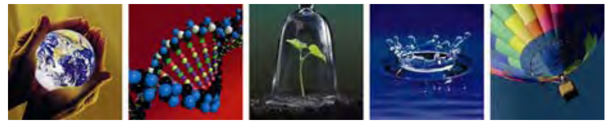

CORRECTIVE MEASURES PROPOSAL
Stony Creek Floodplain
Noblesville, Indiana

Prepared for:
Bridgestone Americas
Tire Operations, LLC
Nashville, Tennessee

Prepared by:
ENVIRON International Corporation
Portland, Maine

Date:
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Contents

List of Tables

List of Figures

ACRONYMS AND ABBREVIATIONS

%	percent
95% UCL	95% upper confidence limit on the mean
AOC	Administrative Order on Consent
BERA	baseline ecological risk assessment
CELS	Counsel in Environmental Law & Science
CILTI	Central Indiana Land Trust, Incorporated
CMP	corrective measures proposal
CMS	corrective measures study
ENVIRON	ENVIRON International Corporation
EPC	exposure point concentration
ERA	ecological risk assessment
Firestone	Bridgestone Americas Tire Operation, LLC
ft	feet
HHRA	human health risk assessment
HI	hazard index
IDEM	Indiana Department of Environmental Management
MCMS	Maverick Construction Management Services
mg/kg	Milligram(s) per kilogram
MNR	monitored natural recovery
PCBs	polychlorinated biphenyls
PIP	public involvement plan
RBC	risk-based concentration
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RISC	Risk Integrated System of Closure
SCSIP	Stony Creek supplemental investigation project
SWAC	spatially-weighted average concentration
TOC	total organic carbon
TSCA	Toxic Substances Control Act
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service

Executive Summary

ENVIRON International Corporation (ENVIRON) prepared this Corrective Measures Proposal (CMP) for the floodplains of a one mile reach of Stony Creek, on behalf of Bridgestone Americas Tire Operations, LLC (Firestone). This CMP is submitted as part of the Resource Conservation and Recovery Act (RCRA) corrective action program for Firestone's facility located at 1700 Firestone Boulevard in Noblesville, Indiana. The purpose of this CMP is to identify appropriate corrective measures to protect human health and the environment from polychlorinated biphenyls (PCBs) in the undeveloped and residentially developed floodplains of Stony Creek downstream of its confluence with Wilson Ditch and upstream of its confluence with the West Fork of the White River (hereafter referred to as the undeveloped and residentially developed Stony Creek floodplains, even though they represent only part of the entire floodplain of Stony Creek). Although this CMP focuses on these Stony Creek floodplains, it also discusses sampling and analytical results for adjacent areas, including the residentially developed Wilson Ditch floodplain and Stony Creek itself, as a means of providing context and understanding of the potential for migration and risk in these areas.

This CMP describes the current conditions in the undeveloped and residentially developed Stony Creek floodplains, identifies corrective measures objectives and options for these floodplains, describes criteria used to evaluate each corrective measure option, identifies proposed corrective measures for these floodplains, and presents a public involvement plan. This CMP is consistent with guidance issued by the United States Environmental Protection Agency (USEPA) (1994, 1996, 2008).

From 1936 to 2009, Firestone operated a rubber products manufacturing facility at 1700 Firestone Boulevard in Noblesville, Indiana. PCB-containing heat-transfer fluid was used at the facility in the late 1960s and early 1970s. It is believed that floor and roof drain outfalls at the facility released PCBs to Wilson Ditch, an engineered drainage channel that flows south from the facility for approximately 5,000 feet (ft) before draining into Stony Creek. PCBs were first identified in Wilson Ditch sediments in 1984, prompting Administrative Orders on Consent (AOCs) between USEPA and Firestone in 1990 and 2001 that described Firestone's corrective action obligations at and in the vicinity of the facility. The first AOC primarily addressed required on- and off-site field investigations and sampling efforts and some corrective actions within one-quarter mile of Firestone's property. A subsequent Amendment to the first AOC required Firestone to implement interim remedial measures for groundwater near Firestone's property. The second AOC included corrective actions for sediments in Wilson Ditch, monitoring requirements for sediment and fish tissue in Stony Creek, and several other corrective actions related to groundwater underlying and in the vicinity of the facility. The PCB contaminated sediments in Wilson Ditch were remediated in 2005, thus eliminating the source of PCBs to Stony Creek and its floodplains.

Since the issuance of the 2001 AOC, Firestone has conducted the following **sampling programs** within Stony Creek and its floodplains:

- Fish tissue and sediment samples were collected from Stony Creek in 2001, 2003, 2005, 2006, 2007, and 2009.
- The four phase Stony Creek Supplemental Investigation Project (SCSIP) was initially conducted to identify areas within the Stony Creek system that had PCB concentrations exceeding the Toxic Substances Control Act cleanup objective of 1 milligram per kilogram (mg/kg). The SCSIP later focused on residential soil from 45 properties subject to flooding by Stony Creek and it was conducted in multiple rounds from 2006 through 2008.
- Floodplain soil samples were collected from residential and other properties along Wilson Ditch in 2009.
- Soil and biota samples were collected from the undeveloped floodplain of Stony Creek in 2008 to support human health and baseline ecological risk assessments (HHRA and BERA) completed in 2009.

Potential risks to human health and the environment have been evaluated for Stony Creek and its residentially developed and undeveloped floodplains. The conclusions from those **risk assessments** are summarized below:

- Potential ecological risks
  - Stony Creek: Dames and Moore (1994) evaluated potential risks to piscivorous birds, while ENVIRON (2010) evaluated potential risks to piscivorous mammals as part of the BERA, and this CMP evaluates potential risks to benthic invertebrates and fish. All assessments indicate that the measures instituted per the 2001 AOC are protective of ecological receptors foraging within Stony Creek.
  - Floodplains (undeveloped and residentially developed): The BERA indicates that wildlife populations foraging in the Stony Creek floodplain are unlikely to be adversely affected by current concentrations of PCBs in soil or diet.
- Potential human health risks
  - Stony Creek: ChemRisk (1996) evaluated potential risks to human health from direct contact with sediment. Predicted cancer risks and noncancer hazards were well below levels considered acceptable by USEPA and the Indiana Department of Environmental Management (IDEM). Exposure via fish consumption was not evaluated, due to the fish consumption advisory[1] for Stony Creek.
  - Undeveloped floodplain: ENVIRON (2009a) evaluated potential risks to human health within the undeveloped floodplain based on long-term recreational exposure to surface soil. Predicted cancer risks and noncancer hazards were well below levels considered acceptable by USEPA and IDEM.

[1] http://www.in.gov/isdh/files/2008_FCA_Booklet.pdf

- Residentially developed floodplain: ENVIRON (2008a, 2009b,c,d) evaluated potential human health risks at residential properties along Stony Creek, based on long-term residential exposures to surface soil and short-term construction/excavation exposures to surface and subsurface soil. Soil concentrations at 25 of the 29 properties evaluated were below the risk-based closure levels for surface and subsurface soil, while conditions at 4 properties exceeded the surface soil risk-based closure level. Following soil excavation, backfilling, and revegetation, cancer risks and noncancer hazards at all properties were well below those determined to be acceptable by the USEPA and IDEM; USEPA issued letters stating this finding. Concentrations of PCBs in soil samples collected from residences along Wilson Ditch did not exceed risk-based closure levels, and thus, do not warrant further evaluation.

The **corrective action objectives** for the undeveloped and residentially developed Stony Creek floodplains include:

- To protect human health, based on current and reasonably anticipated land uses
- To support conditions that do not pose adverse population- or community-level effects to biota (or individual-level effects to threatened, endangered, or special concern species)
- To preserve or enhance the existing habitat quality in the area
- To inform and engage affected property owners and local residents in meaningful participation throughout the cleanup process.
- To minimize the disruption and disturbance of the community so that the character of the neighborhoods can be maintained
- To use best management practices of USEPA's Green Remediation concepts to reduce the demands placed on the environment

This CMP identifies five **corrective measure options** (each) for the undeveloped and residentially developed Stony Creek floodplains:

- Undeveloped Floodplain
  - No action (UF-CM1): This corrective measure would include no institutional or engineered remedial actions (including those already implemented) and no additional study or monitoring.
  - Monitored Natural Recovery (MNR) (UF-CM2): Floodplain soil would remain in place and soil and/or biota would be monitored to verify that conditions within the floodplain improve.
  - Focused habitat enhancement with vegetative stabilization (UF-CM3): This option will result in two actions that will enhance the habitat property-wide and soil stability in the two areas of higher PCB concentration at the site. In particular, the enhancement activities will focus on improving habitat for bats

(including the federally protected Indiana bat [*Myotis sodalis*]). Bats are valued wildlife species that may forage within the floodplain. Habitat enhancement options will focus on summer habitat for bats by providing suitable foraging and roosting areas. At the two areas of higher soil concentrations of PCBs, appropriate vegetation will be selected and planted with the goal of stabilizing soils in the areas to limit erosion, increasing deposition of clean sediments during flooding, and providing a vegetative barrier for humans and wildlife.

- Capping (UF-CM4): This option would involve placement of a physical barrier, such as soil or an engineered control, over PCB-impacted soil to reduce the potential for human or ecological receptor exposure to that soil.

- Focused excavation (UF-CM5): The upper 12 inches of soil from areas immediately surrounding 2 sampling locations with elevated PCB concentrations would be removed and replaced with clean soil and vegetative cover. Soil excavation would be conducted mechanically and would require designation of staging areas, construction of access roads, and felling of trees.

- Residential Properties. Note that these properties have already undergone remediation and the purpose of this evaluation is to document that the selected remedy meets the objectives set forth by USEPA.
  - No action (RF-CM1): This corrective measure would have included no institutional or engineered remedial actions (including those already implemented) and no additional study or monitoring.
  - MNR (RF-CM2): Floodplain soil would have remained in place and soil concentrations monitored to verify that conditions within the floodplain improve.
  - Risk-based removal action (RF-CM3): This option would have included focused excavation of soil from residential properties where exposure point concentrations exceeded risk-based concentrations and excavated areas backfilled, revegetated, and monitored.
  - Risk-based removal action with owner input and post-excavation monitoring (RF-CM4): This remedy was implemented as an interim measure in 2008 and 2009. Excavation plans were developed based on comparisons to risk-based soil concentrations and homeowner input. Likewise, Firestone prepared neighborhood restoration plans that resulted in complementary landscaping throughout the floodplain, particularly focusing on native understory plantings. Restored areas will be monitored for three growing seasons to verify the success of the restoration activities.
  - Excavation to 1 mg/kg (RF-CM5): All areas with soil concentrations greater than 1 mg/kg would have been excavated, backfilled, and revegetated. Under this measure, all parcels along Stony Creek would have been remediated.

Preferred corrective measures were selected based on the nine evaluation criteria developed by USEPA for the selection of appropriate corrective measures under RCRA. The criteria are divided into four threshold criteria that must all be met in order to be considered a feasible measure plus five balancing criteria that are used to identify those measures with the best combination of attributes. Tables 4 and 5 of this CMP evaluate each corrective measure option based on the nine evaluation criteria.

The **preferred corrective measures** for the Stony Creek floodplains are described below.

Undeveloped Floodplain – Focused habitat enhancement with vegetative stabilization (UF-CM3): The preferred corrective measure for the undeveloped floodplain of Stony Creek involves two actions that will enhance the habitat property-wide and soil stability in the two areas of higher PCB concentration at the site. At the two areas of higher concentrations, appropriate vegetation will be selected and planted with the goal of stabilizing soils in the areas to limit erosion, increasing deposition of clean sediments during flooding, and providing a vegetative barrier for humans and wildlife. In addition, habitat for bats will be enhanced by erecting approximately 50 bat boxes to provide immediate improvement in roosting habitat for bats (including the Indiana bat), as well as planting 100 1- to 2-foot shagbark hickory (*Carya ovata*) and shellbark hickory (*Carya laciniosa*) seedlings to provide long-term habitat improvement for bats. Although it may be argued that “no action” is appropriate for this area, due to the acceptable human health and ecological risks under current conditions, there is a rare opportunity to effectively improve the relatively rare floodplain forest habitat. The focused habitat enhancement with vegetative stabilization offers several distinct advantages over the other four options considered: 1) it offers a net benefit to environmental conditions at a relatively low cost; 2) the public is expected to favor this option; 3) only minimal disruptions to the community are expected during implementation; and 4) short-term risks are expected to be minimal.

Residential Properties along Stony Creek – Risk-based removal action with owner input and post-excavation monitoring (RF-CM4): This corrective measure was selected and approved as an interim remedy for residential parcels along Stony Creek . It was implemented in 2008 and 2009 in close consultation with each landowner and with USEPA. In the absence of further sampling and evaluation, focused soil excavation was required at four properties in order to achieve the site-specific risk-based closure levels. Excavation at another 22 parcels was requested by the homeowners, although risks were already at acceptable levels. Restoration of the excavated properties involved implementing a comprehensive and complementary landscaping plan in the floodplain that focused on native understory plantings. Additional landscaping enhancements were implemented at three properties not requiring excavation at the request of homeowners. Property owners were therefore informed, engaged, and in agreement with the corrective measure decision. These measures were documented in reports submitted to and approved by USEPA and are therefore, deemed complete.

The selection and implementation of corrective measures will follow the existing public involvement program. The Information Repository at the local public library will be maintained and a fact sheet prepared. If requested, individual and group meetings also will be held with residents or other interested parties.

1 Introduction

ENVIRON International Corporation (ENVIRON) prepared this Corrective Measures Proposal (CMP) for the undeveloped and residentially developed floodplains of Stony Creek floodplains, on behalf of Bridgestone Americas Tire Operations, LLC (Firestone). This CMP is submitted as part of the Resource Conservation and Recovery Act (RCRA) corrective action program for Firestone's facility located at 1700 Firestone Boulevard in Noblesville, Indiana. Firestone has worked within the RCRA program to address environmental conditions resulting from historical operations at the Noblesville plant (Figure 1). The purpose of this CMP is to identify appropriate corrective measures to protect human health and the environment from polychlorinated biphenyls (PCBs) within a one-mile reach of the undeveloped and residentially developed floodplains of Stony Creek, from its confluence with Wilson Ditch and to its confluence with the West Fork of the White River (hereafter collectively referred to as the undeveloped and residentially developed Stony Creek floodplains) (Figure 2).

By way of background, the United States Environmental Protection Agency (USEPA) first issued an Administrative Order on Consent (AOC) to Firestone in 1990. Under the 1990 AOC, Firestone was required to perform a RCRA Facility Investigation (RFI) and perform a Corrective Measures Study (CMS) to identify and evaluate alternatives to prevent or mitigate the release of hazardous constituents from the facility (USEPA 1990). Under the 1992 Amendment to the AOC, Firestone was required to expand the RFI and implement interim remedial measures to reduce groundwater contamination originating from the Firestone facility (USEPA 1992). Firestone completed the work set forth in the 1990 AOC and 1992 Amendment to the AOC with the submittal of a CMS in 1998 (CELS 1998). Following a review and public comment period, USEPA selected final corrective measures in 2000. Firestone executed a second AOC with USEPA on March 29, 2001, to implement the following corrective measures: private well sampling, continued operation and monitoring of the groundwater extraction and treatment system, institutional controls, remedial actions in Wilson Ditch, and Stony Creek fish and sediment monitoring. The corrective measures to address PCBs in Wilson Ditch were completed in 2005. The Construction Completion Report for the Wilson Ditch remediation (MCMS 2006) was approved by USEPA in August 2006. In addition to the work performed by Firestone pursuant to the 2001 AOC, Firestone completed a Stony Creek Supplemental Investigation Project (SCSIP) to identify areas within the Stony Creek system that had PCB concentrations exceeding the 1 milligram per kilogram (mg/kg)[2] Toxic Substances Control Act (TSCA) cleanup objective. The SCSIP led to the characterization of the extent of PCBs in Stony Creek downstream of its confluence with Wilson Ditch, the undeveloped floodplain, and the residential properties along Stony Creek (Figure 2).

This CMP is organized as follows: Section 2 describes current conditions in Stony Creek and its floodplains. Section 3 identifies the corrective measures objectives and options for the undeveloped and residentially developed Stony Creek floodplains. Section 4 describes the

[2] Throughout this CMP, sediment and soil PCB concentrations are reported on a dry weight basis.

threshold and balancing criteria used to evaluate each corrective measure option. Section 5 summarizes the proposed corrective measures for the undeveloped and residentially developed Stony Creek floodplains, and Section 6 describes the public involvement plan. Section 7 includes the summary and conclusions, and finally, Section 8 lists references.

2 Description of Current Conditions

This section describes current conditions in the reach of Stony Creek downstream of the confluence with Wilson Ditch and its undeveloped and residentially developed floodplains, with respect to the site setting and history of operations, regulation, investigation, and remediation. This section describes the nature and extent of PCBs in Stony Creek sediment, biota, and floodplain soil, as well as the findings of the various risk assessments completed for the Stony Creek system.

2.1 Site Setting

Two distinct areas are addressed in this CMP: a) the undeveloped floodplain west of the reach of Stony Creek that is downstream of the confluence with Wilson Ditch; and b) the residential properties along that same reach of Stony Creek. For purposes of this report, these two areas are collectively referred to as the Stony Creek floodplain, even though they represent only a very small portion of the overall Stony Creek floodplain. The Stony Creek floodplain is a small part of the larger Stony Creek watershed, which also encompasses Stony Creek upstream of its confluence with Wilson Ditch, tributaries to Stony Creek, and all of the land that is drained by those tributaries and Stony Creek itself.

The reach of Stony Creek between its confluence with Wilson Ditch and Allisonville Road is approximately 0.8 miles in length and 20 to 40 feet (ft) wide, depending on season and recent precipitation. Stony Creek is “flashy,” in that its depth and flow are strongly affected by storm events and seasonal runoff. The creek routinely overtops its banks.

The undeveloped western floodplain of Stony Creek is a generally flat 59-acre patch of wetland and forested land within the Stony Creek watershed (Figure 3). The undeveloped floodplain is divided into two areas, the larger of which (approximately 49 acres) is designated as the Conservation Easement Area. It is a compensatory wetland leased by the city of Noblesville for 50 years. This area is also subject to a conservation easement in favor of the Central Indiana Land Trust, Inc. (CILTI), and therefore is not open to the general public. The smaller of the two areas of the undeveloped floodplain—designated as the Island Area—is surrounded by two branches of Stony Creek and is owned in separate parcels by five residents of neighboring Audubon Court. Land cover in the undeveloped floodplain consists of 37 acres of bottomland, riparian forest and roughly 22 acres of forested wetland and fallow field habitat, which was an agricultural hayfield through the 1990s. It was recently planted with tree seedlings as part of a compensatory wetlands mitigation program.

