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Mr. Christopher Saari
Wisconsin Department of Natural Resources
2501 Golf Course Road
Ashland, WI 54806

ENVIRONMENT

Subject:
Off-Property Focused Corrective Measures Study
Former Koppers Inc. Facility – Superior, WI
WDNR BRRTs No: 02-16-000484
WDNR Facility ID: 816009810

Date:
August 22, 2014

Contact:
David Bessingpas

Phone:
218 829 4607

Email:
david.bessingpas@arcadis-us.com

Our ref:
B0039307.0000

Dear Mr. Saari:

On behalf of Beazer East, Inc. (Beazer), enclosed please find two copies of the *Off-Property Focused Corrective Measures Study* (Off-Property FCMS) for the Former Koppers Inc. Facility in Superior, Wisconsin (the Site). In accordance with Wisconsin Administrative Code NR 722, this document identifies, evaluates, and selects corrective action alternatives for the off-property portion of the Site.

Please feel free to contact me (218 829 4607) or Jane Patarcity of Beazer (412 208 8813) if you have any questions or comments regarding the enclosed document.

Sincerely,

ARCADIS U.S., Inc.

David Bessingpas

David Bessingpas
Sr. Project Manager

Copies:
Jane Patarcity, Beazer
Jeff Holden, ARCADIS
Hillary Evanko, ARCADIS
Stu Messur, Anchor QEA

Imagine the result

Beazer East, Inc.

Pittsburgh, Pennsylvania

Off-Property Focused Corrective Measures Study

Former Koppers Inc. Facility

Superior, Wisconsin

August 2014

ARCADIS

Off-Property Focused Corrective Measures Study

Former Koppers Inc. Facility
Superior, Wisconsin

Prepared for:

Beazer East, Inc.
Pittsburgh, Pennsylvania

Prepared by:

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Our Ref.:

B0039307.0000.00001

Date:

August 2014

I, Hillary Evanko, hereby certify that I am a registered professional engineer in the State of Wisconsin, registered in accordance with the requirements of ch. A-E 4, Wis. Adm. Code; that this document has been prepared in accordance with the Rules of Professional Conduct in ch. A-E 8, Wis. Adm. Code; and that, to the best of my knowledge, all information contained in this document is correct and the document was prepared in compliance with all applicable requirements in chs. NR 700 to 726, Wis. Adm. Code.

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PROFESSIONAL ENGINEER

Hillary Evanko, PE
Senior Environmental Engineer

Charts

Tables

Figures

Appendices

Acronyms and Abbreviations

AMEC	AMEC Earth & Environmental, Inc.
BBL	Blasland, Bouck & Lee, Inc. (now known as ARCADIS)
Beazer	Beazer East, Inc.
bgs	below ground surface
CAMU	Corrective Action Management Unit
CAMU Demonstration Document	*Request for Modification of the Closure and Long-Term Care Plan Approval and Corrective Action Management Unit ("CAMU") Demonstration*, 2000
CAO	Corrective Action Objective
COPC	constituent of potential concern
cy	cubic yard(s)
DNAPL	dense non-aqueous phase liquid
ERA	ecological risk assessment
EPC	exposure point concentration
FCMS	Focused Corrective Measures Study
GHG	greenhouse gas
License	Hazardous Waste Facility Operation License
HHERA	human health and ecological risk assessment
HHRA	human health risk assessment
HI	hazard index
KI	Koppers Inc.
µg/kg	microgram per kilogram

mg/kg	milligram per kilogram
MTR	Minimum Technology Requirement
Off-Property FCMS	*Off-Property Focused Corrective Measures Study*
On-Property FCMS	*Focused Corrective Measures Study*, 2007
PAH	polycyclic aromatic hydrocarbon
PCDD	polychlorinated dibenzo-p-dioxin
PCDF	polychlorinated dibenzofuran
RCM	Reactive Core Mat™
RCRA	Resource Conservation and Recovery Act
RfD	oral reference dose
TCDD	2,3,7,8- tetrachlorodibenzo-p-dioxin
T&D	transportation and disposal
TEQ	toxicity equivalent
TRP	TRP Properties LLC
TRV	toxicity reference values
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
WDHS	Wisconsin Department of Health Services
WDNR	Wisconsin Department of Natural Resources

Executive Summary

As part of the ongoing Resource Conservation and Recovery Act (RCRA) Corrective Action activities at the former Koppers Inc. Facility in Superior, Wisconsin (the Site; Figure 1), this *Off-Property Focused Corrective Measures Study* (Off-Property FCMS) has been prepared to identify and evaluate potential corrective action alternatives to address impacted media within the off-property portion of the Site and, ultimately, to identify a recommended corrective action approach. To this end, various potential corrective action alternatives have been identified in consideration of previous investigation data, current and anticipated future land uses, Site-specific factors, corrective action objectives (CAOs), and previous coordination with the Wisconsin Department of Natural Resources (WDNR). The scope of the corrective action alternatives is also based on the findings of the Site-specific *Human Health and Ecological Risk Assessment* (HHERA; AMEC 2009). The evaluation of corrective action alternatives was performed using criteria established in Section NR 722 of the Wisconsin Administrative Code (Standards for Selecting Remedial Actions).

ARCADIS has prepared this report on behalf of Beazer East, Inc. (Beazer) who retains certain pre-1988 environmental liabilities for the Site as a result of historical property ownership.

This Off-Property FCMS is termed “focused” in that it does not extensively evaluate a broad range of potential corrective action technologies. Rather, it focuses on technologies and alternatives that are known to be successful at addressing similar conditions at other wood-treating sites. This is reflective of Beazer’s 20-plus years of experience at evaluating and implementing corrective action alternatives at numerous sites impacted by wood-treating operations across the country. Many potential alternatives have previously been discussed, reviewed, and/or attempted at some scale at other wood-treating sites in the past, and, based on that experience, have not been considered in this Off-Property FCMS. This approach is consistent with that used for the WDNR-approved On-Property FCMS (ARCADIS 2007).

Site-specific COAs applicable to the portions of the Site addressed within this Off-Property FCMS are summarized as follows:

Area A – Tributary from Hammond Avenue to Crawford Creek Floodplain

1. Mitigate the potential for exposure by ecological receptors to COPC-impacted tributary channel sediment and bank materials

2. Mitigate the generation of COPC-related surface water sheens

Area B – Tributary within Crawford Creek Floodplain

1. Mitigate the potential for exposure by ecological receptors to COPC-impacted tributary channel sediment and bank/floodplain materials

2. Mitigate the generation of COPC-related surface water sheens

Area C – Crawford Creek from Tributary to Railroad Embankment

1. Mitigate the potential for exposure by ecological receptors to COPC-impacted creek channel sediment

2. Mitigate the generation of COPC-related surface water sheens

The development of potential corrective action alternatives for Areas A, B and C involved a multistep process. First, considering Beazer's experience at similar sites and the focused nature of this evaluation, potentially applicable technologies were identified and screened. Retained technologies were then assembled into corrective action alternatives considered capable of achieving the established CAOs. This approach for developing potential corrective action alternatives is consistent with that used in the WDNR-approved On-Property FCMS (ARCADIS 2007).

