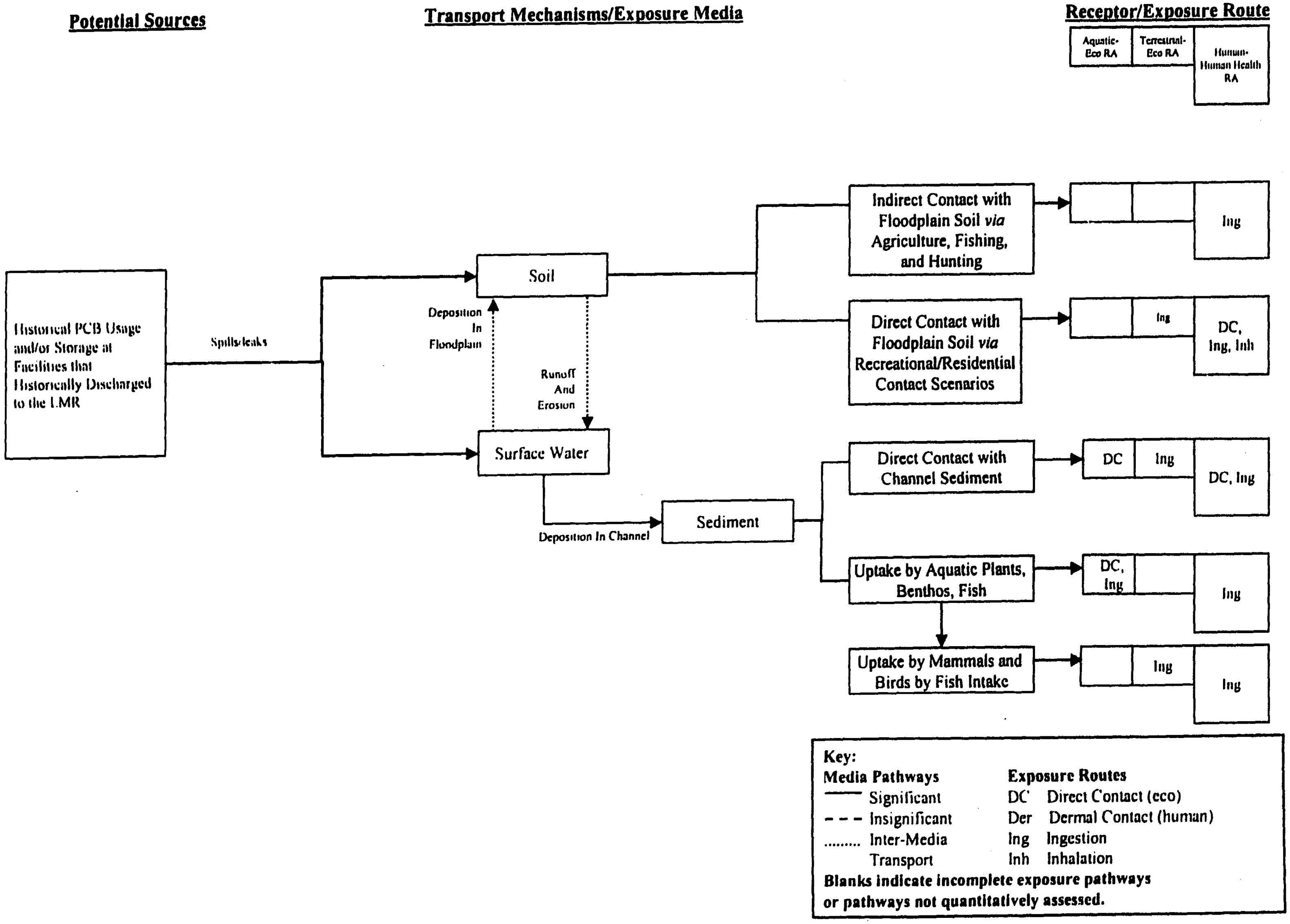
POST-ACTION SOIL PCB – The PCB concentration of fill brought into remediated areas is assumed to be 0.02 ppm. Areas to be remediated are shown in gray.