Two residential neighborhoods are located along Stony Creek between its confluence with Wilson Ditch and Allisonville Road: James Place and Wellington Northeast. A total of 45 residential properties are located along either Stony Creek or the undeveloped floodplain and have backyards that are subjected to periodic flooding of Stony Creek.

2.2 Site History

Between 1936 and 2009, Firestone operated a rubber products manufacturing facility at 1700 Firestone Boulevard in Noblesville, Indiana. PCB-containing heat-transfer fluid was used at the facility in the late 1960s and early 1970s. It is believed that floor and roof drain outfalls at the facility released PCBs to Wilson Ditch, an engineered drainage channel that flows south from the Firestone property boundary for approximately 3,400 ft before draining into Stony Creek. A 1984 investigation by Firestone first identified the presence of PCBs in Wilson Ditch sediment (Woodward-Clyde 1985). Those findings, in addition to the detection of volatile organic compounds in residential wells west of the Firestone property boundary, prompted an AOC between USEPA and Firestone in 1990. The 1990 AOC described Firestone's corrective action obligations under the RCRA Corrective Action Program.

Under the 1990 AOC, Firestone was required to: a) sample all residential, public, and industrial wells within 0.25 mile of the facility boundary and submit results to USEPA; b) implement tasks named in a preliminary RFI work plan and submit a final RFI report upon completion; and c) submit and implement a CMS work plan. Firestone tested all residential, public, and industrial wells in accordance with the AOC and found detectable concentrations of volatile organic compounds in both on-site supply wells and residential wells near the facility. Firestone supplied affected residents with bottled water and later installed an extension to the municipal water supply system for the affected residents (CELS 1998). In addition, a groundwater treatment system was installed to remediate groundwater at the facility (Dames & Moore 1992). Firestone submitted the RFI Phase II Report to USEPA in 1993 (Dames & Moore 1993) and the CMS (CELS 1998) in 1998. USEPA selected corrective measures in 2000, following a public review and comment period.

In March 2001, Firestone and USEPA executed a second AOC (USEPA 2001). Under the 2001 AOC, Firestone was obligated to implement the following corrective measures: a) private well sampling; b) groundwater extraction and treatment; c) source isolation; d) enhanced infiltration pilot study; e) *in-situ* source reduction; f) institutional controls; g) fish and sediment monitoring in Stony Creek; h) relocation and excavation of on-site portions of Wilson Ditch; and i) excavation and lining of off-site portions of Wilson Ditch. The Stony Creek fish and sediment monitoring program, as well as groundwater extraction, treatment, and sampling, are ongoing. Corrective measures for Wilson Ditch were completed in 2005, as documented in the Construction Completion Report that Firestone submitted to USEPA in 2006 (MCMS 2006).

Firestone voluntarily implemented the SCSIP, following collection of residential floodplain soil samples in 2006 that indicated the presence of PCBs at concentrations exceeding 1 mg/kg (Round 1; CEC 2007). A comprehensive residential soil sampling program was conducted in 2006 and 2007 (Rounds 2 and 3, respectively), in which approximately 20 properties were identified with PCB concentrations greater than 1 mg/kg in surface soil (CEC 2007). Round 4 of the SCSIP was conducted in 2008 for purposes of refining the spatial delineation of PCBs in surface and subsurface soils at some residential properties. In 2008 and 2009, Firestone implemented interim measures (focused soil excavation, backfilling with clean soil, planting vegetative cover) at 26 residential properties adjacent to Stony Creek even though the sampling demonstrated that excavation was only required at 4 properties to achieve site-specific closure standards. Firestone also investigated PCB concentrations in soil and biota in the undeveloped floodplain in 2008 to support a human health risk assessment (HHRA) and a baseline ecological risk assessment (BERA) for that area.

In 2009, Firestone conducted a similar soil investigation at residential properties along the lower reach of Wilson Ditch. Analysis of soil samples obtained from low spots along the ditch indicated that concentrations of PCBs in soil samples were either not detected or were very low (Premier 2009a). PCB concentrations did not exceed risk-based cleanup concentrations. This investigation demonstrated that the remedy prescribed in the 2000 Record of Decision and the 2005 remedial action were effective and that no further investigation of this area is warranted.

Firestone also investigated PCB concentrations in soil and biota in the undeveloped floodplain in 2008 to support a human health risk assessment (HHRA) and a baseline ecological risk assessment (BERA) for that area.

2.3 Summary of Sampling Programs

As noted above, the following sampling programs have been conducted within Stony Creek and its floodplains: a) Stony Creek sediment monitoring; b) Stony Creek fish tissue monitoring; c) Rounds 1 through 4 of the SCSIP; d) floodplain soil sampling from residential properties along Wilson Ditch; e) floodplain soil sampling in the undeveloped floodplain; and e) biota sampling in the undeveloped floodplain. While the purpose of this CMP is to set forth the decision making criteria for remediation at the undeveloped and residentially developed Stony Creek floodplains, investigations of the Wilson Ditch floodplain and Stony Creek itself conducted as part of the 2001 AOC are also summarized below, in order to provide the full context for this CMP as well as to respond to community concerns voiced in 2008. In addition, the enhanced sampling program for Stony Creek sediments and fish, approved by USEPA in the 2009 workplan are also presented.

2.3.1 Stony Creek Sediment Monitoring Methods and Results

Firestone has collected sediment samples from Stony Creek during five different sampling events in 2003, 2005, 2006, 2007, and 2009. The sediment sampling conducted in 2003, 2005, and 2007 followed methods outlined in the 2001 Quality Assurance Project Plan (Firestone 2001). During these three sampling events, composite sediment samples were collected from three locations in Stony Creek: the confluence of Wilson Ditch and Stony Creek, the confluence of Stony Creek and the West Fork of the White River, and a station midway between the two other stations. Sediment samples collected in 2003, 2005, and 2007 were analyzed for PCB Aroclors using modified USEPA Method 8082.

Sediment samples were also collected from Stony Creek in 2006 under Rounds 1 and 2 of the SCSIP (as discussed in greater detail in Section 2.3.3), following a different sampling design than that used in 2003, 2005, and 2007 (Firestone 2006). In 2006, 144 surface sediment samples were collected along the entire length of Stony Creek between the confluence with Wilson Ditch and the West Fork of the White River. The 2006 sediment samples were analyzed for PCB congeners and total organic carbon (TOC).

In 2009, with USEPA approval, Firestone submitted an enhanced sediment sampling design (ENVIRON 2009e) to ensure repeatability and definitiveness. The enhanced sediment sampling design included twenty four transects established approximately every 200 ft along the length of Stony Creek. One composite sample from 0 to 6 inch depth and one from 6 to 12 inch depth were collected from each transect – resulting in a total of 48 composite samples. Sediment samples were analyzed for PCB Aroclors by modified USEPA Method 8082 and for TOC.

Table 1 summarizes sediment chemistry results from 2009, while the complete dataset is provided in the monitoring report (ENVIRON 2009f). As shown in Table 1, the 95 percent (%) upper confidence limit on the mean (95% UCL) concentration of PCBs in surface (0 to 6 inches) sediment is 0.69 mg/kg, based on the 24 samples collected in 2009. The 95% UCL concentration of PCBs in subsurface (6 to12 inches) sediment is 0.74 mg/kg, based on the 22 samples collected in 2009. The results of the 2009 sediment sampling were also combined with historical sediment data to explore changes in the sediment PCB concentration over time. Summary statistics for sediment results collected from 2003 to 2009, segregated by year, are presented in Table 2. Although there are substantial differences in sample sizes between monitoring events, there is a clear trend of decreasing concentrations of PCBs over time. Based on the average values, the PCB concentration in 2009 is less than 10% of the value reported in 2003 (Table 2). In addition, the average concentration has consistently decreased with every sampling event since 2003.

2.3.2 Stony Creek Fish Tissue Monitoring Methods and Results

Firestone and its contractors have collected fish tissue samples from Stony Creek in 2001, 2003, 2005, 2006, 2007, and 2009. Although the Indiana State Board of Health apparently collected fish tissue samples from Stony Creek as early as 1984, information is not available on sampling locations, methods, analytical methods, and quality control. Even for the fish tissue sampling events conducted since 2001, fish species, sample matrices (i.e., fillet or whole body), size class, and PCB analytical methods (i.e., Aroclors or congeners) have not been consistent. Thus, based on data collected prior to 2009, it is difficult to discern trends in concentrations over time, or across species or locations. Samples were analyzed for PCB Aroclors in 2001, 2003, 2005, 2007 and 2009, while samples collected in 2006 were analyzed for PCB congeners. ENVIRON (2009e) details the methods and results of the pre-2009 sampling events. Given the inconsistencies in fish monitoring methods across sampling events, an enhanced sampling program was proposed for the 2009 monitoring event (ENVIRON 2009e) and approved by USEPA. Thus, the following discussion focuses on the 2009 sampling event.

The 2009 fish monitoring event targeted three trophic levels, as represented by three species: green sunfish (*Lepomis cyanellus,* a forage fish species), Northern hog sucker (*Hypentelium nigricans*, a benthivorous fish species), and rock bass (*Ambloplites rupestris*, a piscivorous fish species). Green sunfish and rock bass were collected for analysis of skin-on fillet concentrations and reconstructed whole body concentrations; Northern hog sucker were collected for analysis of whole body concentrations. Recognizing that fish are mobile, the fish tissue monitoring program did not differentiate among sampling stations for fish. Rather, fish were collected from the entire length of Stony Creek from the confluence with Wilson Ditch to the confluence with the West Fork of the White River. Fish samples were homogenized in the laboratory, and the composite tissue samples were analyzed for PCB Aroclors, lipid content, and percent moisture.

Table 3 presents summary statistics for total PCBs in Stony Creek fish collected in 2009, while the complete dataset is provided in the monitoring report (ENVIRON 2009f). All samples had detectable concentrations of PCBs. Concentrations of PCBs in fillet samples were consistently lower than in whole body samples. For example, mean whole body total PCB concentrations ranged from 2.4 mg/kg (for Northern hog sucker) to 4.8 mg/kg (for green sunfish), while mean fillet concentrations ranged from 0.35 mg/kg (for rock bass) to 0.64 mg/kg (for green sunfish)[3].

2.3.3 Stony Creek Supplemental Investigation Project (Rounds 1-4) Methods and Results

The residentially developed floodplain of Stony Creek has been investigated under the SCSIP, which involved four rounds of sampling undertaken in 2006 (Round 1 and Round 2), 2007 (Round 3), and 2008 (Round 4). The methods and results from the first three rounds are presented in individual reports. Methods and results from all four rounds (cumulatively) are presented in numerous reports and ultimately concluded in HHRAs and Construction Completion Reports prepared for four groups of properties: James Place, Audubon Court and Stony Creek Circle, 106-130 Stony Creek Overlook, and 132-140 Stony Creek Overlook.

As detailed by Counsel in Environmental Law & Science (CELS 2006), in Round 1 of the SCSIP, 15 sediment samples were collected from the confluence of Wilson Ditch with Stony Creek. Seventeen sediment samples were collected from the “midpoint” location approximately halfway between the confluence of Wilson Ditch and Stony Creek and Allisonville Road. Four soil samples were collected from a residential property at the midpoint location. Concentrations of PCBs in sediment from the confluence ranged from below detection (with detection limits ranging from 0.59 mg/kg to 1.4 mg/kg) to 6.7 mg/kg. At the midpoint location, PCBs were detected in all four soil samples, at concentrations ranging from 1.3 mg/kg to 2.3 mg/kg. PCB concentrations in sediment from the midpoint ranged from below detection (with detection limits ranging from 0.56 mg/kg to 0.7 mg/kg) to 5.4 mg/kg.

As detailed by CELS (2007a), in Round 2 of the SCSIP, PCBs were analyzed in 109 sediment samples collected as composites of transects from 150 ft upstream of its confluence with Wilson Ditch down to the creek’s confluence with the West Fork of the White River. Most sediment

[3] Fish tissue PCB concentrations are reported on a wet weight basis throughout this CMP.

transects have PCB concentrations less than 1 mg/kg. The overall average concentration of PCBs in sediment collected under Round 2 was approximately 1 mg/kg; PCB concentrations in sediment ranged from below detection (with detection limits ranging from 0.53 mg/kg to 0.76 mg/kg) to 7.8 mg/kg. Under Round 2, PCBs were also analyzed in 36 floodplain soil samples collected from low-lying terraces in residential backyards, as well as the undeveloped floodplain. Concentrations of PCBs in floodplain soil samples collected under Round 2 ranged from below detection (with detection limits ranging from 0.5 mg/kg to 5 mg/kg) to 12 mg/kg.

As detailed by CELS (2007b), in Round 3 of the SCSIP, low-lying terraces in residential backyards were further characterized. The Round 3 report presents floodplain soil results from 79 locations not previously sampled, as well as 23 locations previously sampled and reported in the SCSIP Round 1 and 2 reports. In total, the Round 3 report provides floodplain soil results for 31 parcels along Stony Creek. Concentrations of PCBs in floodplain soil samples collected under Round 3 range from below detection (with detection limits ranging from 0.55 mg/kg to 0.76 mg/kg) to 45 mg/kg. Based on the results of the Round 3 investigation and initial results from the Round 4 investigation, Firestone, with USEPA's approval, conducted risk assessments at the 29 properties where PCBs were detected in soil samples exceeding 1 mg/kg.

In place of a Round 4 SCSIP report, methods and results from all four rounds of sampling are compiled in a series of HHRAs (ENVIRON 2008a, 2009b,c,d) and Construction Completion Reports (ARCADIS 2008a, 2009a,b, Premier 2009b) that document pre-excavation and post-excavation conditions at all of the residential properties.

2.3.4 Wilson Ditch Residential Sampling Methods and Results

In April and May of 2009, in response to 2008 comments by the community, Firestone voluntarily collected soil samples from residential properties along Wilson Ditch to confirm that PCBs were not present in soil above the risk-based closure levels developed for the residentially developed Stony Creek floodplain. This sampling program, conducted by Premier (2009a), was outside of the scope of the implementation of corrective measures in Wilson Ditch in 2005. Sample locations targeted low-lying depositional areas that appeared to be the most likely places in which sediment deposition could have occurred during historical flooding events. PCBs were not detected in six of the ten sample grids. Where they were detected, concentrations were consistently below the risk-based closure levels for surface soil (3.8 mg/kg) and soil from all depths (27 mg/kg) demonstrating that the remedial action prescribed by the 2000 Record of Decision and the 2005 remedial action was effective.

2.3.5 2008 Undeveloped Floodplain Soil Sampling Methods and Results

In October 2008, ENVIRON collected 37 floodplain surface (0 to 6 inches) soil samples from the Conservation Easement Area and 8 soil samples from the Island Area. Samples were collected from the upper six inches of soil to best represent the depth interval contacted most frequently by human and ecological receptors. This sampling depth interval is also consistent with the IDEM (2006) definition of surface soil for risk assessment purposes. Furthermore, in this floodplain environment, where subsurface soils are frequently saturated, burrowing mammals and their prey are unlikely to spend significant time in the deeper soils due to the high moisture content.

Sampling methods were consistent with those described in the Risk Assessment Work Plan (ENVIRON 2008b). All 45 soil samples were analyzed for PCB homologues (a subset of 10 samples was also analyzed for PCB Aroclors for comparability with historical data). Total PCB homologue concentrations in soil ranged from 0.0098 mg/kg to 41 mg/kg, as illustrated in Figure 4. Concentrations of PCBs in all but two samples were below 5 mg/kg. The two highest measured concentrations (28 mg/kg and 41 mg/kg) were detected adjacent to and immediately downstream of the Island Area, respectively. Concentrations generally decrease with distance from Stony Creek, consistent with the expected mechanism of transport (i.e., deposition of sediment on the floodplain during flooding of Stony Creek). Concentrations also generally decrease with the direction of flow of Stony Creek (i.e., from north to south).

2.3.6 2008 Undeveloped Floodplain Biota Sampling Methods and Results

Biological tissue was sampled in October 2008 in order to characterize chemical concentrations in potential food items for wildlife. As detailed in the Risk Assessment Work Plan (ENVIRON 2008b), biota targeted for collection during the October 2008 sampling event consisted of terrestrial invertebrates and small mammals and were co-located with surface soil samples, to the greatest extent possible.

Ten samples of terrestrial invertebrates (primarily earthworms) were collected using a shovel or stainless steel trowel to repeatedly turn over surface soil.

One white-footed mouse (*Peromyscus leucopus*) was collected at each of five locations, whereas one short-tailed shrew (*Blarina brevicauda*) was collected at each of three locations. Each small mammal sample was submitted individually for tissue analyses, consistent with the Risk Assessment Work Plan (ENVIRON 2008b).

Figure 5 presents the individual biota sample locations and concentrations along with the co-located soil concentrations. Concentrations of PCBs in terrestrial invertebrates and small mammals are generally similar. Concentrations of PCBs in terrestrial invertebrates tend to decrease with distance from Stony Creek. Small mammal concentrations vary with the feeding guild of the organism. Shrews are carnivorous; they feed mostly on insects, worms, other invertebrates, and even small mammals and birds (USEPA 1993). Mice are generally herbivorous, feeding mostly on seeds, fruits, vegetation, and fungi, although they also occasionally consume invertebrates (USEPA 1993). Concentrations of PCBs in two of the three shrews analyzed were substantially higher than those in the other mammal samples. This is not unexpected, given their carnivorous dietary habits. While concentrations in the three shrews were positively correlated with soil and invertebrate PCB concentrations, no such relationships were observed in mice.

2.4 Summary of Risk Assessments

Stony Creek and its floodplains have been the subject of several HHRAs and ecological risk assessments (ERAs). The objective of this subsection is to succinctly summarize the scope and findings of all pertinent risk assessments related to PCBs. Findings from ERAs are presented first, followed by findings from HHRAs. Again, although this CMP focuses only on the floodplains of Stony Creek, risks posed by PCBs in Stony Creek sediment and biota are also discussed in this subsection, in order to provide the full context for this interconnected system.