The corrective action alternatives evaluated in this Off-Property FCMS are summarized below:

Area A – Tributary from Hammond Avenue to Crawford Creek Floodplain

- Alternative A1: Channel and Bank Cover

- Alternative A2: Channel and Bank Cover, with Dense Non-Aqueous Phase Liquid (DNAPL) Collection Provisions

- Alternative A3: Extended Channel and Bank Excavation/Backfill

Area B – Tributary within Crawford Creek Floodplain

- Alternative B1: Partial Channel Excavation/Backfill, 1-Foot Floodplain Cover
- Alternative B2: Partial Channel Excavation/Backfill, 1-Foot Floodplain Excavation/Backfill
- Alternative B3: Extended Channel and Floodplain Excavation/Backfill

Area C – Crawford Creek from Tributary to Railroad Embankment

- Alternative C1: Channel Relocation with Armored Channel
- Alternative C2: Channel Relocation with Clay-Lined Channel
- Alternative C3: Partial Channel Excavation/Backfill
- Alternative C4: Extended Channel and Floodplain Excavation/Backfill

These alternatives were evaluated relative to the six criteria defined in Sections NR 722.07(4) and NR 722.09(2) of the Wisconsin Administrative Code: long-term effectiveness, short-term effectiveness, implementability, restoration time frame, economic feasibility, and compliance with environmental laws, standards and permitting requirements. Additionally, "sustainability" was also evaluated as a seventh criteria, in accordance with NR 722.09(2m) and the WDNR January 2012 Green & Sustainable Remediation Manual (Pub-RR-911; WDNR 2012). Based on these evaluations, the following corrective action approach is proposed[1]:

- Area A (Tributary from Hammond Avenue to Crawford Creek Floodplain) – Alternative A2: Channel and Bank Cover, with DNAPL Collection Provisions.

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[1] In addition to the components listed above, corrective actions would also be implemented in the portion of the Tributary to Crawford Creek located between the facility property boundary and Hammond Avenue (i.e., upstream of "Area A"). Corrective actions for this portion of the tributary would likely consist of installing an engineered liner system, pending coordination with an approval by the property owners.

- Area B (Tributary within Crawford Creek Floodplain) – Alternative B1: Partial Channel Excavation/Backfill, 1-Foot Floodplain Cover.

- Area C (Crawford Creek from Tributary to Railroad Embankment) – Alternative C2: Channel Relocation with Clay-Lined Channel.

- Establishing and implementing long-term monitoring and maintenance plans to verify the corrective actions and restored areas are functioning as designed.

- Establishing and implementing institutional controls (continuing obligations/GIS Registry) to guide future land and groundwater use to mitigate the potential for exposure to or disturbance of impacted materials that remain in place following implementation of "active" corrective actions.

Based on the comparative evaluation of alternatives, this combination of measures would achieve the Site-specific CAOs, offers long-term protection to human health and the environment, results in minimal/controllable short-term risks, is technically and administratively implementable, is cost effective, and can be designed/implemented to comply with applicable laws, standards and permits.

Under this proposed corrective action approach, the total volume of impacted materials generated from all three corrective action areas is anticipated to be approximately 3,340 cubic yards. A final decision on whether a CAMU would be the preferred method for long-term management of the excavated materials would depend on the actual volume of materials generated, the available CAMU capacity, CAMU design/operational requirements, and the cost of off-Site transportation and disposal at the time of generation. Accordingly, at this time Beazer would like to maintain both on-Site CAMU disposal and off-Site transportation and disposal as potentially applicable options.

1. Introduction

1.1 Purpose and Scope

This *Off-Property Focused Corrective Measures Study* (Off-Property FCMS) has been prepared as a component of the ongoing Resource Conservation and Recovery Act (RCRA) Corrective Action activities associated with the former Koppers Inc. (KI) Facility (facility) in Superior, Wisconsin (**Figure 1**). The facility is currently owned and operated by TRP Properties LLC (TRP), which acquired the facility from KI in 2012. Beazer East, Inc. (Beazer) retains certain pre-1988 environmental liabilities for the Site as a result of historical property ownership. On behalf of Beazer, this Off-Property FCMS has been prepared by ARCADIS for submittal to the Wisconsin Department of Natural Resources (WDNR).

Previous investigations have indicated the presence of wood-treating-related compounds in certain environmental media at the facility, as well as within and adjacent to a downgradient ditch/tributary and creek on nearby properties. The facility and affected downgradient areas are collectively referred to herein as “the Site.” The facility is also referred to as the “on-property portion of the Site,” whereas affected downgradient areas are referred to as the “off-property portion of the Site.” A *Focused Corrective Measures Study* (On-Property FCMS; ARCADIS 2007) for the on-property portion of the Site was previously submitted to and approved by WDNR, and corrective actions for that portion of the Site were implemented in 2010 and 2011. This Off-Property FCMS focuses specifically on the off-property portion of the Site.

The purpose of this Off-Property FCMS is to identify and evaluate potential corrective action alternatives to address impacted media within the off-property portion of the Site and, ultimately, to identify a recommended corrective action approach. To this end, various potential corrective action alternatives have been identified in consideration of previous investigation data, current and anticipated future land uses, Site-specific factors, corrective action objectives (CAOs), and previous coordination with WDNR. The scope of the corrective action alternatives is also based on the findings of the Site-specific *Human Health and Ecological Risk Assessment* (HHERA; AMEC Earth & Environmental, Inc. [AMEC] 2009), which is further discussed within this Off-Property FCMS. The evaluation of corrective action alternatives was performed using criteria established in Section NR 722 of the Wisconsin Administrative Code (Standards for Selecting Remedial Actions).

This Off-Property FCMS is termed “focused” in that it does not extensively evaluate a broad range of potential corrective action technologies. Rather, it focuses on technologies and alternatives that are known to be successful at addressing similar conditions at other wood-treating sites. This is reflective of Beazer’s 20-plus years of experience at evaluating and implementing corrective action alternatives at numerous sites impacted by wood-treating operations across the country. Many potential alternatives have previously been discussed, reviewed, and/or attempted at some scale at other wood-treating sites in the past, and, based on that experience, have not been considered in this Off-Property FCMS. This approach is consistent with that used for the WDNR-approved On-Property FCMS (ARCADIS 2007).

1.2 Report Organization

The remaining sections of this Off-Property FCMS are organized as follows.

- **Section 2 – Site Description and Land Use:** describes the physical setting of the Site.
- **Section 3 – Site History:** summarizes the operational history of the Site.
- **Section 4 – Previous Investigations/Evaluations:** summarizes the findings of previous investigations/evaluations pertinent to the identification, evaluation, and selection of corrective action alternatives. The HHERA is also summarized in this section.
- **Section 5 – Corrective Action Goals and Objectives:** presents the Site-specific CAOs established for the off-property portion of the Site, and discusses the areas of the off-property portion of the Site targeted for corrective action.
- **Section 6 – Identification of Corrective Action Alternatives:** identifies a variety of potential corrective action technologies and process options, and screens them based on considerations of Site-specific feasibility and effectiveness. The retained technologies and process options are then assembled into potential corrective action alternatives to target achievement of the Site-specific CAOs.
- **Section 7 – Evaluation of Corrective Action Alternatives:** presents a comparative evaluation of the potential corrective action alternatives with respect to the criteria described in NR 722.07 of the Wisconsin Administrative Code.
- **Section 8 – Selected Corrective Action Approach:** identifies the selected corrective action alternatives for the off-property portion of the Site, including the rationale for selection and summarizes the overall corrective action approach.

- **Section 9 – References:** cites documents, correspondence, and references supporting this Off-Property FCMS.

This document is supported by various attached tables, figures and appendices, which are referenced throughout the document.

2. Site Description and Land Use

As indicated in Section 1.1, the former KI Facility and affected downgradient areas are collectively referred to herein as "the Site." The former KI Facility is also referred to as the "facility" or "on-property portion of the Site," whereas affected downgradient areas are referred to as the "off-property portion of the Site."

The facility is located in a rural, sparsely populated setting in northwestern Wisconsin, approximately 5 miles southeast of the City of Superior (Douglas County) at the junction of County Roads A and Z (**Figure 1**). The facility property is approximately 112 acres and is zoned for industrial use. As shown on the Site Plan (**Figure 2**), the eastern property boundary generally parallels County Road A and the northern property boundary parallels Hammond Avenue. Historical wood-treating operations were located at the north end of the property and the remaining operational portions of the property were primarily used to store treated and untreated wood. KI discontinued wood-treating operations at the facility in 2006, and the majority of the buildings and structures associated with the former wood-treating processes were decommissioned in 2006 and 2007. The current property owner, TRP, runs a used railroad tie grinding operation in the southern portion of the facility, and KI leases a limited area in the southern portion of the facility for storage, sorting, and shipment of untreated railroad ties.