RAL – The remediation action level for each foraging area is shown in bold type. It represents the lowest PCB concentration that needs to be remediated in a particular foraging area so that the surface-weighted average concentration over the entire foraging area (FULL SWAC SOIL PCB) does not exceed the NOAEL –based clean up goal (CUG) of 1.5 ppm.

ENCLOSURE 3

(Revised) DRAFT Figure 1
Conceptual Site model
Little Mississinewa River
Randolph County, Indiana

PCB Release Sources, Pathways of Exposure, and Potentially Exposed Receptors



ENCLOSURE 5

HUMAN HEALTH RISK TABLES- LMR SITE- UNION CITY, IN

A summary of the calculated human health cancer risks for the Site is presented below.

	Total Cancer Risk		
	Highest Exposure Area	Central Tendency (Overall)	Reasonable Maximum Exposure (LMR Channel-edge)
Child Resident	F - north	7.2×10^{-6}	Not Applicable
Adolescent Resident	F - south	5.2×10^{-6}	1.4×10^{-5}
Adult Resident	F - south	2.0×10^{-6}	7.7×10^{-6}
Lifetime (Combined) Resident	F - north	1.4×10^{-5}	2.2×10^{-5}
Adolescent Recreational Visitor	F - middle	4.9×10^{-7}	7.4×10^{-7}
Adult Recreational Visitor	F - middle	3.6×10^{-7}	5.6×10^{-7}
Lifetime (Combined) Recreational Visitor	F - middle	8.5×10^{-7}	1.3×10^{-6}
Adult Construction Worker	F	1.2×10^{-7}	5.8×10^{-7}
Adult Utility Worker	F	3.2×10^{-7}	5.5×10^{-7}

A summary of the human health non-cancer risks calculated for the Site is shown below.

	Total Non-cancer Hazards		
Receptors	Highest Exposure Area	Central Tendency (Overall)	Reasonable Maximum Exposure (LMR Channel-edge)
Child Resident	F - north	**2.1**	Not Applicable
Adolescent Resident	F - south	0.83	**2.3**
Adult Resident	F - south	0.27	0.71
Adolescent Recreational Visitor	F - middle	0.077	0.12
Adult Recreational Visitor	F - middle	0.033	0.051
Adult Construction Worker	F	0.21	**1.0**
Adult Utility Worker	F	0.023	0.038

ENCLOSURE 6

Q&A FACT SHEET- TECHNICAL CLARIFICATIONS TO PROPOSED PLAN FOR LITTLE MISSISSINEWA RIVER SITE

The Questions and Answers listed below are designed to supplement the Proposed Plan Fact Sheet for the Little Mississinewa Site that was released in February 2004

QUESTION 1: Why are PCBs dangerous?

Answer: Poly-chlorinated Biphenyls (PCBs) are a group of synthetic organic chemicals that include 209 individual chlorinated biphenyl compounds (also known as congeners) that vary in toxicity. PCBs have been demonstrated to cause a variety of adverse health effects in animals, including cancer, liver toxicity, reproductive toxicity, developmental effects, neurotoxicity, immunotoxicity, dermal toxicity, thyroid effects, and endocrine effects. PCBs are classified by EPA as “B2” probable human carcinogens. PCBs are persistent in the environment since they are not easily broken down or destroyed by biological processes, and PCBs bioaccumulate (increase in concentration) as they are passed up the food chain. For example, at the Little Mississinewa River (LMR) Site, the PCBs accumulate in the tissues of fish as they eat smaller animals, such as insects, crayfish, and smaller fish that are in contact with contaminated river sediments. PCB levels have been measured in fish captured in the LMR, and a fish advisory has been issued for the LMR based on this data. Humans who consume fish caught in the LMR will be exposed to the mass of PCBs accumulated in these fish.

QUESTION 2: Why is EPA proposing to take this action?