2.4.1 Stony Creek Aquatic Ecological Risk Assessment

Dames & Moore (1994) conducted a draft preliminary ERA as an addendum to the RFI Phase II report. The ERA focused exclusively on aquatic habitats within Wilson Ditch and Stony Creek, based on the assumption that aquatic habitats are likely the most sensitive and their receptors most highly exposed, compared to terrestrial habitats. It was assumed that if no adverse ecological effects were observed or predicted for aquatic habitats, then other local habitats and receptors also would not be adversely affected. Ecological risks associated with terrestrial habitats (i.e., the Stony Creek floodplain) were subsequently evaluated by ENVIRON (2010), as summarized in Section 2.4.2. Because this CMP does not address Wilson Ditch, only those aspects of Dames & Moore's (1994) ERA that pertain to Stony Creek are summarized here.

As described in 1994, the great blue heron (*Ardea herodias*), representing piscivorous birds, was selected as the principal receptor of concern for the ERA. Dietary exposure was assumed to be the dominant exposure pathway for great blue herons.

The maximum concentration of Aroclor 1248 in fish tissue at the time that the ERA was prepared—7.7 mg/kg—was used as a conservative representation of the great blue heron's dietary exposure. Based on the broader and more recent fish tissue data now available, this concentration is clearly conservative in that 95% UCL concentrations of PCBs in whole body fish samples collected in 2009 ranged from 2.4 mg/kg (for Northern hog sucker) to 4.8 mg/kg (for green sunfish). The toxicity quotient resulting from the 1994 ERA was 0.5, which is well below the acceptable benchmark of 1, indicating that piscivorous birds were unlikely to be adversely affected by the maximum concentration of PCBs in fish at the time the ERA was prepared.

2.4.2 Terrestrial Ecological Risk Assessment for the Stony Creek Floodplain

ENVIRON (2010) prepared the BERA for the undeveloped floodplain of Stony Creek between the confluence with Wilson Ditch and Allisonville Road. The objective of the BERA was to evaluate potential ecological risks from exposure to PCBs in floodplain soil and terrestrial prey. In particular, the BERA evaluated whether PCBs in soil and terrestrial prey are likely to adversely affect birds and mammals that may forage within the floodplain. Although the ENVIRON (2010) BERA focused on the undeveloped floodplain of Stony Creek, it is also protective of ecological exposures within the residentially developed floodplain. The wildlife habitat provided by the undeveloped floodplain is far more extensive and high quality than that provided by the residentially developed floodplain. Consequently, birds and mammals are likely to forage to a far greater extent in the undeveloped floodplain than in the residentially developed floodplain. Thus, findings for the undeveloped floodplain also serve as conservative estimates for the residentially developed floodplain.

Environmental media relevant to the ENVIRON (2010) BERA for which analytical data were available include floodplain soil, terrestrial invertebrates, and small mammals. Mean and 95% UCL concentrations of PCBs in floodplain surface soil are 2.5 mg/kg and 5.5 mg/kg, respectively. Mean and 95% UCL concentrations of PCBs in invertebrates are 0.44 mg/kg and 0.70 mg/kg, respectively. Mean and 95% UCL concentrations of PCBs in small mammals are 0.35 mg/kg and 0.81 mg/kg, respectively. Mean and 95% UCL concentrations are used to characterize the most likely and high end exposures, respectively.

The following assessment and measurement endpoints were evaluated in the BERA:

1. Survival and reproduction of invertivorous and carnivorous bird populations foraging in the floodplain of Stony Creek: Comparison of estimated PCB doses for American robins (*Turdus migratorius*) and American kestrels (*Falco sparverius*) to species-specific toxicity data (expressed as doses) derived from the scientific literature.

2. Survival and reproduction of insectivorous and carnivorous mammal populations foraging in the floodplain of Stony Creek: a) Comparison of estimated PCB doses for short-tailed shrew, red fox (*Vulpes vulpes*), mink (*Mustela vison*), and Indiana bat (*Myotis sodalis*) to toxicity data (expressed as doses) derived from the scientific literature; b) comparison of estimated PCB body burdens in mink to toxicity data (expressed as tissue concentrations) derived from the scientific literature.

Based on the overall weight-of-evidence presented in the ENVIRON (2010) BERA, wildlife populations foraging in the Stony Creek floodplain—both the undeveloped and the residentially developed portions—are unlikely to be adversely affected by current concentrations of PCBs in soil or diet. The results of the BERA support a conclusion that, other than continued monitoring of fish in Stony Creek (as stipulated in the 2001 AOC and discussed in Section 2.3.2 above), no further investigation is warranted.

2.4.3 Stony Creek Human Health Risk Assessment (Sediment Exposures)

ChemRisk (1996) prepared a HHRA in support of the 1998 CMS (CELS 1998). Of the numerous on-site and off-site exposure scenarios evaluated in the 1996 HHRA, one is pertinent to Stony Creek: recreational contact by children with Stony Creek sediment.

Based on the assumptions discussed in the 1996 HHRA, ChemRisk (1996) reported an estimated cancer risk of 2×10^{-7} for Stony Creek recreators. This value is well below the lower bound of USEPA's range of acceptable cancer risks (1×10^{-6} to 1×10^{-4}), as well as the Indiana Department of Environmental Management's (IDEM's) benchmark of 1×10^{-5}, indicating that cancer risks associated with recreational activity in Stony Creek were acceptable. The noncancer hazard index (HI) of 0.06, is also well below USEPA's and IDEM's benchmark of acceptable noncancer hazard (i.e., 1), indicating that noncancer hazards also were acceptable. Given the 10-fold decrease in concentrations of PCBs in sediment since this HHRA was issued, current risks are significantly lower than those predicted by ChemRisk (1996).

2.4.4 Human Health Risk Assessment for the Undeveloped Floodplain of Stony Creek (Soil Exposures)

ENVIRON (2009a) prepared an HHRA for the undeveloped floodplain of Stony Creek between the confluence with Wilson Ditch and Allisonville Road. The objective of the HHRA was to evaluate potential human health risks from exposure to soil in the undeveloped floodplain of Stony Creek. The HHRA was streamlined, in that soil concentrations were compared to risk-based closure levels calculated based on long-term recreational exposure to surface soil. Based on factors discussed in the 2009 HHRA, the recreational risk based concentration (RBC) for surface soil is 34 mg/kg.

Potential human health risks are evaluated by comparing measured exposure point concentration (EPC) for soil to the recreational risk-based closure level. The 95% UCL concentration for surface soil in the undeveloped floodplain is 5.2 mg/kg, well below the recreational risk-based closure level.

Given that the EPC of 5.2 mg/kg for surface soil is well below the recreational RBC of 34 mg/kg, predicted cancer risks are below the IDEM Risk Integrated System of Closure (RISC) program's default acceptable cancer risk level of 1 in 100,000 (1×10^{-5}) (IDEM 2006). Noncancer hazards are also below IDEM's acceptable HI. Thus, conditions in the undeveloped floodplain of Stony Creek do not pose unacceptable risks or hazards based on IDEM criteria.

Cancer risks are also within the acceptable incremental cancer risk range of 1×10^{-6} to 1×10^{-4}, defined by USEPA in the Superfund National Contingency Plan for the selection of remedial actions that protect human health and the environment. USEPA (1991) has stated that remediation generally is not warranted for a contaminated property if the cumulative cancer risk is less than 1×10^{-4}. Noncancer hazards are below USEPA's acceptable HI of 1 in the study area. Thus, conditions in the study area do not pose unacceptable risks or hazards based on USEPA criteria. Based on these findings, soil in the undeveloped floodplain of Stony Creek poses no unacceptable risk for reasonably foreseeable land uses under either IDEM or USEPA criteria.

2.4.5 Human Health Risk Assessments for Residential Properties Along Stony Creek (Soil Exposures)

ENVIRON prepared four HHRAs for the residential properties along Stony Creek (ENVIRON 2008a, 2009b,c,d). The HHRAs evaluated potential human health risks from exposure to soil in four groups of residential parcels along Stony Creek: James Place (Monticello Court and

Overland Court), Audubon Court and Stony Creek Circle, 132–140 Stony Creek Overlook, and 106-130 Stony Creek Overlook (Figure 2). In total, 29 residential properties were evaluated in the HHRAs. Like the HHRA for the undeveloped floodplain, the HHRAs for the residential properties along Stony Creek were streamlined, in that soil concentrations were compared to risk-based closure levels. The residential RBC for surface soil is 3.8 mg/kg, and the construction worker RBC for all soil depths is 27 mg/kg.

Potential human health risks were evaluated by comparing measured soil concentrations (the EPC) to the residential and construction worker risk-based closure levels. In most cases the EPC was calculated as the 95% UCL concentration of PCBs in surface soil (0 to 6 inches) and subsurface soil (all depths). However, USEPA agreed to the use of a spatially-weighted average concentration (SWAC) as the EPC, in cases where the 95% UCL concentration exceeded the risk-based closure level.

Depending on the property, the 95% UCLs in residential surface soil ranged from 0.52 mg/kg to 6.8 mg/kg, while the 95% UCLs in soils from all depths ranged from 0.65 mg/kg to 19.6 mg/kg. While the 95% UCL concentrations of PCBs in soils from all depths were all below the construction worker RBC (i.e. 27 mg/kg), 4 residential properties had pre-excavation EPCs of PCBs in surface soil above the residential risk-based closure level (i.e., 3.8 mg/kg): 199 Overland Court, 240 Overland Court, 130 Stony Creek Overlook, and 116 Stony Creek Overlook. Following soil excavation, backfilling, and revegetation (see Section 2.5.3), 95% UCL concentrations of PCBs in surface soil at all properties were below the applicable risk-based closure level. In addition, noncancer HIs were below 1 at all properties. Thus, surface and subsurface soils at the residential properties along Stony Creek do not pose unacceptable risks for reasonably foreseeable land uses, including all residential land uses.

2.5 Corrective Measures Already Implemented

Several corrective measures have already been implemented within Stony Creek and its floodplains. First, in 1984, the Indiana Department of Health implemented a fish consumption advisory that recommends no consumption of any fish caught from Stony Creek[4]. The advisory is still in effect. Second, in accordance with the 2001 AOC, Firestone removed PCB-contaminated sediment from Wilson Ditch in 2005. This action eliminated what had been an ongoing source of PCBs to Stony Creek and its floodplain. Third, the 2001 AOC specified monitored natural recovery (MNR) for Stony Creek; thus, Firestone has monitored Stony Creek sediment and fish since 2001. This monitoring program has documented a steady decline in PCB concentrations in sediment and fish tissue both since the start of the monitoring program and since the 2005 source control action for Wilson Ditch. Fourth, in 2008 and 2009, Firestone voluntarily excavated, backfilled, and revegetated floodplain soils in 26 residential parcels along Stony Creek. Firestone also implemented landscape improvements at three other properties, at the homeowners' requests. Although pre-excavation conditions had not posed unacceptable

[4] http://www.in.gov/isdh/files/2008_FCA_Booklet.pdf

risks to human health at the vast majority of properties, soil remediation was undertaken to accommodate homeowner preferences. This subsection further describes the three types of corrective measures that have already been implemented for the Stony Creek system.

2.5.1 Wilson Ditch Source Control

Between July and November 2005, Firestone remediated soil and sediment containing PCBs in portions of Wilson Ditch, in accordance with the Corrective Measures Implementation Design Report (MCMS 2005). Remedial activities focused on approximately 5,000 ft of Wilson Ditch upstream of its confluence with Stony Creek, as well as a small part of Stony Creek at the confluence. The key objectives of these corrective measures were to:

- Construct a new channel to reroute Wilson Ditch on the facility property
- Remove sediment and soil containing PCBs at concentrations above removal objectives from on-site and off-site portions of Wilson Ditch
- Remove soils containing PCBs at concentrations above removal objectives from the north and south access road areas
- Remove visibly contaminated sediments and sediments containing PCBs above removal objectives from a small section of Stony Creek

2.5.2 Stony Creek Monitored Natural Recovery

MNR was selected as the corrective measure for Stony Creek in the March 29, 2001 AOC (USEPA 2001). The 2001 AOC stipulated that sediment and fish tissue concentrations were to be monitored to ensure that concentrations of PCBs are diminishing in Stony Creek. The AOC established threshold PCB concentrations in sediment and fish of 1 mg/kg and 2 mg/kg, respectively. MNR includes leaving Stony Creek sediment in place (except that which was removed at the confluence with Wilson Ditch, as described above) and allowing physical, chemical, and/or biological processes to contain, destroy, alter, or otherwise reduce the bioavailability and toxicity of PCBs (NRC 1997), while undertaking long-term monitoring to verify that risk reduction is occurring.

In July 2009, ENVIRON (2009e) proposed updated sampling and analytical methods to support the monitored recovery of Stony Creek. USEPA approved that plan on August 14, 2009. The updated monitoring plan increased the spatial extent of sediment and fish tissue sampling, increased the sample sizes for both sediment and fish, and standardized the target fish species in order to allow for improved differentiation of incremental decreases in sediment and fish tissue concentrations over time. The updated monitoring plan was designed to answer the following two decision rules:

- Does the 95% UCL concentration in sediment exceed 1 mg/kg?

- Do the 95% UCL concentrations in fish tissue samples representing three feeding guilds (i.e., forage fish, benthic feeding fish, and predatory fish) exceed 2 mg/kg?

The primary goal of the changes described in the monitoring plan is to maximize statistical rigor and, consequently, improve clarity and certainty in decision making. It may also be appropriate to suspend fish tissue monitoring (or to decrease sampling frequency) once sufficient data have been collected that it is possible to predict with reasonable certainty the time required to attain the target concentration of 2 mg/kg in representative species of the three feeding guilds.

Methods and results of the 2009 monitoring program are detailed in Sections 2.3.1 and 2.3.2 above, as well as in the monitoring report (ENVIRON 2009f). Concentrations of PCBs in sediment and fish have steadily declined both since 2001 and since the 2005 source control Wilson Ditch removal action. Based on the 2009 sampling results, no additional sampling or analysis is necessary for sediment or for fish fillet samples. Firestone will continue to biennially monitor whole body fish from three trophic levels (eight samples each of green sunfish, Northern hog sucker, and rock bass) until the 95% UCL concentration of PCBs for each species no longer exceeds the target concentration of 2 mg/kg or sufficient data have been collected to allow prediction (with reasonable certainty) of time to achieve that goal.

2.5.3 Residential Soil Removal

In 2008 and 2009, Firestone voluntarily implemented interim remedial measures at 29 residential properties along Stony Creek. At 26 of those properties, Firestone excavated soil from selected grids in the back yards and backfilled the excavated areas with clean topsoil. The properties were restored based on a complementary landscape plan for the floodplain that focused on native understory plantings. At three properties where excavation was not conducted, Firestone implemented landscape enhancements with the objectives of mitigating erosion and contact with soil. All residential remediation activities are documented in four Construction Completion Reports (ARCADIS 2008a, 2009a,b, Premier 2009b). It is worth noting that, even before remedial measures were implemented, predicted cancer risks were below IDEM RISC program's default acceptable cancer risk level of 1 in 100,000 (1×10^{-5}) at 25 of 29 properties evaluated. Estimated risks posed at all 29 properties were within USEPA's acceptable cancer risk range of 1×10^{-6} to 1×10^{-4} prior to remediation. Nonetheless, at the request of homeowners, Firestone undertook extensive interim measures, as detailed in the Construction Completion Reports. Following the completion of these interim remedial measures, excess lifetime cancer risks were well below the acceptable cancer risk level and concentrations of PCBs in soils were consistently less than the risk-based closure levels of 3.8 mg/kg and 27 mg/kg for surface soil and soil from all depths, respectively.

PCBs were first identified in Wilson Ditch sediments in 1984, prompting AOCs between USEPA and Firestone in 1990 and 2001 that described Firestone's corrective action obligations at the facility. The first AOC in 1990 addressed corrective actions within one-quarter mile of Firestone's property. The second AOC in 2001 included corrective actions for Wilson Ditch, Stony Creek, and groundwater near Firestone's property.

Since the issuance of the 2001 AOC, Firestone has conducted the following sampling programs within the Stony Creek study area: a) fish tissue and sediment monitoring samples have been collected from Stony Creek from 2001 through 2009; b) the SCSIP was conducted to identify areas within the Stony Creek system that had PCB concentrations exceeding the TSCA cleanup objective of 1 mg/kg; c) soils were collected at residences and other properties along Wilson Ditch to verify that PCBs had not been deposited during flood events; and d) soil and biota samples were collected from the undeveloped floodplain of Stony Creek in 2008.

Potential risks to human health and the environment were evaluated for Stony Creek and its floodplains. The ERAs indicated that wildlife foraging within Stony Creek or its floodplains are unlikely to be adversely affected by current concentrations of PCBs in soil, sediment, or their diet. Potential cancer and noncancer risks from exposures to soil and sediment from Stony Creek and the undeveloped floodplain were determined to be acceptable. Following soil excavation, backfilling, and revegetation of residential properties in 2008 and 2009, surface and subsurface soils at all residential properties along Stony Creek do not pose unacceptable cancer or noncancer risks for reasonably foreseeable land uses, including all residential land uses.

The following corrective measures have already been implemented within the Stony Creek system: a) institution of a fish advisory in 1984; b) Wilson Ditch source control in 2005; c) Stony Creek MNR since 2001; d) residential soil removal in 2008 and 2009.

3 Corrective Action Objectives and Options

The goals of this section are to define the underlying objectives for any corrective measures that have been or may be undertaken—i.e., the goals of remediation—and to describe options—i.e., different corrective measures—for accomplishing those goals. This analysis considers the undeveloped floodplain of Stony Creek downstream of its confluence with Wilson Ditch and the residential properties along that same reach of Stony Creek. Corrective action objectives and options for these two portions of the Stony Creek floodplain focus on PCB-impacted soil. It is important to note that it is not unusual for a CMP to consider as options interim actions and remedies that have already been implemented. For example, the "no action" alternative for the residential properties along Stony Creek would not take into account the Wilson Ditch remediation completed in 2005 or the 2008-2009 residential soil removal interim actions. In this manner, this CMP fully documents the system-wide benefits of the corrective measures in the two areas of the Stony Creek floodplain that are the subject of this CMP—the Undeveloped Floodplain and the Residential Properties.

3.1 Corrective Measures Objectives and Options for the Undeveloped Floodplain of Stony Creek

This subsection presents the overall objectives for any corrective measure taken to address PCB-contaminated soils in the undeveloped floodplain of Stony Creek. It then describes options for accomplishing those goals in the undeveloped floodplain.