The area surrounding the facility, which has remained relatively unchanged for more than 60 years, is predominantly undeveloped and vegetated with trees, shrubs, and grasses. The area to the north, west, and northeast of the facility is zoned as a Resource Conservation District. National Wetland Inventory maps indicate that the property is primarily surrounded by wetlands, with the exception of an area zoned for agricultural use located south and southeast of the facility. No county parks, state parks, or fish hatcheries have been identified within a one-mile radius of the facility. Some private residences are located near the southeast portion of the facility on County Road A, and to the north and northeast of the facility along Hammond Avenue and County Road A. A series of railroad tracks run immediately north, west, and south of the facility. Crawford Creek, a tributary to the Nemadji River (which discharges to Lake Superior), is located approximately one-half mile northwest of the facility. Surface-water runoff from the majority of the facility drains to Crawford Creek via the tributary to Crawford Creek (previously referred to as the Outfall 001 drainage ditch).

3. Site History

The facility was constructed by the National Lumber and Creosoting Company and operations began in 1928. The property changed hands through a series of transactions between 1938 and 1988 when Beazer (then the property owner) sold it to KI. KI sold the facility to TRP in 2012. While the facility is currently owned by TRP, Beazer retains certain pre-1988 environmental liabilities for the Site as a result of historical property ownership.

Pressure-treated railroad cross ties, bridge timbers, switch ties, and crossing panels were historically produced at the former KI facility. Creosote with a number 6 fuel oil carrier was the primary preservative used at the plant; however, pentachlorophenol with a petroleum oil carrier was also used as a preservative between 1955 and 1979. Four non-RCRA wastewater impoundments were constructed in 1977 and closed in 1982. Two clay-lined RCRA surface impoundments were constructed in 1982 to store wastewater from the wood-treating process, following pretreatment via oil/water separation. The two RCRA surface impoundments were closed in August 1988. Closure certification was submitted to WDNR in November 1989. Between 1988 and 2006, wastewater from the treating process was treated via oil/water separation, biological activity and aeration, and treated water was evaporated in an evaporation unit. Wood-treating operations at the facility were discontinued in 2006.

In September 1988, the United States Environmental Protection Agency (USEPA) issued a RCRA Part B Corrective Action Permit for the Site, which expired in September 1998. In December 1990, a Hazardous Waste Facility Operation License (License) was issued for the Site by WDNR. The License, which expires in 2020, governs long-term care of the closed RCRA surface impoundments. The License, along with a Closure and Long-Term Care Approval, have been the WDNR's primary mechanisms for managing corrective action activities at the Site since the RCRA Part B Corrective Action Permit expired in 1998.

4. Previous Investigations/Evaluations

4.1 Summary of Off-Property Investigations

Various investigations activities were performed in the off-property portion of the Site between 1996 and 2014. These have included surface water sampling, soil and sediment sampling, fish and insect sampling, soil boring advancement, test pit excavation, piezometer installation/groundwater level monitoring, surface water gauge installation/surface water level monitoring, temporary monitoring well installation/groundwater sampling, and benthic macroinvertebrate and fish surveys. The various investigation events are summarized in the following chart.

Chart 1 Timeline of Off-Property Investigations

Year	Scope
1996	· Collection/laboratory analysis of 7 surface water samples, 14 channel sediment samples from 11 locations, and 2 ditch bank samples
1999	· Installation of 3 surface water gauges · 51 sediment and floodplain probing transects for visual classification; collection/laboratory analysis of 3 channel sediment and 105 floodplain samples along these transects · Collection/laboratory analysis of 4 surface water samples, 178 sediment samples from 41 locations, 7 ditch bank samples from 6 locations, 21 geochronological samples from 3 channel sediment sample locations, and geotechnical samples from 8 channel sediment and 4 floodplain sample locations · Benthic macroinvertebrate survey at 4 locations · Fish survey at 5 locations
2003	· Excavation of 113 test pits for visual observation · Collection/laboratory analysis of 10 floodplain samples from varying depths in the test pits · Collection/laboratory analysis of 6 channel sediment samples · Advancement of 65 borings along 15 sediment/floodplain transects for visual observation

Year	Scope
2005	· Reconnaissance and sediment probing · Excavation of three test pits and advancement of 35 soil borings for visual observation · Installation and monitoring of 25 piezometers and 5 surface water gauges · Collection/laboratory analysis of 25 floodplain , 9 channel sediment, 7 fish, 5 insect and 4 surface water sheen samples
2013 – 2014	· Advancement of hand auger borings at 13 floodplain locations for visual observation and collection/laboratory analysis of 8 samples from 4 locations · Advancment of direct push borings at 23 floodplain locations for visual observation and collection/laboratory analysis of 12 samples from 6 locations · Installation of 13 temporary monitoring wells, and collection/laboratory analsys of groundwater samples (two sampling events)

A comprehensive summary of the off-property investigations performed between 1996 and 2005 was provided in the *Off-Property Investigation Data Summary Report* (Blasland, Bouck & Lee, Inc. [BBL] 2006). Overall conclusions from the report are summarized below.

- Based on groundwater and surface water elevation measurements along the Tributary to Crawford Creek, both shallow and deep groundwater along the tributary generally have a downward flow component. Shallow groundwater in the immediate vicinity of the tributary appears to discharge to the tributary. However, shallow groundwater farther away from the tributary, and deeper groundwater, appear to be migrating downward, with flow beneath and beyond the tributary, indicating that the tributary does not act as a hydraulic boundary.

- Based on groundwater and surface water measurements along Crawford Creek, both shallow and deep groundwater along the creek generally have a downward flow component. Shallow groundwater recharges the creek in certain stretches, while in other areas, water may be flowing from the creek to groundwater. It may be that this condition exists following rain, before the level of the creek returns to base flow conditions. Deeper groundwater flows beneath and beyond the creek, indicating that the creek does not act as a hydraulic boundary.

- Constituents of potential concern (COPCs) include polycyclic aromatic hydrocarbons (PAHs), pentachlorophenol, and polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans (PCDDs/PCDFs).

- Surface water data indicate limited impact from Site-related COPCs. Low concentrations of PAHs and pentachlorophenol were detected in surface water samples, with the highest concentrations and frequency of detection observed in the tributary samples. Concentrations of PAHs and pentachlorophenol were relatively low in surface water samples, although sheens are periodically observed on surface water in the Tributary to Crawford Creek and Crawford Creek, resulting from the presence of creosote-like product in sediments and bank materials in contact with the surface water. The frequency of sheen presence has diminished with time.

- Channel bottom sediments containing creosote-like product have been observed at intermittent locations along the entire length of the Tributary to Crawford Creek and in Crawford Creek between the confluence of the Tributary to Crawford Creek and the railroad embankment. At half of the locations where creosote-like product was observed in sediments, such impacts were present in surficial sediments (i.e., the upper 1 foot). At the remaining locations, sediments containing creosote-like product were present beneath up to 0.5 feet of visibly unimpacted sediments and/or sediments with odor, staining, and/or sheen (but that did not contain creosote-like product).

- Odor, staining, and/or sheens were observed in channel bottom sediment at most locations probed in the Tributary to Crawford Creek and the upstream section of Crawford Creek (i.e., between the confluence with the Tributary to Crawford Creek and the railroad embankment). Odor, staining, and/or sheens were observed intermittently in Crawford Creek sediment downstream of the railroad embankment.