Answer: This cleanup is being pursued under the Superfund Alternative Sites Program, which addresses sites that have not yet been scored, on the Superfund National Priorities List (NPL), but would score high enough to be placed on the NPL. A removal action was conducted in 2001-2002 to address PCB levels in the LMR that were high enough to serve as source areas that would continue to spread contamination downstream in the river and flood plain areas. The remaining portions of the river have been addressed through the remedial program of Superfund, and the LMR Site has been quickly moved through the process of sampling and remedy selection due to the ongoing exposure of humans to PCBs at high concentrations in the flood plain areas and the river sediments. There is a fish consumption advisory in effect for the LMR. There is also unacceptable risk posed to aquatic and terrestrial animals in the river sediments and some flood plain areas. There are some residents who have had restrictions placed on the use of their land as a result of this PCB contamination. The actions proposed by EPA will address the unacceptable risks due to PCB contamination at the Site, allow use restrictions to be lifted from residences, and allow the fish consumption advisory to be removed from the LMR.

QUESTION 3: What previous cleanup actions have been taken at the Little Mississinewa River (LMR) Site?

Answer: The Indiana Department of Environmental Management (IDEM) performed sampling in the 1980s and 1990s that identified PCBs as the primary contaminant of concern in the LMR and documented that other contaminants, such as pesticides, were present in the LMR in concentrations that were negligible.

Regarding PCBs, several removal actions have been performed on the Westinghouse Facility since the late 1980s. Two of these actions addressed PCB contamination in the former “skimmer box” at Westinghouse, which was used to skim oily materials from the discharge water from the facility. This discharge water flowed directly into the LMR. In 1996, Westinghouse, under EPA direction, excavated several buried trenches with waste materials and debris, primarily containing PCBs; cleaned PCBs out of areas inside the building that still remained after previous cleanings; and constructed a soil vapor extraction system to remove xylene contamination that leaked from a tank at the facility that had been previously removed by Westinghouse/A.O. Smith. In 2001, a voluntary action was performed that sealed off all connections and old catch basins from the storm sewer line and addressed the skimmer box/ditch area that had been the conduit for PCBs to the LMR. The skimmer box and ditch were cleaned and capped, and the discharge from the current lumber facility is hard-piped to the storm sewer line. At the former Sheller-Globe facility, voluntary actions were taken from 1999-2001 which included permanent abandonment and removal of storm water sewer lines and associated catch basins, wastewater treatment discharge lines associated with the former facility that discharged to the LMR at the Outfall Area, and installation of new and re-routed storm water sewer lines to facilitate storm water conveyance that completely bypass the former plant. Additionally, a PCB removal action was performed under the Toxic Substances Control Act that remediated a primary source of PCBs at the former plant. All of the former buildings have been razed. At both facilities, ground water sampling for oils used in the processes was conducted. Such oils were not present in the ground water and are not expected to be in the future. As stated in the Remedial Investigation for the LMR Site, “These removal activities have addressed all known PCB source areas that could have impacted the Site.”

QUESTION 4: What were the maximum PCB concentrations found at the LMR Site during the Remedial Investigation?

Answer: The maximum concentration of PCBs in the river sediments was 460 parts per million (ppm), in River Area A. There were several other sampling results that exceeded 100 ppm, all of which were in River Area A. The PCB sediment concentrations continually decreased after the Sewage Treatment Plant, until the levels were not high enough to require cleanup after New Lisbon. The maximum PCB concentration in the flood plain was 450 ppm, and numerous other samples exceeded 100 ppm, all but one of which were in Flood Plain Areas E and F, upstream of the Sewage Treatment Plant. The flood plain PCB concentrations continually decreased after the Sewage Treatment Plant, until the levels were not high enough to require cleanup after New Lisbon.

QUESTION 5: Were options other than dredging considered at the LMR Site?