3.1.1 Corrective Measures Objectives for the Undeveloped Floodplain of Stony Creek

Objectives for the application of corrective measures in the undeveloped floodplain of Stony Creek include protection of human health and the environment, habitat preservation or enhancement, and minimization of disruption to the community and environmental demands posed by the corrective measures. Each of these objectives is further described below.

To Support Conditions within the Study Area that do not pose Adverse Population- or Community-Level Effects to Wildlife – This objective focuses on the maintenance of current ecological conditions within the undeveloped floodplain of Stony Creek, particularly relative to the assessment endpoints evaluated in the BERA (ENVIRON 2010): a) survival, reproduction, and growth of invertivorous and carnivorous bird populations foraging in the floodplain of Stony Creek; and b) survival, reproduction, and growth of insectivorous and carnivorous mammal populations foraging in the floodplain of Stony Creek. As discussed in Section 2.4.2, under current conditions, PCBs in floodplain soil and biota do not pose population- or community-level risks to wildlife in a variety of feeding guilds.

To Support Conditions within the Study Area that do not Pose Adverse Individual-Level Effects to Threatened, Endangered or Special Concern Species – This objective also focuses on the maintenance of current ecological conditions in the undeveloped floodplain of Stony Creek, particularly with respect to threatened, endangered or special concern species. For such species, including the bald eagle (*Haliaeetus Leucocephalus*) and the Indiana bat, local populations may already be sufficiently stressed (irrespective of chemical exposures) that adverse effects to individual organisms may have population level consequences. Although there is no evidence that either species actually is or has been present in the Stony Creek floodplain, their habitat preferences and ranges suggest that they could forage there. Because these are the only two protected terrestrial species that can reasonably be expected to forage within the floodplain, they are the focus of this objective. As discussed in Section 2.4.2, current concentrations of PCBs in floodplain soil and biota are not expected to adversely affect either Indiana bats or bald eagles. Individual-level effects to the bald eagle were extrapolated from those predicted for the American kestrel, a surrogate species within the same carnivorous bird feeding guild as the bald eagle, but with a higher body-weight normalized food ingestion rate and area use factor.

To Preserve or Enhance Existing Habitat Quality within the Study Area – This objective focuses on the protection of the forested floodplain habitat. Within forested floodplains, habitat quality is largely a function of canopy cover, vegetation, microtopography, and hydrology. Active remediation within the floodplain would likely impact its habitat quality, in that removal of trees and other vegetation, soil compaction, and soil erosion would be largely unavoidable. Depending on the scale of any active corrective measures, habitat effects may be either localized or widespread and either short-term or long-term. Examples of activities that can preserve or enhance habitat quality include: protection of mature trees, maintenance of wetlands functions, and introduction of features such as bat boxes to enhance the attractiveness of the undeveloped floodplain for desirable species, such as bats.

To Preserve Existing Conditions within the Study Area with Respect to the Lack of Significant Risks to Human Health – This objective focuses on the protection of human health based on current and reasonably anticipated land uses within the undeveloped floodplain of Stony Creek. Because several residential neighborhoods surround the undeveloped floodplain of Stony Creek, the most plausible exposure scenario involves recreational use by neighboring children. As discussed in Section 2.4.4, under current land use conditions, concentrations of PCBs in floodplain soil do not pose significant risks to human health.

To Minimize Disruption and Disturbance of the Community, so that the Character of the Neighborhoods can be Maintained – This objective focuses on minimizing disruption to the local residents' quality of life during and after implementation of any corrective measure. Examples of possible sources of disruption include noise, vehicular traffic and related possibility of accidents, lights, access through private property, diminished privacy, removal of vegetation (particularly mature trees), trip/slip/fall hazards, and degradation of views. In short, the goal of this objective is to avoid negative effects on the quality of local residents' daily lives during or after the implementation of corrective measures.

To Use Best Management Practices of USEPA's Green Remediation Concepts to Reduce the Demands Placed on the Environment – This objective focuses on minimizing the environmental footprint associated with implementation of corrective measures within the floodplain. For example, any corrective measure's environmental footprint is influenced by fossil fuel and electricity use, emission of carbon and other air pollutants during remedy-related travel, removal of trees and other vegetation, water quality impacts (e.g., turbidity), soil erosion and/or compaction, waste generation, use of impermeable barriers that change drainage patterns, introduction of non-native species, and use of pesticides. Again, it would be nonsensical to pursue a corrective measure for which the environmental costs approach or exceed the benefits.

3.1.2 Corrective Measures Options for the Undeveloped Floodplain of Stony Creek

Based on current site conditions and pre-screening of measures likely to be effective in achieving the corrective measures objectives discussed above, five main corrective measure options were identified for the undeveloped floodplain of Stony Creek:

UF-CM1. No Action
UF-CM2. MNR
UF-CM3. Focused Habitat Enhancement with Vegetative Stabilization
UF-CM4. Capping
UF-CM5. Focused Excavation

These five options are summarized in Table 4 and are described in greater detail below.

UF-CM1: No Action – "No action" is the baseline case against which all other corrective measures are compared. For the undeveloped floodplain of Stony Creek, "no action" would have involved no institutional or engineered remedial actions, including the 2005 source control action at Wilson Ditch, and no additional study or monitoring. "No action" would have meant leaving all floodplain soils in place and taking no measures to reduce exposures to that soil or to enhance the existing habitat. Existing access restrictions would remain in place, however, at the discretion of current land owners and consistent with the existing conservation easement.

UF-CM2: MNR – Under MNR, floodplain soil would remain in place and existing natural processes would be allowed to contain, destroy, alter, or otherwise reduce the bioavailability and toxicity of chemicals in floodplain soil. In particular, the accumulation and degradation of leaf litter within the floodplain enriches surface soil with organic carbon; the high affinity of PCBs for organic carbon reduces the bioavailability of PCBs. In addition, the frequent (i.e., at least annual) flooding of Stony Creek results in deposition of silt on the floodplain soil. As a result of the 2005 source removal action in Wilson Ditch, sediment and suspended solids in Stony Creek have generally low concentrations of PCBs (below 1 mg/kg). When those materials are deposited on floodplain soil during flooding, concentrations of PCBs in the most accessible soils (i.e., surface soils) are reduced. MNR would include long-term monitoring of soils or biota to verify that conditions within the undeveloped floodplain are continuing to improve.

UF-CM3: Focused Habitat Enhancement with Vegetative Stabilization – Focused habitat enhancement involves two actions that will enhance the habitat property-wide and soil stability in the two areas of higher PCB concentration at the site. At the two areas of higher concentrations, appropriate vegetation will be selected and planted with the purpose of stabilizing soils in the areas to limit erosion, increasing deposition of clean sediments during flooding, and providing a vegetative barrier for humans, as well as wildlife. In addition, this alternative will include activities that will improve habitat for valued wildlife species, while avoiding any increase in their contact with PCBs. This option will focus on habitat enhancement for socially valued species expected to forage within the undeveloped floodplain—bats, including the federally protected Indiana bat. The BERA (ENVIRON 2010) demonstrated that the Indiana bat, despite its endangered status, is not currently at risk of adverse effects from the PCBs in prey within the undeveloped floodplain of Stony Creek, even when highly conservative assumptions regarding EPCs and area use factors are employed. Although there are no records of Indiana bats present in the undeveloped floodplain of Stony Creek, this area lies within the Indiana bat's range and provides suitable foraging and roosting habitat. However, in the likely event that Indiana bats never roost within the undeveloped floodplain of Stony Creek, this corrective measure option will also benefit other mammalian (particularly bat), avian, and plant species that are known to inhabit the area.

Portions of the undeveloped floodplain offer suitable bat habitat because many of the mature trees in the area provide the required roosting structure for breeding females (i.e., loose-barked trees, such as hickory and sycamore). In addition, the area is consistent with the characteristics of essential summer habitat due to the availability of permanent surface water within 0.3 miles of suitable roosting trees (e.g., the White River and Stony Creek) (Evans et al. 1998). Habitat enhancement actions will focus on summer habitat for bats, which may already be present in the area.[5] In particular, Firestone will erect artificial roosting sites (i.e., bat houses) and plant seedlings of tree species favored as summer roosts by bats. Bat houses will serve as short-term roosting habitat, while seedlings of loose-barked tree species (e.g., shagbark hickory (*Carya ovata*), shellbark hickory (*Carya laciniosa*), and eastern cottonwood (*Populus deltoides*) will eventually provide long-term roosting habitat, once they mature.

If this corrective measure option is selected, a detailed habitat enhancement plan will be prepared prior to initiating the work. The detailed plan will strive to replicate ideal roosting habitat conditions for bats, as described by numerous researchers (e.g., Sparks and Whitaker 2004, Menzel et al. 2001, Romme et al. 1995, American Consulting, Inc. 2002, Whitaker et al. 2006, Ritzi et al. 2005). Taking into consideration these researchers' recommendations, the detailed plan will strive to maximize roosting and foraging conditions favored by bats (including the Indiana bat), such as:

- Partially exposed loose barked species or trees with exfoliating bark

[4] http://www.in.gov/isdh/files/2008_FCA_Booklet.pdf

[5] In the winter, bats congregate in large numbers in hibernacula such as caves, which are not known to be present in the floodplain.

- Diameter at breast height greater than 15 inches
- Located in gaps in the canopy, such as along a fenceline or wooded edge, providing partial exposure to sunlight
- Suitable artificial roosts are birdhouse-style bat boxes arranged either individually or in a cluster of up to three boxes per tree

In general, the plan will specify placement of approximately 50 bird-house style bat boxes within canopy gaps in the forested portion of the undeveloped floodplain. One to three bat boxes will be placed per tree, oriented to the north, west, and south (per Ritzi et al 2005). Boxes will be placed 16 to 30 ft high in trees (per United States Fish and Wildlife Service [USFWS] 2007), so that the entrance is not obstructed by branches and boxes receive direct sunlight. Box placement will also be guided by preferred tree species (e.g., Evans et al. 1998), including:

Shellbark hickory *(Carya laciniosa)*	Mockernut hickory (*C. tomentosa)*
Shagbark hickory (*C. ovata*)	Honey locust (*Gleditsia triacanthos*)
Eastern cottonwood (*Populus deltoides*)	Northern red oak (*Quercus rubra*)
White oak (*Quercus alba*)	American elm (*Ulmus americana*)
American sycamore (*Platanus occidentalis*)	Slippery elm (*U. rubra*)
Sugar maple (*Acer saccharum*)	White or green ash (*Fraxinus americana* or *F. pennsylvanica*)

Firestone will also plant approximately 100 1- to 2-foot tall seedlings of shagbark hickory, shellbark hickory, and/or eastern cottonwood. Shagbark hickory is adapted to dry or mesic habitat, and is a facultative upland species, as defined using the USFWS Plant Indicator Status. Therefore, it will be planted in the more upland areas, outside of the Stony Creek Mitigation Wetlands Boundary, unless permission is received from the permit holders that planting of wetland tree seedlings along the forest border is acceptable. Shellbark hickory is a facultative wetland species while eastern cottonwood is a shade intolerant species that is more likely to occur in wetlands than in non-wetlands. Consequently, shellbark hickory and cottonwood seedlings will be planted within the undeveloped floodplain. Shellbark hickory will be planted in areas with a slightly open canopy that will receive some sunlight, while cottonwood seedlings will be planted in limited numbers only in open areas receiving full sunlight. These 3 tree species also differ in the time required to grow to maturity, requiring as little as 5 years for eastern cottonwood to as much as 100 years for hickory (Burns and Honkala 1990). Thus, planting a mixture of species will extend the overall duration of the habitat benefits achieved by this action.

If UF-CM3 is selected for the undeveloped floodplain, the detailed habitat enhancement plan will specify targeted seedling planting locations and densities, but will take into consideration optimal roost densities reported in the literature. For example, in their *Range-wide Indiana Bat Protection and Enhancement Plan Guidelines* developed under the Surface Mining Control and Reclamation Act of 1977, the USFWS (2009) recommends a "stocking success rate" (density of surviving seedlings) of 300 stems/acre. Menzel et al. (2001) report an optimal density of roost trees of 26 roost trees/acre for upland habitat and 17 roost trees/acre for floodplain. In developing the detailed plan, resultant densities (stems/acre) will reflect trees already present, as well as the potential for seedling mortality.

In developing the detailed plan for this option (if it is selected), Firestone will consult with the City of Noblesville, CILTI, and the Island Area's five landowners in order to identify their preferred locations for habitat enhancement, as well as areas that will not interfere with ongoing wetland monitoring projects or other projects within the Conservation Easement Area. While Firestone will implement the habitat enhancement activities and monitor seedling growing success over three growing seasons, any other future habitat enhancement activities will be conducted at the landowners' discretion and expense.

UF-CM4: Capping – This corrective measure option would involve placement of a physical barrier, such as soil or an engineered control, over the most highly PCB-impacted soil (i.e., areas immediately surrounding sampling stations UFP-41 and UFP-24) to reduce the potential for human or ecological receptor exposure to that soil. Specific design details would be dictated by site conditions, which could significantly affect cost and recovery potential. For example, cap thickness and permeability inevitably influence drainage within the floodplain forest; because microtopography within floodplain forests is critical to the hydrologic regime, these design considerations would affect achievement of several corrective measure objectives.

UF-CM5: Focused Excavation – Focused excavation in the undeveloped floodplain would involve removal of the upper 12 inches of soil from areas immediately surrounding sampling stations UFP-41 and UFP-24, backfilling the excavated areas with clean soil, and planting vegetative cover. Focused excavation is typically conducted within areas with high exposure potential and/or where there is a concern that soil is not stable and is at risk of being mobilized by natural events (e.g., erosion) or anthropogenic activities (e.g., lawn care). Soil excavation would be conducted mechanically and would require designation of staging areas, construction of access roads or paths for equipment, and tree felling. For example, it is estimated that at least 12 mature trees (including two 30-inch diameter sycamores) in the immediate vicinities of UFP-41 and UFP-24 would require removal prior to initiating any excavation activities. This estimate does not include the trees that also would require removal for construction of access roads or paths.

3.2 Corrective Measures Objectives and Options for the Residential Properties Along Stony Creek

This subsection presents the overall objectives for corrective measure options for addressing PCB-contaminated soils on residential properties along Stony Creek. It then describes corrective measure options that were considered for those soils; with USEPA, the community, and Firestone ultimately deciding on a risk-based removal action with owner input and post excavation monitoring.

3.2.1 Corrective Measures Objectives for the Residential Properties Along Stony Creek

Objectives for the application of corrective measures to the residential properties along Stony Creek include supporting conditions in the study area that protect human health based on current and reasonably anticipated land use; informing and engaging affected property owners throughout the remediation process; minimizing disruption of and disturbance to the community; and applying USEPA's Green Remediation concepts to reduce environmental demands posed by application of corrective measures.

To Protect Human Health, Based on Current and Reasonably Anticipated Land Uses – This objective focuses on the protection of human health based on current and reasonably anticipated land use in the residential area along Stony Creek.

To Inform and Engage Affected Property Owners and Local Residents in Meaningful Participation Throughout the Cleanup Process – This objective focuses on engaging affected property owners during application of corrective measures in residential properties along Stony Creek.

To Minimize Disruption and Disturbance of the Community, so that the Character of the Neighborhoods can be Maintained – This objective focuses on limiting disruption and disturbance to the local community during implementation of corrective measures within the residential areas along Stony Creek. The goal of this objective is to maintain the character of the neighborhood during and following implementation of corrective measures.

To Use Best Management Practices of USEPA's Green Remediation Concepts to Reduce the Demands Placed on the Environment – This objective focuses on application of USEPA's Green Remediation concepts during implementation of corrective measures within the residential areas along Stony Creek. The goals of this objective are to reduce the demands on the environment as described above for Stony Creek and the undeveloped floodplain.

3.2.2 Corrective Measures Options for the Residential Properties Along Stony Creek

The following five potential corrective measures options were identified for the soil on residential properties along Stony Creek:

RF-CM1. No Action
RF-CM2. MNR
RF-CM3. Risk-based removal action
RF-CM4. Risk-based removal action with owner input and post-excavation monitoring (which was selected as the Interim Action in 2008 and 2009)
RF-CM5. Excavation to 1 mg/kg

These options are listed in Table 5 and are described in greater detail below.

RF-CM1: No Action – "No action" is the baseline case against which all other corrective measures are compared. For the residential properties along Stony Creek, this would not have involved any institutional or engineered remedial actions including the 2005 source control action at Wilson Ditch. It would also have meant leaving contaminated floodplain soils in place and taking no measures to reduce potential risks to residents from exposure to the soil.

RF-CM2: MNR – MNR of residential floodplain soil would have been similar to the process described above for undeveloped floodplain soil where all soil would have remained in place, allowing physical, chemical, and/or biological processes to contain, destroy, alter, or otherwise reduce the bioavailability and toxicity of contaminants. MNR would have included long-term monitoring of residential soils to verify that risk reduction is occurring.

RF-CM3: Risk-based removal action – Risk-based removal would have solely relied on comparison of SWACs or 95% UCL concentrations to risk-based closure levels (3.8 mg/kg for surface soil and 27 mg/kg for all soil depths) as basis for excavation plans, such that no more than 4 parcels would have been remediated. Excavated areas would have been backfilled, revegetated, and monitored.

RF-CM4: Risk-based removal action with owner input and post-excavation monitoring – This remedy was implemented in 2008 and 2009. Excavation plans were developed based on comparison of 95% UCL concentrations to risk-based closure levels, combined with homeowner input, such that 26 parcels were remediated. Excavated areas were backfilled, revegetated, and will be monitored for three growing seasons to verify the success of the restoration activities.

CM5: Excavation to 1 mg/kg – This corrective measure would have involved removal of all soil at residences with grid (composite) sample results above 1 mg/kg. Excavated areas would have been backfilled, revegetated, and monitored for three growing seasons.