- Surficial channel bottom sediments with the highest PAH concentrations were generally located in the portion of the Tributary to Crawford Creek within the Crawford Creek floodplain and the portion of Crawford Creek between the confluence with the Tributary to Crawford Creek and the railroad embankment.

- Low-level concentrations (less than 1 milligram per kilogram [mg/kg]) of pentachlorophenol were detected in eight of the 14 channel bottom sediment samples collected in 1996. Pentachlorophenol was not detected in any of the 186 channel bottom sediment samples collected in 1999 and 2005.

- Low-level concentrations of PCDDs/PCDFs were detected in channel bottom sediment samples throughout the Tributary to Crawford Creek and Crawford Creek. All samples had 2,3,7,8- tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) toxicity equivalent (TEQ) values less than 0.5 micrograms per kilogram (µg/kg).

- Creosote-like product was observed in isolated cracks/fractures within the clay bank/floodplain materials along the Tributary to Crawford Creek. In areas upstream of the Crawford Creek floodplain, such impacts were observed laterally up to 55 feet away from the tributary channel. Along the portion of the tributary that lies within the Crawford Creek floodplain, impacts were observed laterally up to 250 feet from the tributary channel. Isolated seams of creosote-like product generally occurred at or below the elevation of the channel bottom, and were observed at depths up to 24 feet below ground surface (bgs).

- Creosote-like product was observed in isolated cracks/fractures within the clay bank/floodplain materials along the east side of Crawford Creek from approximately 350 feet upstream to approximately 300 feet downstream of the confluence of the Tributary to Crawford Creek, and along both the east and west sides of Crawford Creek from approximately 600 feet upstream of the railroad embankment to the railroad embankment. Within the creek floodplain, creosote-like product was observed at distances of up to approximately 300 feet from the creek and depths of up to 17 feet bgs. At the majority of the locations where isolated seams of creosote-like product were observed, such impacts were present below at least 3 feet of material that did not contain creosote-like product.

- In addition to the isolated seams of creosote-like product, a black stained layer was observed in several locations along the Crawford Creek floodplain. This black stained layer was typically about 2 feet thick and encountered at a depth of approximately 2 feet bgs. This black stained layer appeared to be a sandy silt material that was visibly distinguishable from the overlying and underlying materials (predominantly red/brown clays and silty clays) and typically exhibited a creosote-like odor, but no visible creosote-like product.

- No occurrences of creosote-like product, the black stained layer, odor, staining, or sheens were observed in Crawford Creek floodplain materials downstream of the railroad embankment.

- Surficial bank/floodplain materials with the highest PAH concentrations were located along the Tributary to Crawford Creek (both upstream of and within the Crawford Creek floodplain area).

- Arithmetic average concentrations of PAHs are generally higher in subsurface floodplain materials (i.e., below 1 foot bgs) than in surficial floodplain materials (i.e., 0- to 1-foot bgs interval). This is consistent with the observation of a visually unimpacted layer of depositional material present above visually impacted materials throughout the Crawford Creek floodplain.

- Pentachlorophenol was detected in only nine of the 100 bank/floodplain samples collected in 1996 and 1999; the highest concentrations were detected in samples collected along the Outfall 001 drainage ditch (upstream of the Crawford Creek floodplain). Pentachlorophenol was not detected in any of the 25 composite samples collected from the Crawford Creek floodplain in 2005.

- Low-level concentrations of PCDDs/PCDFs (i.e., 2,3,7,8-TCDD TEQ values all less than 1 ug/kg, with one exception) were detected in bank/floodplain samples throughout the Tributary to Crawford Creek and Crawford Creek areas.

- Beazer has not collected floodplain samples for laboratory analysis from the portion of Crawford Creek downstream of the railroad embankment. Based on data collected at the time of the *Off-Property Investigation Data Summary Report*, significant impacts to floodplain materials in these areas by COPCs was not anticipated based on the following considerations:

  - No occurrences of creosote-like product, the black stained layer, odor, staining, or sheens were observed in Crawford Creek floodplain materials downstream of the railroad embankment during the 1999 probing.

  - The culvert beneath the railroad embankment acts as a flow restriction and limits the potential for transport of COPCs to floodplain areas downstream of the embankment as a result of surface water flow (this is consistent with the observations of water backing up behind the railroad embankment during flood events, during which times historical discharges of COPCs would more likely be deposited throughout the floodplain area upstream of the embankment).

  - The majority of the floodplain downstream of the embankment is physically disconnected from the upstream portion. Whereas releases may have been transported to floodplain areas upstream of the embankment during high water conditions, they could not migrate to the corresponding downstream floodplain locations because of the physical barrier created by the embankment.

- With respect to surficial floodplain materials, there is a decreasing trend in COPC concentrations with distance downgradient from the facility. With the exception of samples collected near the Tributary to Crawford Creek, COPC concentrations in Crawford Creek floodplain samples upstream of the railroad embankment were generally low. This trend suggests that concentrations farther downgradient (i.e., within the floodplain area downstream of the railroad culvert) would be even lower.

- During the fish survey conducted in 1999, a total of 15 taxa (mostly minnow species and no edible-sized game fish, typical of a warm-water minnow-type stream) were identified in Crawford Creek. None of the fish collected during the fish survey exhibited any external anomalies. Minnows were the dominant fish collected during the 2005 sampling; white suckers and sticklebacks were also observed. Analytical results from the 2005 fish sampling indicated the highest concentrations of PAHs and PCDDs/PCDFs occur in samples collected from the upstream portions of Crawford Creek, near the confluence with the Tributary to Crawford Creek.

- During the 2005 insect sampling, mostly terrestrial species (i.e., moths and beetles) were observed in the samples, although some aquatic insects were observed (i.e., caddisflies and midges). Analytical results indicate the highest PAH concentrations in insect samples occurred in the sample collected near the confluence of the Tributary to Crawford Creek and Crawford Creek. The highest 2,3,7,8-TCDD TEQ concentration in an insect sample occurred in the sample collected along Crawford Creek approximately 900 feet upstream of the railroad embankment.

As indicated in the table above, additional investigation activities were completed between August 2013 and January 2014. These investigations were completed in accordance the WDNR-approved *Work Plan for Supplemental Off-Property Investigations* (ARCADIS 2013a) to address data gaps identified by WDNR based on its review of the historical investigation data presented in the *Off-Property Investigation Data Summary Report*. The results of the August 2013 through January 2014 investigations were provided in the *Supplemental Off-Property Investigation Summary Report* (ARCADIS 2014), which was approved by WDNR in a letter to Beazer dated June 11, 2014 (WDNR 2014). The *Supplemental Off-Property Investigation Summary Report* included the following overall conclusions:

- Site-related impacts are not present at higher flood elevations at the edges of the Crawford Creek floodplain. The horizontal extent of PAH and PCDD/PCDF impacts within the floodplain has been adequately delineated.

- The horizontal and vertical extent of visibly impacted materials within the targeted floodplain investigation areas have been adequately delineated. In general, visual observations from the 2013 direct push soil borings support the previous conceptual site model for the nature and extent of impacted materials within the Crawford Creek floodplain, with two exceptions:

  - Creosote-like product was observed in isolated clay fractures to depths of up to 30 feet bgs. Previously, the maximum depth that these conditions were observed to be present was 17 feet bgs (based on equipment limitations during test pit excavations in 2003).

  - In three of the 29 direct push soil borings advanced in the floodplain in 2013, creosote-like product was observed in thin, isolated sand seams, at depths ranging from 15.9 to 27.8 feet bgs. Although not previously encountered in the Crawford Creek floodplain (likely because previous investigations did not reach depths where sand seams are present), the presence of thin, isolated sand seams is consistent with observations from historical soil boings advanced in the on-property portion of the Site.