Answer: Yes, a “no action” option was considered, as required by law, and a combination of capping, deed restrictions, and monitored natural recovery was considered as Remedial Alternative 2. Alternative 2 was not recommended for this site because the contamination levels are too high for monitored natural attenuation to be effective without posing significant risks to human health and aquatic and terrestrial life. Capping was not considered to be effective in the long-term because of the potential for failure of the cap over time due to wear and tear from erosion and large flood events in the LMR. There are significant variations in the flow rates in the LMR, from an average of 3 cubic feet per second in August to 18 cubic feet per second in April, and as high as 480 cubic feet per second during flood events. This extreme variation in the flow coupled with the fine sediments that are present in many portions of the LMR and flow constrictions such as bridges, lead EPA to believe that the sediments at the LMR are not stable and are subject to significant scouring and redistribution during flood events. The sampling data in the Remedial Investigation confirm this, as many of the highest sediment concentrations were in the deep (12-18 inch) sampling zone. Dredging is also favorable because there is a nearly continuous clay layer that forms the river channel bottom, located at depths ranging from 12-30 inches. The ease of excavating the contaminated sediments is greatly enhanced by the presence of this clay layer, both as a visible barrier and a barrier to the vertical migration of the PCBs. Additionally, under the capping alternative, most of the PCBs are left in place, which is also not favorable to dredging/removing the PCBs from the LMR sediments, which permanently removes the majority of PCBs from the river sediments.

QUESTION 6: Why is dredging being recommended for the LMR Site?

Answer: As discussed above, monitored natural recovery and capping, alone or in combination, are not considered viable long-term solutions to the PCB contamination problems at the LMR Site. Dredging can be easily performed because the LMR is a fairly small stream, and flow can be easily diverted to allow for “dry” excavation of the PCB-contaminated sediments. In 2001-2002, a successful dredging project was performed in the portion of LMR immediately upstream of the area that is the subject of this Proposed Plan. This ½ -mile portion, which runs south from the railroad bridge north to Division Street, including portions of Harter Park, was successfully cleaned up via dredging, even though 2001 was a year with very high rainfall.

QUESTION 7: What risks are driving the need for cleanup in the different areas of the LMR Site?

Answer: For the river sediments/river channel, the main risk driving the cleanup is the ecological risk to animals that consume fish and other small animals such as crayfish and frogs. However, there are also potential risks to humans from consumption of contaminated fish caught in the LMR. This is why there is a fish advisory for the LMR. Redistribution of PCBs into the flood plain from flooding events also presents a future risk to humans (Alternative 3f, the recommended alternative, adequately protects against this possibility). For the residential flood plain areas, the main risk driving the cleanup is potential risk to human health from direct contact and ingestion of PCBs in soils. For the flood plain areas that are not residential (recreational or agricultural), the main risk driving the cleanup is the ecological risk to animals that consume insects such as worms that are in nearly constant contact with PCB-containing soils. There is also potential future risk to humans if any of the recreational flood plain areas are converted to residential areas.

The PCB contamination also impacts some residents by resulting in the placement of use restrictions on their land. There were limited risks to the agricultural properties in the vicinity of the LMR because there are no livestock that graze in the contaminated flood plain areas of concern in the LMR, and all of the samples that were taken in the plowed areas of crop fields nearest the LMR were clean. No endangered species have been identified to date in the immediate vicinity of the LMR.

QUESTION 8: What will happen to wooded areas along the LMR?

Answer: Every precaution will be taken to preserve all of the trees in the wooded flood plain areas that require cleanup. An excavation depth limit of one foot has been established for the wooded areas, and much of this work will performed using hand tools rather than heavy equipment.

QUESTION 9: What will be done during the cleanup to make sure that people are not exposed to PCBs in soils and dust?

Answer: Performing dry dredging and excavation of flood plain areas will greatly reduce the potential for releases of PCBs to areas surrounding the work zone. Trucks used to transport the contaminated soils and sediments will be lined with plastic and covered to prevent release of dust, and the work areas will be wetted, as necessary, during dry periods to minimize the potential for release of dust from the work area. EPA will perform oversight of the cleanup to help ensure that these measures are used effectively throughout the cleanup action.

QUESTION 10: What will be done after dredging is completed?

Answer: After dredging and excavation, the LMR channel and flood plain areas will be backfilled with clean fill and restored to their pre-excavation condition. Fill materials and soils will be placed in layers and in a manner that will minimize the potential for scouring of the river channel and flood plain areas that have been cleaned up. The detailed design for the LMR channel restoration will be developed after the Record of Decision is issued for the LMR Site; however, it is EPA’s full intent to ensure that the LMR is restored to its pre-excavation condition, including the preservation of wooded areas along the stream.