The **corrective action objectives** for the floodplains of Stony Creek are:

- To protect human health, based on current and reasonably anticipated land uses
- To support conditions that do not pose adverse population- or community-level effects to biota (or individual-level effects to threatened, endangered, or special concern species)
- To preserve or enhance the existing habitat quality in the area
- To inform and engage affected property owners and local residents in meaningful participation throughout the cleanup process.
- To minimize the disruption and disturbance of the community so that the character of the neighborhoods can be maintained
- To use best management practices of USEPA's Green Remediation concepts to reduce the demands placed on the environment

This CMP identifies five **corrective measures options** each for the undeveloped and residentially developed Stony Creek floodplains:

Undeveloped Floodplain	**Residential Properties**
• No Action • MNR • Focused habitat enhancement with vegetative stabilization • Capping • Focused excavation	• No Action • MNR • Risk-based removal action • Risk-based removal action with owner input and post-excavation monitoring[6] • Excavation to 1 mg/kg

[6] Chosen as the interim action in 2008

4 Criteria for Evaluating Corrective Measures

Each of the proposed corrective measures was evaluated based on the nine evaluation criteria developed by USEPA (1994) for the selection of appropriate corrective measures under RCRA. The criteria are divided into four threshold criteria that must all be met in order to be considered a feasible measure, plus five balancing criteria that are used to identify those measures with the best combination of attributes. This section summarizes the nine criteria; the detailed evaluations of each proposed measure are presented in Tables 4 (undeveloped floodplain of Stony Creek) and 5 (residential properties along Stony Creek).

4.1 Threshold Criteria

In order for a corrective measure to be evaluated relative to other possible measures, it must meet each of the four threshold criteria. The four criteria are described in detail below.

Protection of Human Health and Environment
The preferred corrective measure must be protective of human health and the environment in both the short-term and long-term. Any potential risks to human health and the environment predicted from baseline conditions must be balanced with the potential short-term and long-term risks associated with implementing the corrective measure. The evaluation of this criterion for all proposed corrective measures is presented in Tables 4 and 5.

Attain Corrective Measure Objectives
The second threshold criterion relates to the ability of the corrective measure to achieve the relevant corrective measure objectives. Implicit in this criterion is attainment of media cleanup standards, as required by USEPA guidance. The corrective measure objectives depend on the area to be remediated and were developed in consultation with USEPA. The corrective measure objectives for the undeveloped floodplain of Stony Creek are listed in Section 3.1.1, and those for the residential properties along Stony Creek are listed in Section 3.2.1.

Source Control
Any corrective measure must be able to prevent further environmental degradation by eliminating or controlling further releases that may pose a threat to human health or the environment. Corrective measures will be ineffective unless source control measures are instituted. Therefore, the evaluation of each corrective measure includes an assessment of whether or not source control measures are required and whether each proposed measure adequately addresses any need for source control.

Comply with Waste Management Standards
Any corrective measure that requires removal of waste or contaminated media must comply with all applicable state and federal regulations (i.e. enacted according to RCRA, Clean Air Act, or Clean Water Act).

4.2 Balancing Criteria

The five balancing criteria listed below are intended to serve as the basis for selecting a preferred corrective measure from those that meet the four threshold criteria listed above.

Long-Term Reliability and Effectiveness
This criterion refers to any potential risks remaining to human health and the environment after the corrective measure objectives have been met. Factors considered when evaluating this criterion include the magnitude of potential risk remaining after completion of the corrective measure objectives due to residual contamination, the reliability of the controls used at the site particularly with respect to uncontrollable events (e.g., heavy storms), and whether failure of any of the measures could adversely impact human health or the environment (USEPA 1994). In addition, some corrective measures have the potential to degrade over time. Therefore, an evaluation of the long-term reliability and effectiveness must also account for the projected useful life of each component of the measure.

Reduction in the Toxicity, Mobility, or Volume of Wastes
This criterion considers whether each corrective measure option eliminates or substantially reduces the potential for future environmental releases or other risks to human health or the environment. Therefore, the factors considered for this criterion include the treatment process used and materials treated, amount of hazardous waste destroyed or treated, degree of expected reductions in toxicity, mobility, or volume, degree to which treatment is irreversible, and type and quantity of remaining residuals.

Short-Term Effectiveness
The short-term effectiveness criterion addresses the immediate effect on human health and the environment during implementation of the corrective measure. This criterion considers whether implementation of the remedy may pose substantial risks to workers, the general public, or the environment. Those risks may be from exposure to the hazardous substance that is the focus of the corrective measure or from other physical dangers present during implementation of the measure. In addition to the potential risks posed during implementation, this criterion also includes an evaluation of the time required to meet the corrective measure objectives.

Implementability
This criterion refers to the ease of implementing the corrective measure. The implementability criterion accounts for both administrative and technical aspects of the corrective measure. Specific information to consider under this criterion includes:

- Administrative activities, such as obtaining any required federal, state, or local permits or access agreements that are needed to implement the corrective measure and the length of time and level of effort required to complete these administrative activities
- Technical feasibility to construct the corrective measure and the time required for implementation and beneficial results

- The availability of off-site treatment, storage, and/or disposal facilities required under the corrective measure
- The availability of prospective technologies for each corrective measure (USEPA 1994)

Cost

The relative cost of implementing a corrective measure can be considered when there are several possible measures offering similar benefits to human health and the environment. The cost estimates may include engineering and design costs, site preparation, materials, construction, waste management and disposal, permitting, health and safety measures, sampling and analysis, training, and long-term maintenance and monitoring costs associated with each corrective measure (USEPA 1994). This criterion also considers the certainty of cost estimates.

Criteria for Evaluating Corrective Measures

Threshold Criteria

- Protection of human health and environment
- Attain corrective measure objectives
- Source control
- Comply with waste management standards

Balancing Criteria

- Long-term reliability and effectiveness
- Reduction in the toxicity, mobility, or volume of wastes
- Short-term effectiveness
- Implementability
- Cost

5 Proposed Corrective Measures

The objective of this section is to recommend preferred corrective measures for the undeveloped and residentially developed Stony Creek floodplains. Towards that end, Tables 4 and 5 detail corrective measure options for the undeveloped and residentially developed floodplains of Stony Creek, respectively. These tables systematically evaluate the corrective measure options (Section 4) in terms of the four threshold criteria and five balancing criteria (Section 5). Based on that analysis, the preferred remedies for the two floodplain areas are described below, along with rationale for their selection.

5.1 Proposed Corrective Measures for the Undeveloped Floodplain of Stony Creek: Focused Habitat Enhancement with Vegetative Stabilization (UF-CM3)

Focused habitat enhancement with vegetative stabilization (UF-CM3) is the preferred corrective measure for the undeveloped floodplain of Stony Creek. This option involves two actions that will enhance the habitat property-wide and soil stability in the two areas of higher PCB concentration at the site. At the two areas of higher concentrations, appropriate vegetation will be selected and planted for the purpose of stabilizing soils in the areas to limit erosion, increasing deposition of clean sediments during flooding, and providing a vegetative barrier for humans and wildlife. Prior to implementation of this corrective measure, appropriate plants will be chosen to meet the objectives of the project.

Habitat enhancement will focus primarily on bats, particularly the endangered Indiana bat. This will be accomplished by erecting approximately 50 bat boxes to provide immediate improvement in roosting habitat for the native bat species (including the Indiana bat), as well as planting approximately 100 1- to 2-foot tall seedlings of shagbark hickory, shellbark hickory, and/or eastern cottonwood to provide long-term habitat improvement for these and other species. As detailed in Section 3, a recent baseline HHRA (ENVIRON 2009a) and BERA (ENVIRON 2010) determined that current conditions do not pose unacceptable risks to local residents (including children), songbirds, birds of prey, small mammals, bats, mustelids, or other medium-sized carnivorous mammals. Given these findings, it may be argued that no action is appropriate for this area. However, given the importance and relative rarity of floodplain forests in the larger Stony Creek watershed (CBBEL 2007), as well as the existing conservation easement established for much of the undeveloped floodplain of Stony Creek, there is a unique opportunity to effectively improve existing habitat at a relatively low cost.

The focused habitat enhancement option offers several distinct advantages over the other four options considered, as detailed in Table 4. Importantly, it offers a net benefit (i.e., improvement) to environmental conditions. Although there is a small environmental footprint in the short-term associated with personnel travel and shipping of seedlings, in the long-term that footprint will be off-set as the planted trees mature and sequester carbon, help limit soil erosion, and improve habitat for bats and other wildlife species. The public—including residents near Stony Creek and CILTI—is expected to favor this option, as it will improve habitat, views, and character of the neighborhood. During implementation (i.e., erection of bat boxes and tree planting), only minimal disruptions to the community are expected, related to access through a few parcels. Likewise, short-term risks associated with worker health and safety and traffic accident hazards are expected to be minimal and readily mitigated through common sense precautions and defensive driving techniques.

Given the acceptable risks to human health and the environment under current conditions, perhaps the most important consideration in the evaluation of corrective measure options for the undeveloped floodplain of Stony Creek (Table 4) relates to the need to fell trees (or plant them) under each option. There are three key reasons to focus on tree preservation, as follows.

First, during the focused excavation of the residentially developed floodplain of Stony Creek in 2008-2009, residents strongly and consistently voiced their preference that mature trees not be damaged or felled as part of the remedy. Most residents view the mature trees in the floodplain as important, if not critical, elements of the views and character of their neighborhood.

Second, the undeveloped floodplain of Stony Creek currently offers suitable habitat for bats, including a federally endangered species, the Indiana bat[7]. Indiana bats roost under the loose bark of mature shagbark hickory, shellbark hickory, and similar trees. As such, it is imperative that the habitat (i.e., mature trees) of this protected species not be damaged; likewise, actions that will enhance bat habitat, in general, or Indiana bat habitat, in particular, are desirable.

Third, the vast majority of the overall Stony Creek watershed has been developed for agricultural (90%) and suburban and urban (5%) development (CBBEL 2007). Less than 405 hectares (1,000 acres) remains forested and that forested habitat is fragmented. Vegetated buffers, as exemplified by floodplain forest, are critical to water quality in that they: a) filter and trap sediments and pollutants carried by stormwater; b) store stormwater and decrease water velocity in receiving waterways (thereby mitigating erosion); and c) create important wildlife habitat. In contrast with this reach of Stony Creek, most streams within the Stony Creek watershed have less than 30 ft of vegetated buffer on one or both stream banks. Thus, preservation of the integrity of the existing floodplain forest is critical to water quality throughout the watershed.

In light of these three factors, capping (UF-CM4) and focused excavation (UF-CM5) are not favorable as corrective measure options. In addition to other disadvantages—such as uncertainty of effective restoration, environmental footprint, disturbance in the neighborhood and community, cost, short-term risks to worker health and safety and traffic accidents—the capping and focused excavation options were ruled out, due to the need to fell significant numbers of mature trees. For all of the reasons discussed in this subsection, focused habitat enhancement is the preferred corrective measure for the undeveloped floodplain of Stony Creek.

[7] Despite the local suitability of habitat for Indiana bats, none have been documented as present within the Stony Creek floodplain.

5.2 Corrective Measures for the Residential Neighborhoods Adjacent to Stony Creek: Risk-based Removal Action with Owner Input and Post-Excavation Monitoring (RF-CM4)

The risk-based removal action with owner input and post-excavation monitoring (RF-CM4) has already been selected and approved by USEPA and implemented by Firestone as the remedy of choice for the residential properties along Stony Creek. RF-CM4 was implemented in 2008 and 2009 in close consultation with each landowner and USEPA. Following detailed sampling and analysis at hundreds of sampling locations and grids in the residential backyards along Stony Creek, Firestone mapped results and conferred with USEPA and homeowners regarding potential risks to human health and options for soil excavation, backfilling, and planting vegetative cover. Soils were excavated from residential backyards, in accordance with the agreed upon plans in 2008 and 2009. Excavated areas were backfilled with clean soil. The properties were restored based on a complementary landscape plan for the floodplain that focused on native understory plantings. Restored areas will be monitored for three growing seasons to verify the success of the restoration activities.

As detailed in Table 5, RF-CM4 offers several advantages over the other corrective measure alternatives. For four properties (199 and 240 Overland Court and 116 and 130 Stony Creek Overlook), focused soil excavation was necessary in order to achieve EPCs in soil that were below site-specific risk-based closure levels. Neither the no action alternative (RF-CM1) nor MNR (RF-CM2) would have readily reduced PCB concentrations to acceptable levels at those four properties. At the other parcels, excavation was not necessary in order to achieve risk-based closure levels—i.e., pre-excavation soil EPCs were already below closure levels—but excavation was requested by 22 homeowners nonetheless. Thus, property owners were informed, engaged, and in agreement with the corrective measure decision. Excavation to 1 mg/kg (RF-CM5) would have been far beyond that needed to mitigate risks to human health and would not have been consistent with homeowner expectations. In addition, RF-CM5 would have generated a significant environmental footprint with excessive short-term risks related to worker health and safety for minimal benefit. In implementing RF-CM4, Firestone took a number of precautions specifically intended to limit disruption to the community and character of the neighborhood. For example, low impact equipment and vehicles were scaled appropriately for the job, trees were not felled unless so desired by the homeowner, and the duration of excavation, backfilling and revegetation was compressed. Short-term risks were also minimized through development and implementation of a site health and safety plan and local disposal of the vast majority of excavated materials at the Southside Landfill. For all of these reasons, focused excavation is the preferred corrective measure for the residentially developed floodplain of Stony Creek.

Proposed Corrective Measures

Undeveloped Floodplain of Stony Creek: Focused Habitat Enhancement and Vegetative Stabilization (UF-CM3)

Residential Properties Along Stony Creek: Risk-based Removal Action with Owner Input and Post-Excavation Monitoring (RF-CM4)

6 Public Involvement Plan

Once the proposed remedy has been identified by USEPA, the agency will request public comment on the Administrative Record and the proposed corrective measure(s) for sites under RCRA (USEPA 1994). USEPA will solicit public comment and incorporate public comments into their final decisions (USEPA 1996). USEPA (1996) also encourages RCRA facilities to communicate with the public throughout the corrective measure implementation process. Therefore, this CMP includes a Public Involvement Plan (PIP) consistent with USEPA guidance (USEPA 1996). In addition, this PIP is consistent with the PIP developed as part of the Corrective Measures Implementation Workplan (BBL 2001) following the 2001 AOC between Firestone and USEPA.

6.1 Objectives of the Public Involvement Plan

As documented in the original PIP (BBL 2001), Firestone has worked with the Noblesville community throughout the course of the RCRA process. As such, the objectives for this PIP are the same as those in the original PIP and will continue to define the community relations activities during the implementation of this CMP. The objectives of this PIP are to:

1. Provide for the exchange of information regarding the corrective measures
2. Solicit input, comments, and active involvement from the public, elected and civic officials, and concerned agencies regarding the corrective measure activities
3. Provide a centralized point of contact for the public to efficiently receive project information and express concerns as needed

6.2 Public Involvement Activities

This subsection presents the planned community relations activities during the implementation of the corrective measures evaluated in this CMP. As noted in Section 2.5, corrective measures for the residential properties along Stony Creek have already been implemented. The public involvement activities for implementation of corrective measures in the undeveloped floodplain, described in Sections 6.2.1 through 6.2.7, are, therefore, largely a continuation of activities already implemented for the completed corrective measures for Stony Creek and the residential properties along Stony Creek. The roles of public involvement during the decision and implementation processes for those corrective measures already implemented are summarized below.

The corrective measure for Stony Creek was originally selected in the 2001 AOC between Firestone and USEPA. USEPA provided the public with an opportunity to review and comment on the corrective measures identified in the AOC (USEPA 2001), including the MNR of Stony Creek. The public comment period was open from January 10, 2000 to February 9, 2000, during which time USEPA received one comment. The public was then notified of the final corrective measure decision for Stony Creek in September 2000, which served as the basis for the AOC between USEPA and Firestone in March of 2001. As described in Section 2.5.2, source control measures were implemented in Wilson Ditch and Stony Creek in 2005 and monitoring of Stony Creek has been underway since 2003.

In preparation for the cleanup activities at the residential properties along Stony Creek, Firestone prepared the *Stony Creek Residential Soil Removal Workplan* (ARCADIS 2008b). This plan was made available by USEPA for public comment during the period of January 14, 2008 to February 12, 2008. Substantial comments, both oral and written were received and changes to the plan were made as directed by USEPA. USEPA approved the plan on July 11, 2008. Under the plan, homeowners were notified of the results of the SCSIP sampling of low-lying terraces of residential properties. Firestone provided each homeowner with tables and maps of the results from the SCSIP soil sampling from their properties, along with the results of human health risk calculations using USEPA-approved exposure assumptions. Firestone met individually with each homeowner to review the results and determine a remediation plan for the property. Homeowners also had access to an independent technical expert. Although EPCs for soil exceeded the risk-based PCB concentrations at only four of the properties, all homeowners were given the option to have areas where soil concentrations exceeded 1 mg/kg PCB excavated, as long as it would not compromise the stability of the creek banks and did not pose unacceptable risk[8]. Property-specific excavation plans were developed in consultation with USEPA and individual homeowners. Soil remediation was completed on all properties in 2008 and 2009. Upon completion of soil cleanup, each homeowner received a letter from the USEPA certifying that cleanup was complete and that their property posed no unacceptable residual risks to human health.

6.2.1 Key Contacts

Points of contact for the implementation of corrective measures in the Stony Creek system are listed below:

Jane Johnson
Manager of Remediation
Bridgestone Americas Holding, Inc.
535 Marriott Drive
Nashville, TN 37214
(615) 937-1856

[8] Potential bank erosion concerns prohibited excavation in areas with soil concentrations greater than 1 mg/kg (but below the RBC) at two properties.

John Grossman
Environmental Consultant
1700 Firestone Boulevard
Noblesville, IN 46060
(317) 773-0650 (ext. 351)

David Shelton
Shelton Environmental, LLC
1120 Zinnia Street
Golden, CO 80401
(303) 483-8408

David Johnson
Independent Community Technical Advisor
IEGS Environmental Services
15211 Herriman Boulevard
Noblesville, IN 46060
(317) 773-5020

6.2.2 Information Repository

An Information Repository for the Firestone RCRA project was established in the early 1990s at the Noblesville Public Library. The repository will be maintained and supplemented with relevant new documents, such as this CMP and the final decision document, as soon as they are approved and available. The repository location is below:

Noblesville Public Library
One Library Plaza
Noblesville, IN 46060
(317) 773-1384

Hours
Monday – Thursday: 9:00 am – 9:00 pm
Friday – Saturday: 9:00 am – 5:30 pm
Sunday: 1:30 pm – 5:30 pm

6.2.3 Fact Sheet

A fact sheet explaining the selected corrective measures and the design plans for implementation of the measures will be prepared and distributed to residents and local officials. The document will also be placed in the Information Repository.