- The 2013 floodplain sampling data support the previously presented visual/analytical data correlation for PAHs (i.e., visibly impacted materials have relatively higher PAH concentrations and visibly unimpacted materials have relatively lower PAH concentrations).

- Groundwater impacts are present only in the immediate vicinity of visibly impacted zones (i.e., impacted groundwater does not migrate significant distances either laterally or vertically from the visibly impacted zones).

4.2 Summary of HHERA

The HHERA (AMEC 2009) documented results of risk assessments completed for potential human and ecological receptors in the off-property portion of the Site. The HHERA was prepared in accordance with a WDNR-approved *Work Plan for Outfall 001 Drainage Ditch and Crawford Creek Investigation Activities*, prepared by AMEC/BBL, dated November 17, 2004, as well as two separate WDNR-approved ecological and human health approach memoranda dated March 2006 and September 2007. These documents laid out the conceptual site model, methods for sample collection, screening benchmarks, COPCs, receptors of concern, toxicity reference values (TRVs), biotransfer factors, and the assessment and measurement endpoints to conduct the ecological risk assessment. The HHERA also considered WDNR comments on the work plan and the ecological approach memoranda dated October

30, 2006, April 24, 2007, May 12, 2008, May 28, 2008, and July 23, 2008. On behalf of WDNR, the Wisconsin Department of Health Services (WDHS) provided a comment on the human health risk assessment (HHRA) portion of the HHERA in a memorandum dated August 10, 2011, and the USEPA provided comments on the ecological risk assessment (ERA) portion of the HHERA in a memorandum dated February 3, 2012. WDHS and USEPA comments, along with Beazer's responses addressing those comments, are provided in **Appendix A**. As indicated in **Appendix A**, the WDHS and USEPA comments do not affect the conclusions of the HHERA.

Using the agreed-upon approach and investigation data obtained between 1996 and 2005, the HHERA (AMEC 2009) estimated potential human health and ecological risks associated with exposures to COPCs in the following three areas in the off-property portion of the Site (**Figure 2**):

- HHERA Area 1: The portion of the Tributary to Crawford Creek and the surrounding floodplain that is located within the Crawford Creek floodplain

- HHERA Area 2: Crawford Creek and the surrounding floodplain from the confluence with the Tributary to Crawford Creek downstream to the railroad embankment

- HHERA Area 3: Crawford Creek and the surrounding floodplain from the railroad embankment downstream to the confluence with the Nemadji River

The purpose of the HHERA was to identify areas in the off-property portion of the Site where corrective actions are required to mitigate potentially unacceptable risks under current conditions. Note that the portion of the Tributary to Crawford Creek between the facility property boundary and the Crawford Creek floodplain was not evaluated in the HHERA. Beazer previously committed to implement corrective actions in this portion of the tributary, such that risk assessments were not necessary to determine if corrective actions for this area are required.

The HHRA portion of the HHERA evaluated risks to human receptors from potential exposure to COPCs in floodplain materials, surface water, and channel sediment. Exposure point concentrations (EPCs) were estimated for COPCs detected in a given medium. In floodplain materials, COPCs included PAHs, pentachlorophenol, and PDCDs/PCDFs. In tributary/creek channel sediment, COPCs included PAHs and PCDDs/PCDFs. In surface water, COPCs included PAHs and pentachlorophenol. Potential human receptors evaluated in the HHRA included:

- Recreational Visitor (12 to 18 year old teen, 7 to 18 year old teen, and adult)
- Hunter (12 to 18 year teen, 7 to 18 year old teen, and adult)
- Trapper (adult)

The results of the HHRA indicated that potential noncarcinogenic effects are not expected for any of the evaluated potential receptors. Similarly, the HHRA also indicated that potential excess lifetime cancer risks for all evaluated potential receptors fall within the USEPA allowable risk range of $1x10^{-6}$ to $1x10^{-4}$ and the WDNR allowable risk threshold of $1x10^{-5}$. Thus, the HHRA demonstrated that for the most likely and expected current and future uses, the evaluated off-property portions of the Site do not pose an unacceptable potential non-cancer or cancer risk.

The ERA portion of the HHERA evaluated potential risks to benthic macroinvertebrates, fish, and the following potential upper trophic level receptors: meadow vole, little brown bat, tree swallow, American robin, mink, and belted kingfisher. EPCs were estimated for COPCs detected in a given medium. In surficial floodplain materials, tributary/creek channel sediment, and forage fish, COPCs included PAHs, pentachlorophenol, and PCDDs/PCDFs. In surface water, COPCs included PAHs and pentachlorophenol. In flying insects, COPCs included PAHs and PCDDs/PCDFs.

The results of the ERA are summarized as follows:

- The existing data preclude a firm conclusion about the presence or absence of an effect of COPCs on the macroinvertebrate community.
- The absence of available criteria for several COPCs combined with the changes observed in the downstream fish community in Crawford Creek preclude a firm conclusion about the presence or absence of an effect of COPCs on the Crawford Creek fish community.
- The evaluation of higher trophic level receptors potentially exposed to COPCs through the food chain found that risks are unlikely.

In summary, while the HHRA suggests no unacceptable risks to potentially foreseeable human receptors in the evaluated off-property areas, the uncertainties of the ERA regarding potential ecological risks in HHERA Areas 1 and 2, and observations of periodic sheens on surface water within Crawford Creek, corrective actions will be evaluated for:

- Tributary to Crawford Creek sediments within HHERA Area 1
- Floodplain materials within HHERA Area 1
- Crawford Creek channel sediments within HHERA Area 2
- Tributary to Crawford Creek channel sediments and adjacent banks materials upstream of HHERA Area 1 (which were not evaluated in the HHERA)

5. Corrective Action Areas and Objectives

Based on the findings of investigations conducted between 1996 and 2014, along with the HHERA, corrective actions are proposed for the following off-property media/areas[2]:

- Sediment within and bank materials adjacent to the portion of the Tributary to Crawford Creek from Hammond Avenue downstream to the Crawford Creek floodplain (Area A; **Figure 3**)
- Sediment within and floodplain materials adjacent to the portion of the Tributary to Crawford Creek located within the Crawford Creek floodplain (Area B; **Figure 3**)
- Sediment within the portion of Crawford Creek from the confluence with the Tributary to Crawford Creek downstream to the railroad embankment (Area C; **Figure 3**)

The following Site-specific CAOs have been developed for Areas A, B, and C:

<u>Area A – Tributary from Hammond Avenue to Crawford Creek Floodplain</u>

1. Mitigate the potential for exposure by ecological receptors to COPC-impacted tributary channel sediment and bank materials
2. Mitigate the generation of COPC-related surface water sheens

<u>Area B – Tributary within Crawford Creek Floodplain</u>

1. Mitigate the potential for exposure by ecological receptors to COPC-impacted tributary channel sediment and bank/floodplain materials
2. Mitigate the generation of COPC-related surface water sheens

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[2] Remediation options for the portion of the Tributary from the facility property line to Hammond Avenue are not included in this FCMS. This stretch is comprised primarily of culverts beneath the railroad tracks and road, with short sections of open channel between culverts. It is anticipated that a prescribed remedy similar to that implemented within the on-property Outfall 001 drainage ditch (i.e., installation of an engineered liner system) will be implemented for this section of the Tributary, pending coordination with an approval by the property owner (BNSF Railway Company).