ENCLOSURE 7

Indiana Department of Environmental Management

We make Indiana a cleaner, healthier place to live.

Joseph E. Kernan
Governor

Lori F. Kaplan
Commissioner

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September 15, 2003

Mr. Brad Bradley, SR 6J
USEPA, Region 5
77 West Jackson Boulevard
Chicago, Illinois 60604-3507

Re: Little Mississinewa River (LMR), Remedy
Review Board Comments, Union City, IN

Dear Mr. Bradley:

This correspondence is in response to the USEPA Remedy Review Board's inquiries about the LMR. Water quality standards, as established by rule 327 IAC 2-1, apply to all waters of the state. For polychlorinated biphenyls (PCBs), these standards are 0.014 ppb for aquatic life and 0.00079 ppb for human health. Without having reviewed the recalculated cleanup goals for the eco-risk assessment, it is difficult to know whether these goals are consistent with the standards. IDEM staff assume that the eco-risk assessment has been revised to incorporate Jim Chapman's comments so that the most appropriate ecological risk-based cleanup goals have been established. It is highly unlikely, however, that these risk-based cleanup goals are low enough to prevent bioaccumulation in the aquatic food chain. Extremely low concentrations of PCBs in sediment have been shown to trigger a fish consumption advisory (FCA). The different levels of a FCA are determined by PCB concentrations in fish tissue.

As long as the residual concentrations of PCB contamination in the sediment are high enough to cause a FCA, there will be injury to the ecological environment that warrants compensation. The more contamination left in place, the less likely the river will recover enough to reduce and eventually eliminate its FCA. This may result in an increase of the natural resource damages claim. At best, the Level 5 FCA may be reduced at the LMR to a lower level. IDEM staff believe that modeling is necessary to determine whether the residual contamination left in soil and sediments will have any effect on the river's ability to recover, thereby, reducing or removing the FCA.

To IDEM staff's knowledge the LMR has not been adversely impacted by non-point discharges. The Level 5 FCA is due to PCBs. Effluent discharges along the LMR have been through National Pollutant Discharge Elimination System (NPDES) permits, which are written to meet water quality standards. The LMR is included on the Indiana 303(d) list due to its Level 5 FCA. It is currently scheduled for a total maximum daily load (TMDL) to be developed sometime during 2008 - 2010.

In addition to protecting human health, it is IDEM's goal to reduce the PCB levels and remove the fish consumption advisories throughout the waters of Indiana. The removal of PCBs to concentrations below acceptable risk-based cleanup goals for both human health and ecological risks without depth limitations will be the first step in that direction. Please do not hesitate to call me at (317) 234-0358 if you have any questions.

Sincerely,

Stephanie Riddle, Project Manager
Federal Programs Section
Office of Land Quality

SR:tr
cc: Rex Osborn, IDEM
Jim Smith, IDEM

ENCLOSURE 8

JAMES CHAPMAN
10/07/2003 04:26 PM

To: LAWRENCE SCHMITT/R5/USEPA/US@EPA, Brad Bradley/R5/USEPA/US@EPA, THOMAS SHORT/R5/USEPA/US@EPA
cc:
Subject: LMR Use Designation

I spoke with Dr. James Smith, IDEM Office of Environmental Response, concerning the use designation or the Little Mississinewa River (LMR). The following discussion focuses solely on use designations that pertain to ecological receptors.

According to 327 IAC 2-1-3 **Water quality standards: surface water use designations; multiple uses,** section (a) (2) “All waters, except as described in subdivision (5), will be capable of supporting a well-balanced, warm water aquatic community and, where natural temperatures will permit, will be capable of supporting put-and-take trout fishing.” Subdivision 5 allows for a limited use designation following “use attainability analysis, public comment period, and hearing”. However, the LMR has not been designated for limited use by the State. LMR is too warm for put-and-take trout fishing. There is also a provision for an “exceptional use” designation (subdivision 6) for “unusual aquatic habitat” (rare or exceptionally high quality), but this does not apply to LMR.

The applicable ecologically-relevant use designation for the LMR therefore is “capable of supporting a well-balanced, warm water aquatic community”.

James Chapman, Ph.D.
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