6.2.4 Official Briefings

If requested, briefings and one-on-one meetings with local officials or other stakeholders will be scheduled to discuss milestone activities. In addition, courtesy calls will be placed as needed to keep officials aware of the on-going issues.

6.2.5 Neighborhood Communications

Communications will continue with property owners along Stony Creek where activities are anticipated. Such communications will include telephone calls and one-on-one meetings as needed and the production and distribution of at least one fact sheet to announce the commencement of the work effort.

6.2.6 Media Relations

Press statements will be prepared as needed to respond to media inquiries.

6.2.7 Community Relations Schedule

Most of the community relations are ongoing and will be implemented over the course of the remediation and restoration efforts. The fact sheet will be prepared when the engineering design and project permitting are completed.

Elements of the PIP

1. Information Repository will be maintained at the Noblesville Public Library.
2. Fact sheet documenting the selected corrective measures and design plan will be issued to residents and local officials.
3. Official briefings with local officials and/or stakeholders will be scheduled as requested.
4. Neighborhood communications will continue with property owners along Stony Creek.
5. Press statements will be prepared as needed.

7 Summary and Conclusions

The purpose of this CMP is to identify appropriate corrective measures to protect human health and the environment from PCBs in the undeveloped and residentially developed Stony Creek floodplains from its confluence with Wilson Ditch to its confluence with the West Branch of the White River. This CMP describes the current conditions in Stony Creek and its floodplains, identifies the corrective measures objectives and options for both the undeveloped and residentially developed floodplains of Stony Creek, describes the criteria used to evaluate each corrective measure option, identifies the proposed corrective measures for each area, and presents a PIP. This CMP is consistent with guidance issued by USEPA (1994, 1996, 2008).

The following corrective measures have already been implemented within Stony Creek and its floodplains: a) Wilson Ditch source control in 2005; b) Stony Creek MNR since 2001; and c) residential soil removal along Stony Creek in 2008 and 2009.

The corrective action objectives for the undeveloped and residentially developed floodplains of Stony Creek include:

- To protect human health based on current and reasonably anticipated land uses
- To support conditions that do not pose adverse population- or community-level effects to biota (or individual-level effects to threatened, endangered, or special concern species)
- To preserve or enhance the existing habitat quality in the area
- To inform and engage affected property owners and local residents in meaningful participation throughout the cleanup process
- To minimize the disruption and disturbance of the community so that the character of the neighborhoods can be maintained
- To use best management practices of USEPA's Green Remediation concepts to reduce the demands placed on the environment

The preferred corrective measures were selected based on the nine evaluation criteria developed by USEPA for the selection of appropriate corrective measures under RCRA. The criteria are divided into four threshold criteria that must all be met in order to be considered a feasible measure plus five balancing criteria that are used to identify those measures with the best combination of attributes. Tables 4 and 5 of this CMP evaluate each corrective measure option based on the nine evaluation criteria.

The preferred corrective measures for each area within the Stony Creek floodplain system are described below:

Undeveloped Floodplain – Focused habitat enhancement with vegetative stabilization (UF-CM3): This preferred corrective measure for the undeveloped floodplain of Stony Creek involves two actions that will enhance the habitat property-wide and soil stability in the two areas of higher PCB concentration at the site. At the two areas of higher concentrations, appropriate vegetation will be selected and planted for the purpose of stabilizing soils in the areas to limit erosion, increasing deposition of clean sediments during flooding, and providing a vegetative barrier for humans and wildlife. Prior to implementation of this corrective measure, appropriate plants will be chosen to meet the objectives of the project.

Habitat enhancement will focus primarily on bats, particularly the endangered Indiana bat. This will be accomplished by erecting approximately 50 bat boxes to provide immediate improvement in roosting habitat for native bats (including the federally protected Indiana bat), as well as planting 100 1- to 2-foot shagbark hickory and shellbark hickory seedlings to provide long-term habitat improvement for these and other species. Although it may be argued that “no action” is appropriate for this area, due to the lack of unacceptable risks to local residents and ecological receptors, there is a somewhat unique opportunity to effectively improve the relatively rare floodplain forest habitat at a relatively low cost. The focused habitat enhancement offers several distinct advantages over the other four options considered: a) it offers a net benefit to environmental conditions; b) the public is expected to favor this option; c) only minimal disruptions to the community are expected during implementation; and d) short-term risks are expected to be minimal.

Residential Properties Along Stony Creek – Risk-based removal action with owner input and post-excavation monitoring (RF-CM4): This corrective measure was selected and approved in 2008 as an interim remedy for residential parcels along Stony Creek. It was implemented in 2008 and 2009 in close consultation with each landowner and USEPA. Focused soil excavation was necessary at four of the properties in order to achieve the site-specific risk-based closure levels. Excavation at 22 other parcels was requested by the homeowners although risks were already at acceptable levels. Vegetative enhancements were implemented at three additional residences at the request of the homeowners. Property owners were, therefore, informed, engaged, and in agreement with the corrective measure decision.

The selection and implementation of corrective measures will follow the existing PIP. The Information Repository at the local public library will be maintained, a fact sheet prepared, and individual and group meetings will be held with residents or other interested parties on an as needed basis.

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Tables

Table 1. Summary Statistics for Total PCBs in Stony Creek Sediment (2009)

Parameter	Depth	Frequency of Detection	Mean	Standard Deviation	Minimum Detected	Maximum Detected	95% UCL[a]	Units[b]
PCB								
	Surface (0-6 in)	18 / 24	0.45	0.56	0.115	2.1	0.69	mg/kg
	Subsurface (6-12 in)	12 / 22	0.40	0.62	0.2	2.8	0.74	mg/kg
TOC								
	Surface (0-6 in)	24 / 24	2.9	1.8	1.37	4.5	3.9	%
	Subsurface (6-12 in)	22 / 22	3.1	1.5	1.35	8.1	3.8	%
TOC Normalized PCBs								
	Surface (0-6 in)	18 / 24	17	19	2.0	69	25	mg/kg OC
	Subsurface (6-12 in)	12 / 22	16	26	2.8	121	31	mg/kg OC

a. 95% UCL calculated using bias-corrected accelerated (BCA) bootstrap method with 10,000 iterations
b. Sediment PCB concentrations are reported on a dry weight basis.

95% UCL: upper confidence limit of the arithmetic mean
in: inches
mg/kg: milligrams per kilogram
PCB: polychlorinated biphenyl
TOC: total organic carbon

Table 2. Average Surface Sediment Total PCB Concentrations, Stony Creek (2003-2009)

Year	Frequency of Detection	Mean	Standard Deviation	Minimum	Maximum	Units[a]
2003	2 / 4	5.9	8.7	1.4	19	mg/kg
2005	3 / 3	2.6	3.0	0.76	6.1	mg/kg
2006	93 / 149	1.1	1.3	0.27	7.8	mg/kg
2007	3 / 3	1.0	0.19	0.84	1.2	mg/kg
2009	18 / 24	0.45	0.56	0.060	2.1	mg/kg

a. Sediment PCB concentrations are reported on a dry weight basis.

mg/kg: milligrams per kilogram
PCB: polychlorinated biphenyl

Table 3. Summary Statistics for Total PCBs in Stony Creek Fish (2009)

Species	Type	Frequency of Detection	Mean	Standard Deviation	Minimum Detected	Maximum Detected	95% UCL[a]	Units[b]
Green sunfish	Whole body	8 / 8	4.8	5.6	0.92	18.3	9.4	mg/kg
Northern hog sucker	Whole body	8 / 8	2.4	1.7	1.0	6.2	3.8	mg/kg
Rock bass	Whole body	8 / 8	2.5	2.2	0.55	7.5	4.4	mg/kg
Green sunfish	Fillets with skin	8 / 8	0.64	0.58	0.15	2.0	1.1	mg/kg
Rock bass	Fillets with skin	8 / 8	0.35	0.19	0.10	0.72	0.47	mg/kg

a. 95% UCL calculated using bias-corrected accelerated (BCA) bootstrap method with 10,000 iterations
b. Fish tissue PCB concentrations are reported on a wet weight basis.

95% UCL: upper confidence limit of the arithmetic mean
mg/kg: milligrams per kilogram

Table 4. Corrective Measures Options Overview: Undeveloped Floodplain of Stony Creek

	CORRECTIVE MEASURE OPTIONS UF-CM1 No Action	UF-CM2 Monitored Natural Recovery (MNR)	UF-CM3 Focused Habitat Enhancement with Vegetative Stabilization	UF-CM4 Capping	UF-CM5 Focused Excavation
Description	No action is the baseline case against which all other corrective measures are compared. No action would not involve any institutional or engineered remedial actions.	MNR would involve leaving contaminated soil in place and allowing physical, chemical, and/or biological processes to contain, destroy, alter, or otherwise reduce the bioavailability and toxicity of PCBs, while undertaking long-term monitoring to verify that risk reduction is occurring. The source control action undertaken in 2005 (i.e., excavation of Wilson Ditch) is an assumed component of UF-CM2.	This option involves two actions that will enhance the habitat property-wide and soil stability in the two areas of higher PCB concentration at the site. Enhancement activities will focus on improving habitat for bats (including the federally protected Indiana bat [*Myotis sodalis*]). At the two areas of higher concentrations of PCBs, appropriate vegetation will be planted for with the goal of stabilizing soils in the areas to limit erosion, increasing deposition of clean sediments during flooding, and providing a vegetative barrier for humans and wildlife. The source control action undertaken in 2005 (i.e., excavation of Wilson Ditch) is an assumed component of UF-CM3.	Capping would involve the placement of a physical barrier, such as soil or an engineered control, over PCB-impacted soil to reduce the potential for exposure to that soil. The source control action undertaken in 2005 (i.e., excavation of Wilson Ditch) is an assumed component of UF-CM4.	Focused excavation woud include removing soil from areas immediately surrounding sampling stations UFP-41 and UFP-24, backfilling with clean soil, and planting vegetative cover over excavated areas. The source control action undertaken in 2005 (i.e., excavation of Wilson Ditch) is an assumed component of UF-CM5.
Threshold Criteria					
Protection of human health and the environment	Because baseline conditions do not pose significant risks to human health or the environment (ENVIRON 2009b, 2010), all options would meet this criterion.				
Attain corrective measures objectives:					
1. To support conditions within the study area that do not pose adverse population- or community-level effects to wildlife	Because baseline conditions do not pose adverse population- or community-level effects to wildlife (ENVIRON 2009a), UF-CM1 through UF-CM3 would meet this objective.			Capping would further reduce the already acceptable ecological risks associated with PCBs.	Focused excavation would further reduce the already acceptable ecological risks associated with PCBs.
2. To support conditions within the study area that do not pose adverse individual-level effects to species that are threatened, endangered or of special concern	Because baseline conditions do not pose adverse individual-level effects to protected species (ENVIRON 2009a) UF-CM1 and UF-CM2 would attain this objective.		To the extent that limited roost sites may constrain sustainability of local populations of native bats, focused habitat enhancement will mitigate habitat constraints and improve conditions for the protected Indiana bat.	Capping would further reduce the already acceptable ecological risks associated with PCBs.	Focused excavation would further reduce the already acceptable ecological risks associated with PCBs.
3. To preserve or enhance existing habitat quality within the study area	Due to existing conservation easement and natural succession processes, existing habitat quality would improve over time under UF-CM1 and UF-CM2.		In combination with existing conservation easement, wetlands lease, and natural succession processes, focused habitat enhancement with vegetative stabilization will result in net benefit to habitat quality over time; this would occur to a greater extent than expected from natural succession alone.	Capping would have a short-term negative effect on habitat quality; placement of barrier materials and potential tree removal would increase habitat patchiness, and would change localized microtopography, hydrology, and canopy of floodplain forest.	The tree removal required for focused excavation would open up canopy, increase habitat patchiness, and change microtopography and hydrology of the floodplain forest. These changes would result in an overall negative impact on habitat quality for decades or longer.
4. To preserve existing conditions within the study area with respect to the lack of significant risks to human health	Because baseline conditions do not pose significant risks to human health (ENVIRON 2010), UF-CM1 through UF-CM3 would attain this criterion.			Capping would further reduce the already acceptable risks to human health, due to reduced exposure potential.	Focused excavation would further reduce the already acceptable risks to human health, due to reduced exposure potential.
5. To minimize disruption and disturbance of the community, so that the character of the neighborhoods can be maintained	No action would not disturb the community and neighborhoods.	Periodic monitoring would require access through a few parcels, but disturbance would be minor and unlikely to change the character of the neighborhoods.	Implementation of focused habitat enhancement with vegetative stabilization will require short-term access through a few parcels, but disturbance will be minor and unlikely to change the character of the neighborhoods; in the long-term, planted trees and ground cover will improve views. Attracting bats to the floodplain could have ancillary benefit to the neighborhood of reduced mosquito abundance.	Cap installation would require trucking barrier material to site, construction of access routes through a small number of parcels, limited excavation, and tree removal.	Implementation of focused excavation would require construction of access routes through a few parcels and the Conservation Easement Area; excavated soil would be trucked through Noblesville to a Subtitle D landfill; removal of trees from access routes and excavation areas would negatively affect views for abutting neighbors.
6. To use USEPA Green Remediation concepts to reduce the demands placed on the environment by the corrective measure (i.e., the "footprint" of the corrective measure)	No action would not place demands on the environment.	The small footprint associated with UF-CM2 would relate to fossil fuel use, electricity use, and carbon emissions from travel to site for sampling, shipping samples to the laboratory, and chemical analysis of samples. Source control in Wilson Ditch and the confluence with Stony Creek required fossil fuel and electricity use for heavy equipment use for excavation, transport of excavated materials offsite for disposal, and use of landfill space for disposal.	The small footprint associated with UF-CM3 will relate to fossil fuel use and carbon emissions during implementation; as the planted trees and vegetative cover mature, their sequestration of carbon will offset emissions generated during implementation. Source control in Wilson Ditch and the confluence with Stony Creek required fossil fuel and electricity use for heavy equipment use for excavation, transport of excavated materials offsite for disposal, and use of landfill space for disposal.	The footprint associated with UF-CM4 would relate to fossil fuel use, electricity use, carbon emissions from travel to site for implementation, and tree removal. Source control in Wilson Ditch and the confluence with Stony Creek required fossil fuel and electricity use for heavy equipment use for excavation, transport of excavated materials offsite for disposal, and use of landfill space for disposal.	Of the corrective measures considered, UF-CM5 would have the largest footprint; that footprint would relate to fossil fuel and electricity use, as well as emission of carbon and other air pollutants from travel to site for implementation, tree removal, heavy equipment use for excavation, transport of excavated materials offsite for disposal, use of landfill space for disposal, and tree removal. Implementation would strive to minimize environmental footprint through use of fuel efficient, low impact equipment and vehicles that are scaled appropriately for the job. Source control in Wilson Ditch and the confluence with Stony Creek required fossil fuel and electricity use for heavy equipment use for excavation, transport of excavated materials offsite for disposal, and use of landfill space for disposal.
Source control	No action would not have controlled the source of PCBs to Stony Creek (i.e., Wilson Ditch).	Source control -- excavation of Wilson Ditch and portions of Stony Creek immediately downstream of the confluence with Wilson Ditch -- would be a component of all options except UF-CM1; it was completed in 2005.			
Comply with waste management standards	Criterion would not be applicable because UF-CM1 would not involve removal of contaminated media.	Waste management standards were adhered to for disposal of PCB-impacted sediment following source control excavation. Specifically, TSCA disposal was used for sediment with PCB concentrations above 50 mg/kg. Other sediment excavated from Wilson Ditch and the confluence was disposed of at a Subtitle D landfill (the Southside Landfill in Indianapolis), in compliance with applicable standards. All necessary permits were obtained.			waste management standards were adhered to for disposal of PCB-impacted sediment following source control excavation. Specifically, TSCA disposal was used for sediment with PCB concentrations above 50 mg/kg. Other sediment excavated from Wilson Ditch and the confluence was disposed of at a Subtitle D landfill (the Southside Landfill in Indianapolis), in compliance with applicable standards. All necessary permits were obtained. PCBs have not been detected in floodplain soils at concentrations above the 50 mg/kg TSCA limit, so excavated soils would be disposed at a Subtitle D landfill, in compliance with applicable standards.