<u>Area C – Crawford Creek from Tributary to Railroad Embankment</u>

1. Mitigate the potential for exposure by ecological receptors to COPC-impacted creek channel sediment

2. Mitigate the generation of COPC-related surface water sheens

6. Identification of Corrective Action Alternatives

6.1 Overview

As described in Section 1.1, this Off-Property FCMS is termed “focused” in that it does not extensively evaluate a broad range of potential corrective action technologies. Rather, it focuses on technologies and alternatives that are known to have been used successfully to address similar conditions at other wood-treating sites. This reflects Beazer’s 20-plus years of experience at evaluating and implementing corrective action alternatives at numerous sites impacted by wood-treating operations across the country. Many potential alternatives have previously been discussed, reviewed and/or attempted at some scale at other wood-treating sites in the past, and, based on that experience, have not been considered in this Off-Property FCMS. This approach results in a focused set of potential corrective action alternatives for the target corrective action areas described in Section 5 and shown on **Figure 3**:

- Area A – Tributary from Hammond Avenue to Crawford Creek Floodplain
- Area B – Tributary within Crawford Creek Floodplain
- Area C – Crawford Creek from Tributary to Railroad Embankment

The development of potential corrective action alternatives involved a multistep process. First, considering Beazer’s experience at similar sites and the focused nature of this evaluation, potentially applicable technologies were identified and screened. Retained technologies were then assembled into corrective action alternatives considered capable of achieving the established CAOs. These steps are detailed in Sections 6.2 and 6.3. This approach for developing potential corrective action alternatives is consistent with that used in the WDNR-approved On-Property FCMS (ARCADIS 2007).

6.2 Initial Screening of Corrective Action Technologies

In accordance with NR 722.07, an initial screening was performed to identify technologies potentially applicable for the targeted off-property areas, upon which corrective action alternatives may be developed. The focused lists of technologies, listed in **Table 1,** were developed considering the following factors:

- Beazer’s 20-plus years of experience at evaluating and implementing corrective action alternatives at numerous sites impacted by wood-treating operations across the country – While several treatment technologies exist that are potentially applicable to the types of constituents present at the Site, Beazer's experience at evaluating and/or applying such technologies at other similar sites suggests they are not appropriate for this Site. These technologies are rarely as effective at full scale as they are in laboratory- or bench-scale testing, typically require extensive bench- or pilot-scale tests, and typically involve high costs.

- Site-specific considerations such as the nature of the COPCs and location and volume of materials targeted for corrective action – The nature of Site clay matrix and climatic conditions would hinder the effectiveness of certain technologies (e.g., bioremediation), while the shallow groundwater table, clay matrix, and other factors preclude other technologies (e.g., thermal treatment, chemical extraction).

- Focus on readily implementable and proven corrective action technologies – The retained technologies presented in **Table 1** have been implemented successfully at a wide range of other sites across the country, have proven to be both technically effective and a cost-effective means of addressing similar constituents in similar media, and are appropriate for Site-specific media and areas addressed in this Off-Property FCMS.

The focused lists of potentially applicable technologies were then screened on the basis of Site-specific feasibility, including applicability to the types of constituents present, target areas/media, and Site characteristics. As appropriate, the degree of effectiveness and relative cost-effectiveness were also considered in the screening process to further differentiate among the various technologies.

Results of the initial screening are summarized in **Table 1**. Because the list was focused to begin with, only a few options were screened from further consideration. In particular, treatment technologies (both in-situ and ex-situ) were eliminated from further evaluation.

The technologies and process options retained for further consideration are listed below.

<u>Area A – Tributary from Hammond Avenue to Crawford Creek Floodplain</u>

- Institutional Controls/Land and Groundwater Use Restrictions

- Monitoring/Field Observation, Sampling and Analysis

- Excavation/Mechanical Excavation

- Physical Barrier/Capping
- On-Site CAMU Disposal
- Off-Site Disposal

Area B – Tributary within Crawford Creek Floodplain

- Institutional Controls/Land and Groundwater Use Restrictions
- Monitoring/Field Observation, Sampling and Analysis
- Excavation/Mechanical Excavation
- Physical Barrier/Capping
- On-Site CAMU Disposal
- Off-Site Disposal

Area C – Crawford Creek from Tributary to Railroad Embankment

- Institutional Controls/Land and Groundwater Use Restrictions
- Monitoring/Field Observation, Sampling and Analysis
- Excavation/Mechanical Excavation
- Physical Barrier/Capping
- Physical Barrier/Channel Relocation
- On-Site CAMU Disposal
- Off-Site Disposal

The basis for retaining each of these technologies and process options is summarized in **Table 1**.

6.3 Corrective Action Alternatives

The retained technologies and process options were assembled into the following corrective action alternatives that would be capable of achieving the Site-specific CAOs identified in Section 5[3]:

<u>Area A – Tributary from Hammond Avenue to Crawford Creek Floodplain</u>

- Alternative A1: Channel and Bank Cover
- Alternative A2: Channel and Bank Cover, with Dense Non-Aqueous Phase Liquid (DNAPL) Collection Provisions
- Alternative A3: Extended Channel and Bank Excavation/Backfill

<u>Area B – Tributary within Crawford Creek Floodplain</u>

- Alternative B1: Partial Channel Excavation/Backfill, 1-Foot Floodplain Cover
- Alternative B2: Partial Channel Excavation/Backfill, 1-Foot Floodplain Excavation/Backfill
- Alternative B3: Extended Channel and Floodplain Excavation/Backfill

<u>Area C – Crawford Creek from Tributary to Railroad Embankment</u>

- Alternative C1: Channel Relocation with Armored Channel
- Alternative C2: Channel Relocation with Clay-Lined Channel
- Alternative C3: Partial Channel Excavation/Backfill
- Alternative C4: Extended Channel and Floodplain Excavation/Backfill

Each of these alternatives is described in detail in Sections 6.3.1 through 6.3.3.

[3] Note that some of these alternatives were previously presented to WDNR in a letter dated December 7, 2011 (Beazer 2011) and at a February 20, 2012 meeting in Madison, WI. Certain WDNR comments and concerns regarding the presented alternatives have been incorporated into the alternatives presented herein.

Three items common to each of the alternatives are wetland restoration/mitigation, management of excavated materials, and institutional controls. Rather than repeating discussions of these three items in the descriptions of each of the corrective action alternatives, they are described below.

Wetland Restoration/Mitigation

For all alternatives, it is assumed that existing wetland areas that are disturbed would be restored as wetlands, and that additional wetland mitigation would not be required by WDNR and/or the United States Army Corps of Engineers (USACE). Actual wetland-related requirements would be determined through the permitting process, as further described below.

Management of Excavated Materials

For the purposes of this Off-Property FCMS, it is assumed that excavated materials would be managed in one of two ways: 1) transported to an off-Site, commercial facility for treatment and/or disposal, or 2) transported to the facility for consolidation in an on-Site Corrective Action Management Unit (CAMU). In anticipation of the potential need for cost-effective management of larger quantities of materials excavated during corrective action activities, a proposal to establish a CAMU at the Site was previously submitted to and approved by WDNR[4,5]. A CAMU is anticipated to provide a more cost-effective means of consolidating large quantities of materials relative to off-Site transportation and disposal (T&D); however, there are space considerations that limit available CAMU capacity on-Site.

In practice, due to the costs associated with constructing and maintaining a CAMU containment cell, there is a volume of excavated material below which off-Site T&D is more cost effective than on-Site CAMU disposal. That volume can vary substantially based on characteristics of the excavated material, off-Site T&D costs, site-specific CAMU design parameters, CAMU operational requirements, etc. Considering these factors, it is assumed that off-Site T&D would be more cost-effective than on-Site CAMU disposal for alternatives that involve the excavation of a relatively small volume of material. Accordingly, for those alternatives with smaller excavation volumes, off-Site

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[4] *Request for Modification of the Closure and Long-Term Care Plan Approval and Corrective Action Management Unit (CAMU) Demonstration* (BBL 2000).

[5] The WDNR issued a letter to Beazer dated November 1, 2000, indicating that the CAMU application was “conditionally in the approval process” and, therefore, “grandfathered” under the 1993 CAMU regulations (WDNR 2000).