Table 4. Corrective Measures Options Overview: Undeveloped Floodplain of Stony Creek

	CORRECTIVE MEASURE OPTIONS				
	UF-CM1	**UF-CM2**	**UF-CM3**	**UF-CM4**	**UF-CM5**
	No Action	Monitored Natural Recovery (MNR)	Focused Habitat Enhancement with Vegetative Stabilization	Capping	Focused Excavation
Balancing Criteria					
Long-term reliability and effectiveness	Because no action would not have involved source control, there would have been a possibility of future mobilization of Wilson Ditch sediments containing the highest concentrations of PCBs. Thus, the long-term reliability and effectiveness of no action would have been uncertain.	Particularly in combination with source control, MNR would be effective at low risk sites with strong evidence for natural recovery processes. The decreasing PCB concentrations in surface floodplain soil relative to subsurface floodplain soil provide evidence of ongoing natural recovery at this site. Thus, MNR would attain this criterion.	In concert with source control, the reliability and effectiveness of habitat enhancement with vegetative stabilization will be a function of nature and extent of action; the actions proposed here are well understood and are expected to be effective, thereby attaining this criterion.	In concert with effective source control, capping is a well tested, reliable, and effective technology.	While soil excavation, in concert with effective source control, is a well-tested and effective technology, subsequent restoration of floodplain forest microtopography and vegetation would be uncertain.
Reduction in toxicity, mobility, volume of wastes	While no action would not change toxicity, mobility, or volume of wastes, baseline conditions do not pose unacceptable risks to human health or the environment (ENVIRON 2009b, 2010).	Although MNR would not reduce the volume of waste present, it would, in concert with source control, reduce the mobility and concentration of PCBs in soil, as cleaner sediment is deposited on the floodplain during flooding.	While focused habitat enhancement with vegetative stabilization will not change toxicity, mobility, or volume of wastes, baseline conditions with source control do not pose unacceptable risks to human health or the environment (ENVIRON 2009b, 2010).	Capping, in concert with source control, would reduce the mobility and concentration of PCBs in surface soil.	Focused excavation, in concert with source control, would reduce volume of PCBs, but mobility may increase due to unavoidable disturbance of microtopography of floodplain. Best Management Practices would be employed to minimize soil erosion.
Short-term effectiveness	short-term risks would not be posed by no action.	Personal protective equipment would be required to mitigate any short-term risks associated with monitoring activities.	Short-term risks associated with focused habitat enhancement with vegetative stabilization will be minor and limited to worker safety associated with tree and ground cover planting and bat house installation (e.g.,	short-term risks would be associated with worker safety related to heavy equipment use, tree felling, and traffic/transportation accidents.	
Implementability	No implementation would be associated with no action.	MNR would be readily implementable.	Habitat enhancement with vegetative stabilization will be readily implementable, assuming access permission is granted. Long-term success will depend on selection of appropriate species, matching species to microhabitat, and quality of implementation.	Implementability would depend on ability to obtain access permission. While capping would be implementable, recovery/restoration of vegetation and microtopography would be uncertain.	Implementability would depends on ability to obtain access permission. While excavation would be implementable, recovery/restoration of vegetation and microtopography would be uncertain.
Cost					
Estimated future costs	$	$$$	$$	$$$$	$$$$$
Past costs		($$$$$)[a]	($$$$$)[a]	($$$$$)[a]	($$$$$)[a]
Certainty of future cost estimate	?	?	??	??	???
Key Advantages					
	Baseline risks to human health and environment acceptable. No cost. No disturbance of existing habitat or other environmental footprint. No short-term risks.	Baseline risks to human health and environment acceptable. No disturbance of existing habitat and small environmental footprint. Monitoring would allow confirmation of stability, and improvement of conditions. No short-term risks.	Baseline risks to human health and environment acceptable. Net benefit to habitat quality at a low cost. The small environmental footprint will be offset as the planted trees and ground cover mature. Favorable public perception. Very low short-term risks.	short-term risks are low and can be mitigated. Reduction in concentration and mobility of PCBs.	Localized reduction in PCB concentration, volume, and mass.
Key Disadvantages					
	Negative public perception associated with lack of action. No source control.	long-term monitoring would require repeated access through residential properties. Higher cost than no action, with little added benefit. short-term effectiveness would be limited by natural recovery rate.	No change in toxicity, mobility, volume of wastes; however, baseline conditions do not pose unacceptable risks to human health or the environment.	Revegetation/restoration of floodplain forest vegetation and microtopography would be uncertain and likely to require decades; negative impact on wildlife habitat. Tree removal would significantly disturb neighborhood and community.	Revegetation/restoration of floodplain forest vegetation and microtopography uncertain and likely to require decades; negative impact on wildlife habitat; greatest environmental footprint of the corrective measures under consideration. Tree removal and transport of excavated material would disturb neighborhood and community. Focused excavation would be the most expensive option and contains the greatest uncertainty in projected costs. short-term risks would relate to worker health and safety and traffic accident hazards.

Notes

a. The source control component of this option -- Wilson Ditch remediation and restoration -- was already completed and cost more than $1,000,000.

$ = $0 - $50,000 ? = high certainty is associated with cost estimate
$$ = $50,001 - $100,000 ?? = some uncertainty is associated with cost estimate
$$$ = $100,001 - $500,000 ??? = high uncertainty is associated with cost estimate
$$$$ = $500,001 - $1,000,000
$$$$$ = greater than $1,000,000

Table 5. Corrective Measures Options Overview: Residential Properties Along Stony Creek

	CORRECTIVE MEASURE OPTIONS				
	RF-CM1	**RF-CM2**	**RF-CM3**	**RF-CM4**	**RF-CM5**
	No Action	Monitored natural recovery (MNR)	Risk-based Removal Action	Risk-based Removal Action with Owner Input and Post-Excavation Monitoring	Excavation to 1 mg/kg
Description	The baseline case against which all other corrective measures are compared, "no action" would not have involved any institutional or engineered remedial actions (including the 2005 source control action at Wilson Ditch).	MNR would have involved leaving contaminated soil in place and allowing physical, chemical, and/or biological processes to contain, destroy, alter, or otherwise reduce the bioavailability and toxicity of contaminants, while undertaking long-term monitoring.	Risk-based removal would have solely relied on comparison of spatially weighted average concentration or 95% UCL to risk-based concentrations (RBCs) of 3.8 mg/kg for surface soil and 27 mg/kg for subsurface soil as basis for excavation plans, such that not more than 4 parcels[a] would have been remediated. Excavated areas would have been backfilled, revegetated, and monitored.	This remedy was selected as an interim measure and implemented in 2008-2009. Excavation plans were developed based on comparison of 95% UCL to RBCs, combined with home owner input, such that 26 parcels were remediated. Restored areas will be monitored for three growing seasons to verify the success of the restoration activities.	All soil with grid (composite) sample results above 1 mg/kg would have been excavated, such that all parcels abutting Stony Creek would have been remediated. Excavated areas would have been backfilled, revegetated, and monitored.
Threshold Criteria					
Protection of human health and the environment	With the exception of 4 parcels[a], baseline conditions did not pose unacceptable risks; thus, at these 4 parcels, no action would not have achieved this criterion, while at all other parcels it would have. ENVIRON (2009a) demonstrated that ecological risks in the undeveloped floodplain of Stony Creek are acceptable; because wildlife are less likely to forage within the residentially developed floodplain, those findings are also protective of the residentially developed floodplain under baseline conditions.	With the exception of 4 parcels[a], baseline conditions did not pose unacceptable risks; thus, at the 4 parcels, risks would have been mitigated over time due to deposition of comparatively cleaner sediment, resulting in long-term decrease in surface soil concentrations and risks. At all other parcels, MNR would have achieved this criterion immediately. ENVIRON (2009a) demonstrated that ecological risks in the undeveloped floodplain of Stony Creek are acceptable; because wildlife are less likely to forage within the residentially developed floodplain, those findings are also protective of the residentially developed floodplain under baseline and future conditions.	Risk-based removal would have focused on only those 4 parcels[a] with spatially weighted average concentrations or 95% UCL concentrations greater than RBCs. Therefore, RF-CM3 would have achieved this criterion. ENVIRON (2009a) demonstrated that ecological risks in the undeveloped floodplain of Stony Creek are acceptable; because wildlife are less likely to forage within the residentially developed floodplain, those findings are also protective of the residentially developed floodplain.	Excavation of contaminated soils in 2008-2009 mitigated the already low risks to human health; post-excavation risks to human health are acceptable (ENVIRON 2008a, 2009b,c,d). ENVIRON (2009a) demonstrated that ecological risks in the undeveloped floodplain of Stony Creek are acceptable; because wildlife are less likely to forage within the residentially developed floodplain, those findings are also protective of the residentially developed floodplain.	As noted for RF-CM3, remediation to RBCs would have mitigated potential risks to human health; more extensive remediation such as that specified under RF-CM5 was not necessary to achieve this criterion. ENVIRON (2009a) demonstrated that ecological risks in the undeveloped floodplain of Stony Creek are acceptable; because wildlife are less likely to forage within the residentially developed floodplain, those findings are also protective of the residentially developed floodplain.
Attain corrective measures objectives:					
1. To protect human health, based on current and reasonably anticipated land uses	With the exception of 4 parcels[a], baseline conditions did not pose unacceptable human health risks; thus, at these 4 parcels, no action would not have achieved this criterion, while at all other parcels it would have.	With the exception of 4 parcels[a], baseline conditions did not pose unacceptable risks; thus, at the 4 parcels, risks would have been mitigated over time due to deposition of comparatively cleaner sediment, resulting in long-term decrease in surface soil concentrations and risks. At all other parcels, MNR would have achieved this criterion immediately.	Risk-based removal would have focused on only those 4 parcels[a] with spatially weighted average concentrations or 95% UCL concentrations greater than RBCs. Therefore, RF-CM3 would have achieved this criterion.	Excavation of contaminated soils in 2008-2009 mitigated the already low risks to human health; post-excavation risks to human health are acceptable (ENVIRON 2008a, 2009b,c,d).	As noted for RF-CM3, remediation to RBCs would have mitigated potential risks to human health; more extensive remediation such as that specified under RF-CM5 was not necessary to achieve this criterion.
2. To inform and engage affected property owners and local residents in meaningful participation throughout the cleanup process	RF-CM1 would not have accounted for some property owners' and local residents' preferences.	RF-CM2 would not have accounted for some property owners' and local residents' preferences.	RF-CM3 would not have accounted for some property owners' and local residents' preferences.	Property owners were informed/engaged during the selection of interim measures. Continuation of post-excavation monitoring is also consistent with property owners' expectations.	RF-CM5 would not have accounted for some property owners' and local residents' preferences.
3. To minimize disruption and disturbance of the community, so that the character of the neighborhoods can be maintained	RF-CM1 would not have disrupted or disturbed the community and neighborhoods. However, many homeowners likely would have been concerned that RF-CM1 would negatively affect property values.	RF-CM2 would not have disrupted or disturbed the community and neighborhoods. However, many homeowners likely would have been concerned that RF-CM2 would have negatively affected property values. Periodic monitoring would have required access through a few parcels, but disturbance would have been minor and no change to the character of the neighborhoods would have been anticipated.	Compared to RF-CM4, RF-CM3 would have required less tree removal, less excavation, less trucking of excavated material and, therefore, less disruption. As with RF-CM4, precautions would have been taken to minimize disruption (e.g., use of equipment appropriately scaled to the project, adherence to strict work schedule, transport of excavated materials to a nearby facility, and financial compensation for permitting access).	Precautions were taken to minimize disruption during excavation (e.g., use of equipment appropriately scaled to the project, adherence to strict work schedule, transport of excavated materials to a nearby facility, and financial compensation for permitting access). Post-excavation monitoring will require infrequent access to residential backyards, with the potential for very minor and brief disturbance to the neighborhood. Such activities have already been approved by the residents, and they are financially compensated for granting access.	Compared to RF-CM4 would have required significantly more tree removal, excavation, trucking of excavated material and, therefore, disruption. As with RF-CM4, precautions would have been taken to minimize disruption (e.g., use of equipment appropriately scaled to the project, adherence to strict work schedule, transport of excavated materials to a nearby facility, and financial compensation for permitting access). In addition, the project schedule would have been significantly lengthened, resulting in additional years of disruption to the community.

Table 5. Corrective Measures Options Overview: Residential Properties Along Stony Creek

	CORRECTIVE MEASURE OPTIONS				
	RF-CM1	**RF-CM2**	**RF-CM3**	**RF-CM4**	**RF-CM5**
	No Action	Monitored natural recovery (MNR)	Risk-based Removal Action	Risk-based Removal Action with Owner Input and Post-Excavation Monitoring	Excavation to 1 mg/kg
4. To use USEPA Green Remediation concepts to reduce the demands placed on the environment by the corrective measure (i.e., the "footprint" of the corrective measure)	Aside from potential risks to human health at 4 parcels, RF-CM1 would not have placed any demands on the environment.	The small footprint associated with RF-CM2 would have related to fossil fuel use, electricity use, carbon emissions from travel to site for sampling, shipping samples to the laboratory, and chemical analysis of samples. Source control in Wilson Ditch and the confluence with Stony Creek required fossil fuel and electricity use for heavy equipment use for excavation, transport of excavated materials offsite for disposal, and use of landfill space for disposal.	Compared to RF-CM4, RF-CM3 would have had a lower environmental footprint, due to less tree removal, heavy equipment use, trucking of excavated material, use of landfill space, fossil fuel/electricity use, and emissions of carbon and pollutants to air. In addition, as the planted vegetation matures, the sequestration of carbon would offset emissions generated during implementation. In addition, source control in Wilson Ditch and the confluence with Stony Creek required fossil fuel and electricity use for heavy equipment use for all the same purposes relating to excavation and disposal.	RF-CM4's environmental footprint from the removal action related to tree removal, heavy equipment use, trucking of excavated material, use of landfill space, fossil fuel/electricity use, and emissions of carbon and pollutants to air. However, as the planted vegetation matures, the sequestration of carbon would offset emissions generated during implementation. The small footprint associated with post-excavation monitoring relates to travel to/from site for sampling. Conversely, monitoring should allow early identification of restored areas that are potentially subject to erosion, thereby avoiding potentially greater environmental demands associated with any such erosion. In addition, source control in Wilson Ditch and the confluence with Stony Creek required fossil fuel and electricity use for heavy equipment use for all the same purposes relating to excavation and disposal.	Of the options considered, RF-CM5 would have had the largest environmental footprint; that footprint would have been associated with greater tree removal, heavy equipment use, trucking of excavated material, use of landfill space, fossil fuel/electricity use, and emissions of carbon and pollutants to air. However, as the planted vegetation matures, the sequestration of carbon would offset emissions generated during implementation. In addition, source control in Wilson Ditch and the confluence with Stony Creek required fossil fuel and electricity use for heavy equipment use for all the same purposes relating to excavation and disposal.
Source control	No action would not have controlled the source of PCBs to Stony Creek (i.e., Wilson Ditch).	Source control -- excavation of Wilson Ditch and portions of Stony Creek immediately downstream of the confluence with Wilson Ditch -- is a component of all options except RF-CM1; it was completed in 2005.			
Comply with waste management standards	Criterion not applicable because RF-CM1 would not have involved removal of contaminated media.	Waste management standards were adhered to for disposal of PCB-impacted sediment following source control excavation. Specifically, TSCA disposal was used for sediment with PCB concentrations above 50 mg/kg. Other sediment excavated from Wilson Ditch and the confluence was disposed of at a Subtitle D landfill (the Southside Landfill in Indianapolis), in compliance with applicable standards. All necessary permits were obtained. The same standards would apply to soils excavated from the floodplain.		Waste management standards were adhered to for disposal of PCB-impacted sediments excavated during source control from Wilson Ditch and soils excavated from residential properties in the floodplain. Specifically, TSCA disposal was used for sediment or soil with PCB concentrations above 50 mg/kg. Other excavated sediment or soil was disposed of at a Subtitle D landfill (the Southside Landfill in Indianapolis), in compliance with applicable standards. All necessary permits were obtained.	Waste management standards were adhered to for disposal of PCB-impacted sediment following source control excavation. Specifically, TSCA disposal was used for sediment with PCB concentrations above 50 mg/kg. Other sediment excavated from Wilson Ditch and the confluence was disposed of at a Subtitle D landfill (the Southside Landfill in Indianapolis), in compliance with applicable standards. All necessary permits were obtained. The same standards would apply to soils excavated from the floodplain.
Balancing Criteria					
Long-term reliability and effectiveness	RF-CM1 would not have been effective in mitigating risks to human health or in demonstrating (through monitoring) natural recovery over time.	MNR is generally effective at low risk sites with source control and strong evidence for natural recovery processes; evidence for such processes in this floodplain is the documented decline in PCB concentrations with decreasing floodplain soil depth. Monitoring would have allowed confirmation of the effectiveness and reliability of RF-CM2.	In concert with source control, RF-CM3 would have had long-term reliability and effectiveness. Post-excavation monitoring would have allowed verification of reliability and effectiveness.	In concert with source control, RF-CM4 is expected to have long-term reliability and effectiveness. Post excavation monitoring allows verification of reliability and effectiveness.	In concert with source control, soil excavation is a well-tested and effective technology. However, under the more extensive excavation of RF-CM5, the rate and extent of restoration of the microtopography and vegetation would have been uncertain, particularly in areas near the stream bank and where tree removal would have been necessary.
Reduction in toxicity, mobility, volume of wastes	RF-CM1 would not have changed toxicity, mobility, or volume of wastes.	Although RF-CM2 would not have reduced the volume of waste present, source control would reduce the mobility and concentration of PCBs in soil, as cleaner sediment is deposited on the floodplain during flooding.	Under RF-CM3, toxicity and volume of wastes would have been reduced sufficiently to mitigate potential risks to human health. Post-excavation monitoring would have allowed verification that the restoration measures continued to control the mobility of native soils.	Toxicity and volume of wastes were reduced by the interim actions implemented in 2008-2009 to a greater extent than necessary to mitigate potential risks to human health. Post-excavation monitoring allows verification that the restoration measures continue to control the mobility of native soils.	Excavation to 1 mg/kg would have substantially reduced the volume and concentration of PCBs in soils, beyond that which is necessary to mitigate potential risks to human health. However, in doing so, the mobility of PCBs could have increased in some areas due to unavoidable disturbance of microtopography of floodplain. Mobility of PCBs could have decreased elsewhere, where ground cover was rapidly and effectively restored.
Short-term effectiveness	Short-term risks would not have been posed by RF-CM1.	Personal protective equipment would have been required to mitigate any short-term risks associated with monitoring activities.	Short-term risks associated with excavation would have primarily related to worker safety (e.g., heavy equipment use, tree felling, slip/trip/fall) and traffic/transportation accidents, with severity commensurate to the scale of excavation. short-term risks associated with post-excavation monitoring would have been minor and primarily related to slip/trip/fall hazards and vehicular accidents.		
Implementability	No implementation would have been associated with RF-CM1.	RF-CM2 would have been readily implementable.	Excavation is implementable, but there is some uncertainty related to stabilization of excavated stream banks and successful restoration of native vegetation, particularly if mature trees must be removed and depending upon the scale of excavation. Post-excavation monitoring is readily implemented, provided access permission is granted.		
Cost					
Estimated future costs	$	$$$	$$$$	$$$$$	$$$$$
Past costs		($$$$$)[a]	($$$$$)[a]	($$$$$)[a]	($$$$$)[a]
Certainty of future cost estimate	?	?	??	??	???