T&D is included in the alternative descriptions and cost estimates discussed below. On the other hand, for alternatives that involve the excavation of a relatively large volume of material, the most cost-effective option for managing excavated materials would depend on the actual volume of materials generated, the available CAMU capacity, CAMU design/operational requirements, and the cost of off-Site T&D at the time of generation. Accordingly, for those alternatives with larger excavation volumes, both off-Site T&D and on-Site CAMU disposal are included in the alternative descriptions and cost estimates discussed below. This approach reflects the range of possible options/costs for material disposal for alternatives that involve the excavation of a relatively large volume of material. Additional information related to consolidation of excavated materials at an on-Site CAMU is provided in Section 6.4.

Specific to the CAMU costs, for the purposes of this document, it is assumed that a separate CAMU would be constructed for each alternative. This assumption is necessary to provide a means for comparability between various alternatives in Section 7. In actuality, a single CAMU would be constructed to accommodate materials generated from alternatives implemented in each of the three corrective action areas (assuming sufficient capacity exists at the Site to accommodate the total volume of materials to be generated, and it is determined that CAMU disposal is more cost-effective than off-Site T&D), and there would be some cost savings for constructing, operating and maintaining a single CAMU rather than individual CAMUs for each area.

For off-Site T&D costs, it is assumed that excavated materials would be disposed of as hazardous waste. Further, it is assumed that materials would be transported via rail to an appropriately licensed, commercial facility located either in the United States or Canada, at a typical current-day cost of $575/ton. If transportation via rail is not a viable option at the time of construction, transportation via trucks is anticipated to be significantly more expensive than transportation via rail (currently estimated at over $1,000/ton).

Institutional Controls

As further discussed elsewhere in this document, due to the nature and extent of the impacts adjacent to the Tributary to Crawford Creek and Crawford Creek, removal of all impacted materials is impracticable, and some impacted materials would ultimately be left in place, regardless of the alternatives selected. Accordingly, it is anticipated that institutional controls would be a component of each of the corrective action alternatives presented below to mitigate the potential for future exposure to or disturbance of impacted materials that may remain in place following implementation of "active" corrective actions.

It is anticipated that institutional controls would be established through the WDNR Site Closure Process. Beazer would propose land and groundwater use restrictions (continuing obligations) in the Case Closure Request/Application. Continuing obligations are anticipated to include restrictions on activities that would remove or damage cover materials and construction of drinking water wells screened within the shallow impacted clay zone without first obtaining permission from WDNR. The final continuing obligations would be specified in the WDNR's Closure Approval Letter. In addition to specifying continuing obligations in the Closure Approval Letter, notifications would be made to affected property owners and the Site would be listed in the WDNR Remediation and Redevelopment Program's GIS Registry of Closed Remediation Sites. The GIS Registry would include a link to the WDNR's Closure Approval Letter. Any maintenance requirements (such as requirements to maintain the condition of any surface covers) would also be identified in the Closure Approval Letter and identified in the GIS Registry.

6.3.1 Area A – Tributary from Hammond Avenue to Crawford Creek Floodplain

Three corrective action alternatives for Area A have been developed for further evaluation. The scope and estimated cost associated with each alternative are summarized in the following subsections.

6.3.1.1 Alternative A1: Channel and Bank Cover

This alternative is an in-situ containment approach that includes installing an engineered cover over impacted Tributary sediments and bank materials. By covering the impacted Tributary materials, the potential for exposure by ecological receptors to the impacted media would be mitigated. In addition, installation of cover materials would isolate surface water from contact with impacted media, and provide a separation between the surface water flow and any residual creosote-like material that could otherwise serve as a source of surface water sheens.

Alternative A1 is depicted in plan and cross-section view on **Figure 4**. Key components of this alternative include the following:

- Build access roads; clear and grub the work area.
- Construct a water management system to handle surface water and groundwater that accumulates in the work area.
- Establish temporary bypass pumping setups to divert surface water flow around a length of channel so that work can be performed in a dewatered condition.

- Clear and smooth/rework the existing ground surface to eliminate vegetation, vertical/undercut banks, large cobbles/boulders, etc. Assumes an estimated 500 cubic yards [cy] of material will be generated for off-Site disposal.

- Install geotextile demarcation layer over the smoothed existing channel surface.

- Place and compact 6 inches of general fill to cover protruding stones, roots, etc. and provide a relatively smooth surface on which to install the engineered cover.

- Install a layer of Reactive Core Mat™ (RCM) within the new channel to inhibit migration of potentially mobile creosote-like product that may be present, and the resulting formation of sheens in the restored channel.

- Place and compact 1 foot (minimum) of general fill over the RCM to provide protective cover and separation, plus additional fill as required to establish subgrade geometry for channel lining materials.

- Install geotextile erosion protection layer within the new channel.

- Install stone-filled gabion mattresses within the new channel to provide long-term erosion protection.

- On each side of the new channel, install a layer of geotextile as a demarcation layer, then place and compact 8 inches of general fill and 4 inches of vegetated topsoil to taper new channel banks into existing side slopes and to cover impacted bank materials.

Post-installation monitoring would be performed to evaluate the integrity of the restored tributary and identify signs of erosion. As necessary, maintenance activities would be performed based on observations from these monitoring events. This may include placement of additional rip-rap or stone-filled gabion mattresses if washed out areas are observed, regrading, or replanting vegetated portions of the engineered cover. For cost estimating purposes, it was assumed that annual inspections would be conducted for 30 years, and maintenance activities would be conducted every 5 years over the 30-year period.

Institutional controls (continuing obligations/GIS Registry) would be required to restrict land and groundwater use to mitigate the potential for future exposure to or disturbance of impacted materials that may remain in place following implementation of "active" corrective actions.

The estimated cost to implement this alternative is $3,153,000. This cost estimate, prepared in accordance with NR 722.07(4)(b), includes estimated capital costs, indirect costs (e.g., pre-design investigations, engineering design), and post-construction operation and maintenance costs associated with this alternative. The alternative-specific cost is summarized in **Table 2** and a detailed estimate is provided in **Appendix B, Table 1**.

6.3.1.2 Alternative A2: Channel and Bank Cover, with DNAPL Collection Provisions

Like Alternative A1, this alternative is an in-situ containment approach that includes installing an engineered cover over impacted Tributary sediments and bank soils. This alternative includes a modified restoration approach consisting of the creation of baseline and secondary flow channels. The baseline flow channel (sized to accommodate 2-year flood events) would be completed with soil-choked stone gabions to reduce the potential for future channel incision. The secondary flow channel (sized to accommodate 25-year flood events) would be completed with topsoil and riparian vegetation. Velocity control structures, such as wedge dams or rock weirs, would be installed at locations matching existing features and as necessary to reduce the velocity of surface water flows within the channel. In addition, a collection trench would be installed upgradient of the railroad crossing (**Figure 5**) to provide a means for collecting potentially mobile creosote-like product (DNAPL), if any, that may be migrating downstream beneath the engineered cover along the Tributary channel[6,7].

Consistent with Alternative A1, covering impacted sediments and bank soils mitigates the potential for exposure by ecological receptors to the impacted media. Installation of cover materials would isolate surface water from contact with remaining impacted tributary channel sediments and bank materials, and provide a separation between the surface water flow and any residual creosote-like material that could otherwise serve as a source of surface water sheens. In addition, potentially mobile residual creosote-

[6] The DNAPL collection component was added to Alternative A2 based on discussions with WDNR at a February 20, 2012 meeting in Madison, WI.

[7] It should be noted that the portion of the Tributary located on the facility (referred to as the “Outfall 001 drainage ditch”) is adjacent to historical sources of creosote-like product and had similar observations of product in clay fractures in adjacent bank materials. A product collection layer and sumps were constructed in the ditch in 2010/2011 as part of on-property corrective measures. Mobile product was not observed during construction and has not accumulated in either of the collection sumps to date. Based on these observations/results for the on-property portion of the Site, similar observations/results (lack of accumulating product) are expected for Area A.

like material, if any, would be removed with this alternative by collection in the DNAPL collection trench.