Table 5. Corrective Measures Options Overview: Residential Properties Along Stony Creek

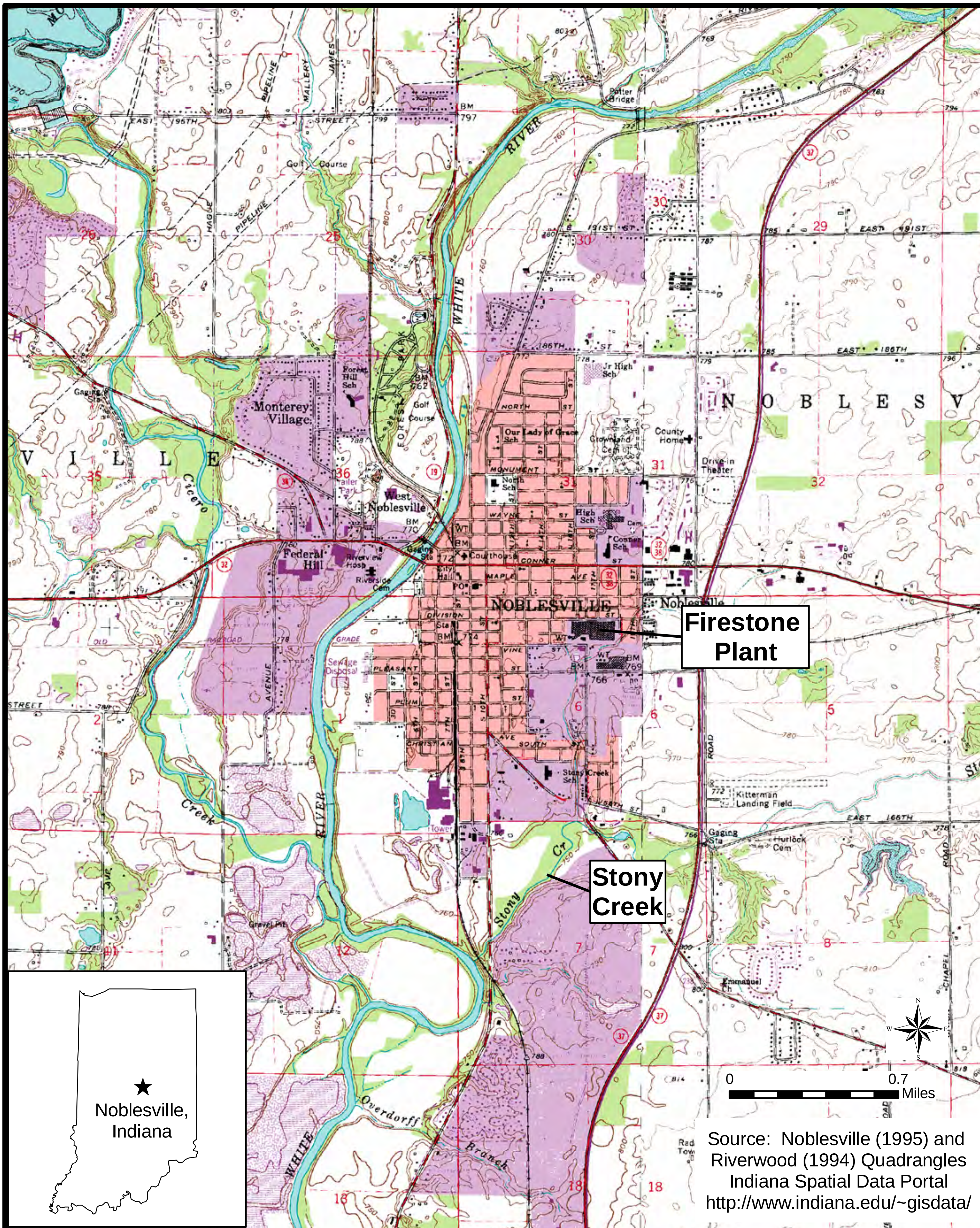
	CORRECTIVE MEASURE OPTIONS				
	RF-CM1	**RF-CM2**	**RF-CM3**	**RF-CM4**	**RF-CM5**
	No Action	Monitored natural recovery (MNR)	Risk-based Removal Action	Risk-based Removal Action with Owner Input and Post-Excavation Monitoring	Excavation to 1 mg/kg
Key Advantages					
	No cost No disturbance of existing habitat No environmental footprint No short-term risks	Low cost Minimal disturbance of existing habitat, environmental footprint, and short-term risks Monitoring would have allowed confirmation of stability/improvement of conditions.	Would have minimized the degree of disturbance of existing habitat, while fully mitigating potential risks to human health at 4 parcels. Would have reduced toxicity and volume of waste. Of the excavation options, would have had lowest environmental footprint and short-term risks. Post-excavation monitoring would have allowed verification that restoration activities were effective.	Reduces toxicity and volume of waste to a degree greater than necessary to mitigate potential risks to human health at 4 parcels. Reflects individual homeowners' preferences. Precautions taken to minimize environmental footprint and disturbance of existing habitat.	Would have substantially reduced toxicity and volume of waste.
Key Disadvantages					
	Would not have mitigated potential risks to human health at 4 parcels. Negative public perception would have been associated with perceived lack of action. No source control.	Long-term monitoring would have required repeated access through residential properties. Negative public perception would have been associated with perceived lack of action. Significant delay in mitigation of potential risks to human health at 4 parcels.	Would not have accounted for some property owners' and local residents' preferences. Minor disturbance to neighborhood, associated with accessing properties for monitoring. However, homeowners would have been compensated for granting that permission to access parcel.	Minor disturbance to neighborhood, associated with accessing properties for monitoring. However, that access permission has already been granted and homeowners are compensated for granting that permission.	Excavation to 1 mg/kg would have been expensive, and far beyond that needed to mitigate risks to human health. Significant environmental footprint would have been associated with fuel consumption, carbon and othe air emissions, construction of access roads, tree felling, and erosion. Short-term risks would have related to worker health and safety and traffic accident hazards. Would not have been consistent with homeowner expectations. Effectiveness of revegetation/restoration would have been uncertain.

Notes
a. The 4 parcels with pre-excavation exposure point concentrations above applicable risk-based closure levels are located at 199 and 240 Overland Court and 116 and 130 Stony Creek Overlook.
b. The source control component of this option -- Wilson Ditch remediation and restoration -- was already completed and cost more than $1,000,000.

$ = $0 - $50,000
$$ = $50,001 - $100,000
$$$ = $100,001 - $500,000
$$$$ = $500,001 - $1,000,000
$$$$$ = greater than $1,000,000
? = high certainty is associated with cost estimate
?? = some uncertainty is associated with cost estimate
??? = high uncertainty is associated with cost estimate

95% UCL: 95 percent upper confidence limit on the mean concentration
mg/kg: milligrams per kilogram
MNR: monitored natural recovery
RBC: risk-based closure level

Figures



ENVIRON

Site Location Map
Noblesville, Indiana

Figure 1

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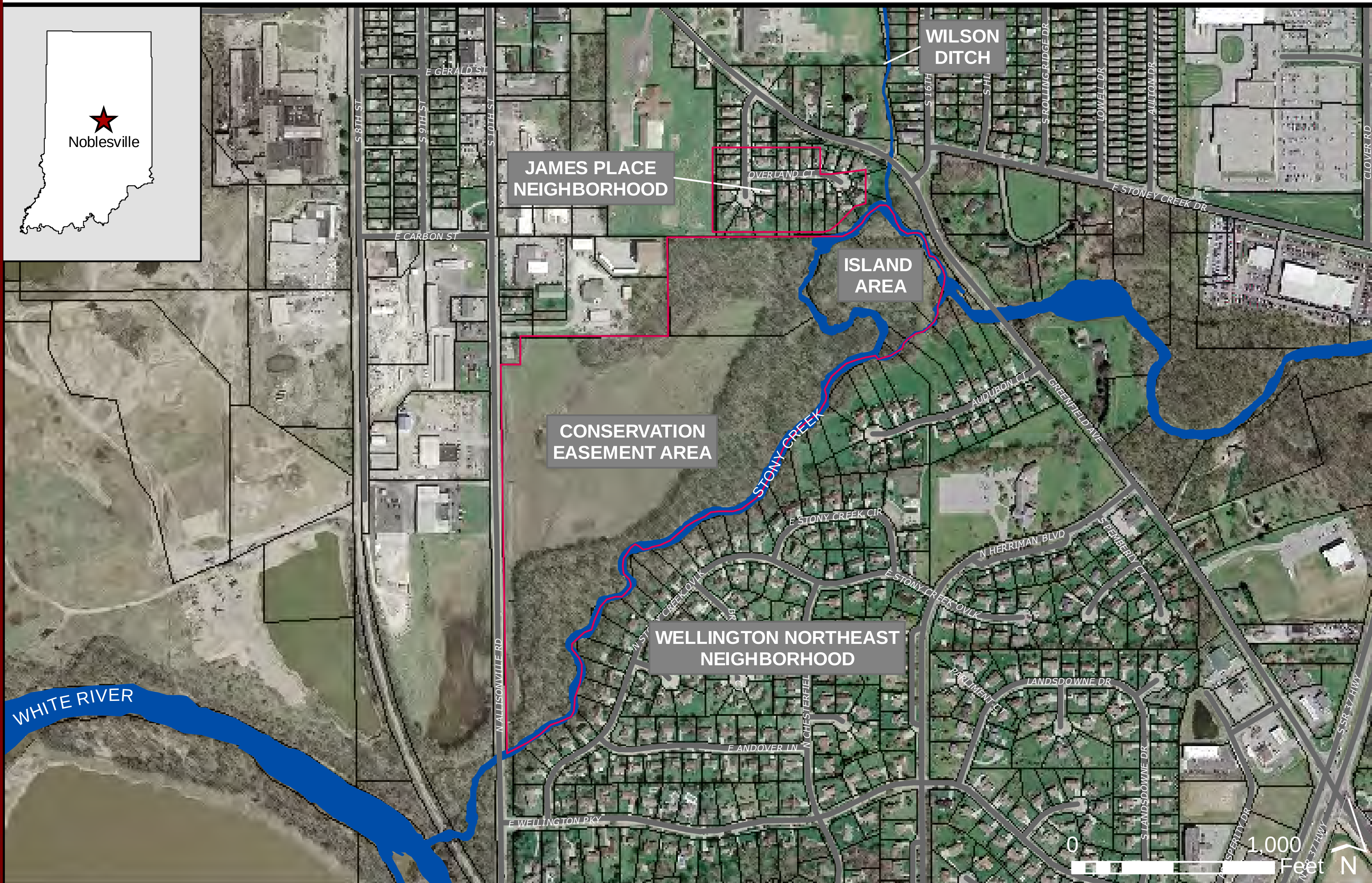

ENVIRON

Study Areas
Noblesville, Indiana

Figure 2

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ENVIRON

Topographic Map of the Study Areas

Figure 3

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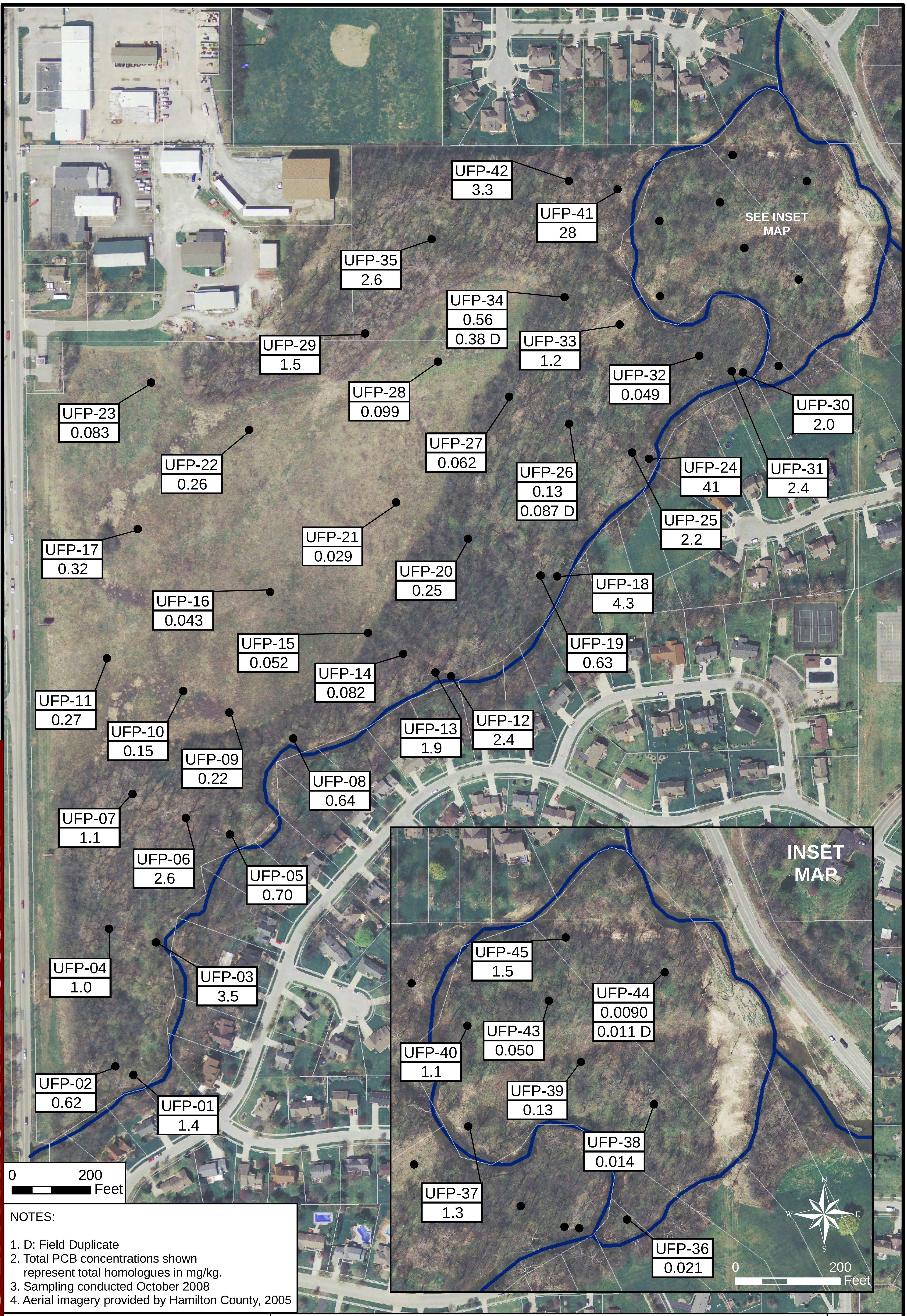

NOTES:

1. D: Field Duplicate
2. Total PCB concentrations shown represent total homologues in mg/kg.
3. Sampling conducted October 2008
4. Aerial imagery provided by Hamilton County, 2005

ENVIRON

Total PCB Concentrations (mg/kg) in Surface Soil (0-6")
Undeveloped Floodplain of Stony Creek
Noblesville, Indiana

Figure 4

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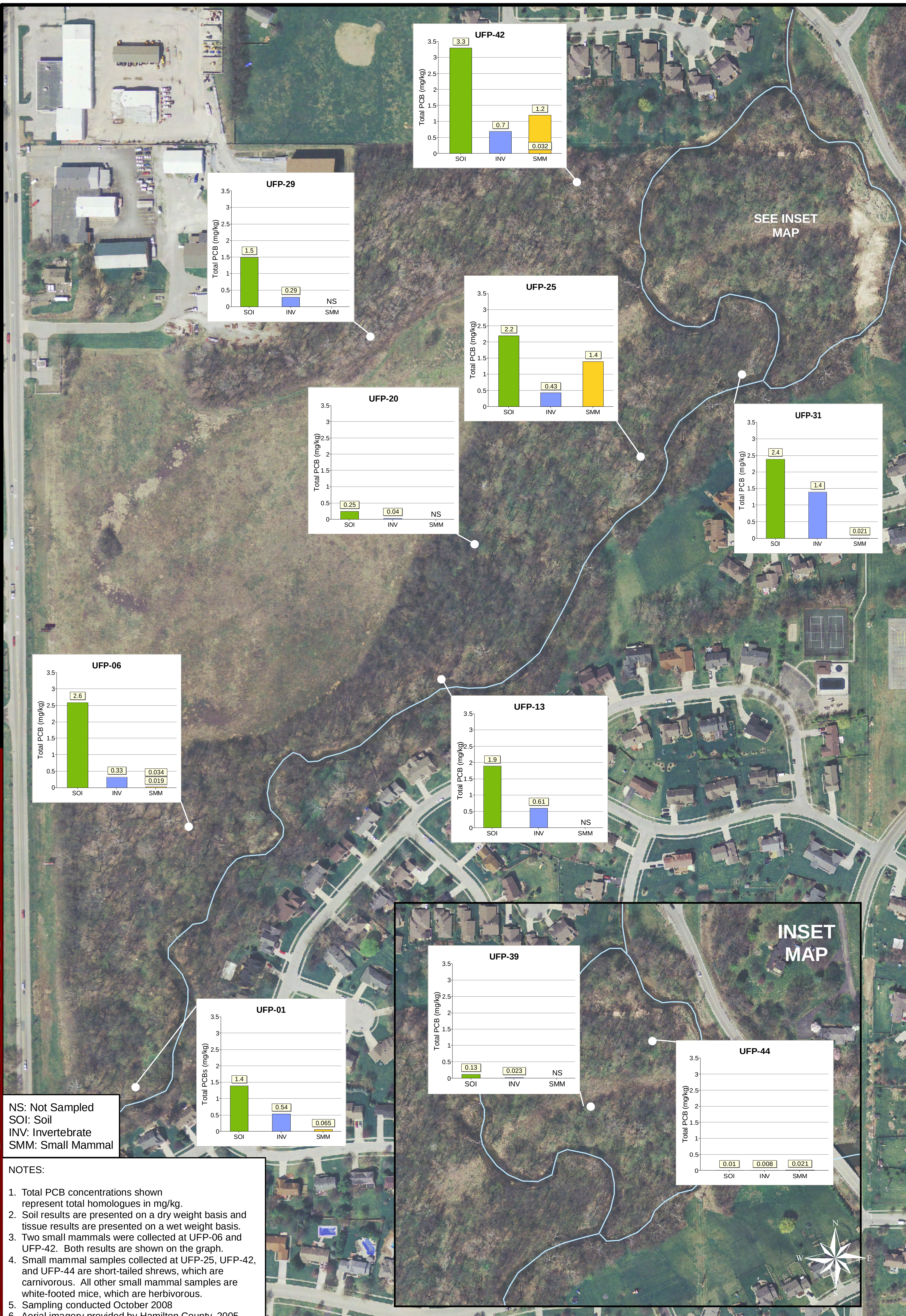

NS: Not Sampled
SOI: Soil
INV: Invertebrate
SMM: Small Mammal

NOTES:

1. Total PCB concentrations shown represent total homologues in mg/kg.
2. Soil results are presented on a dry weight basis and tissue results are presented on a wet weight basis.
3. Two small mammals were collected at UFP-06 and UFP-42. Both results are shown on the graph.
4. Small mammal samples collected at UFP-25, UFP-42, and UFP-44 are short-tailed shrews, which are carnivorous. All other small mammal samples are white-footed mice, which are herbivorous.
5. Sampling conducted October 2008
6. Aerial imagery provided by Hamilton County, 2005

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Total PCB Concentrations (mg/kg) in Surface Soil (0-6"), Invertebrates, and Small Mammals

Figure 5

Wednesday, December 23, 2009 2:05:56 PM
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