Alternative A2 is depicted in plan and cross-section view on **Figure 5**. Key components of this alternative include the following:

- Build access roads; clear and grub the work area.

- Construct a water management system to handle surface water and groundwater that accumulates in the work area.

- Establish one or more temporary bypass pumping setups to divert surface water flow around a length of channel so that work can be performed in a dewatered condition.

- Clear and smooth/rework the existing ground surface to eliminate vegetation, vertical/undercut banks, large cobbles/boulders, etc. Assumes an estimated 500 cy of material will be generated for off-Site disposal.

- Install geotextile demarcation layer over the smoothed existing channel surface.

- Place and compact 6 inches of general fill to cover protruding stones, roots, etc. and provide a relatively smooth surface on which to install the engineered cover.

- Install a layer of RCM within the new channel to inhibit migration of potentially mobile creosote-like product that may be present, and the resulting formation of sheens in the restored channel.

- Place and compact 6 inches (minimum) of general fill over the RCM to provide protective cover and separation, plus additional fill as required to establish subgrade geometry for baseline and secondary flow channels.

- Install geotextile erosion protection layer and soil-choked stone-filled gabion mattresses as the baseline flow channel.

- Install 4 inches of topsoil, riparian vegetation and erosion control mat as the secondary flow channel.

- Install velocity control structures.

- Construct a 1-foot wide gravel-filled DNAPL collection trench a short distance upgradient of the railroad crossing. As shown on Detail 1 of **Figure 5**, the 1-foot wide DNAPL collection trench would extend to 10 feet on each side of the channel. The bottom of the DNAPL collection trench would slope to allow for collection of potentially mobile residual creosote-like product, and would be set 4 to 5 feet below the base of the existing channel.

Post-installation monitoring would be performed to evaluate the integrity of the restored tributary and identify signs of erosion, and to monitor the gravel-filled trench for accumulation of DNAPL (accumulated DNAPL, if any, would be pumped out of the trench and containerized for off-Site disposal). As necessary, maintenance activities would be performed based on observations from these monitoring events. This may include placement of additional stone-filled gabion mattresses if washed out areas are observed, regrading, or replanting vegetated portions of the secondary flow channel. For cost estimating purposes, it was assumed that annual inspections would be conducted for 30 years, and maintenance activities would be conducted every 5 years over the 30-year period.

Institutional controls (Continuing obligations/GIS Registry) would be required to restrict land and groundwater use to mitigate the potential for future exposure to or disturbance of impacted materials that may remain in place following implementation of "active" corrective actions.

The estimated cost to implement this alternative is $2,844,000. This cost estimate, prepared in accordance with NR 722.07(4)(b), includes estimated capital costs, indirect costs (e.g., pre-design investigations, engineering design), and post-construction operation and maintenance costs associated with this alternative. The alternative-specific cost is summarized in **Table 2** and a detailed estimate is provided in **Appendix B, Table 2**.

6.3.1.3 Alternative A3: Extended Channel and Bank Excavation/Backfill

This alternative includes excavating impacted materials from within, below, and adjacent to the existing tributary channel. Although this extended removal alternative has significant short-term effectiveness and implementability issues (as discussed in Section 7), it is included in this FCMS for comparison to Alternatives A1 and A2. The excavation limits and depths are shown on **Figure 6**, and are based on existing soil boring and test pit data (Section 4.1). As shown on **Figure 6**, excavation limits extend up to approximately 55 feet from the edge of the channel and to depths up to 24 feet bgs. Note that even under this extended removal alternative, due to the nature and extent of the impacts adjacent to the Tributary to Crawford Creek, removal of all impacted materials is impracticable, and some impacted materials would ultimately be left in place. Excavated materials would be disposed at either an on-Site CAMU containment cell or an off-Site licensed facility. The excavated channel area would be backfilled and restored to re-establish the existing channel configuration to the extent possible. By excavating impacted sediments and bank materials, the potential for exposure by ecological receptors to the impacted media and generation of surface water sheens would be mitigated.

Alternative A3 is depicted in plan and cross-section view on **Figure 6**. Key components of this alternative include the following:

- Build access roads; clear and grub the work area.
- Construct a water management system to handle surface water and groundwater that accumulates in the work area.
- Establish temporary bypass pumping setups to divert surface water flow around a length of channel so that work can be performed in a dewatered condition.
- Excavate the Tributary channel and adjacent bank materials to the limits and depths shown on **Figure 6** (60,700 cy). Excavated materials would be transported to the on-property portion of the Site for consolidation in a CAMU containment cell or disposed of off-Site.
- Within the channel limits, place and compact general fill to within 12 inches of final grade, then install a layer of geotextile, followed by stone-filled gabion mattresses to provide long-term erosion protection.
- Outside of the channel (**Figure 6**), place and compact general fill to within 4 inches of final grade, then install 4 inches of vegetated topsoil.

Post-installation monitoring would be performed to evaluate the integrity of the restored tributary and identify signs of erosion. As necessary, maintenance activities would be performed based on observations from these monitoring events. This may include placement of additional rip-rap or stone-filled gabion mattresses if washed out areas are observed, regrading, or replanting vegetated portions of the engineered cover. For cost estimating purposes, it was assumed that annual inspections would be conducted for 30 years, and maintenance activities would be conducted every 5 years over the 30-year period. CAMU-related operation and maintenance is discussed in Section 6.4.

Due to the nature and extent of the impacts adjacent to the Tributary to Crawford Creek, removal of all impacted materials is impracticable, and some impacted materials would ultimately be left in place. Accordingly, institutional controls (Continuing obligations/GIS Registry) would be required to restrict land and groundwater use to mitigate the potential for future exposure to or disturbance of impacted materials that may remain in place following implementation of "active" corrective actions.

The estimated cost to implement this alternative ranges from $28,888,000 (on-Site CAMU disposal option) to $82,243,000 (off-Site T&D option). This cost estimate, prepared in accordance with NR 722.07(4)(b), includes estimated capital costs, indirect costs, and post-construction operation and maintenance costs associated with this alternative. The alternative-specific cost is summarized in **Table 2** and a detailed estimate is provided in **Appendix B, Table 3**.

6.3.2 Area B – Tributary within Crawford Creek Floodplain

Three corrective action alternatives for Area B have been developed for further evaluation. The scope and estimated cost associated with each alternative are summarized in the following subsections.

6.3.2.1 Alternative B1: Partial Channel Excavation/Backfill, 1-Foot Floodplain Cover

This alternative is a combination removal and in-situ containment approach that includes excavating impacted materials from the bottom and banks of the Tributary to Crawford Creek and installing an engineered cover over impacted floodplain materials outside of the excavation area. By excavating impacted channel materials and covering the impacted floodplain, the potential for exposure by ecological receptors to the impacted media would be mitigated. Also, the installation of backfill and channel restoration materials would isolate surface water from contact with remaining impacted materials, and mitigate the generation of surface water sheens. The assumed channel restoration media consists of clay to provide a more natural channel character compared to engineered materials (e.g., rip-rap) that might otherwise be used to minimize the potential for future meandering of the channel.

Alternative B1 is depicted in plan and cross-section view on **Figure 7**. Key components of this alternative include the following:

- Build access roads; clear and grub the work area.

- Construct a water management system to handle surface water and groundwater that accumulates in the work area.

- Establish temporary bypass pumping setups to divert surface water flow around a length of channel so that work can be performed in a dewatered condition.

- Excavate Tributary channel bottom sediments and bank materials as necessary for the new channel geometry (estimated 140 cy; see **Figure 7** for new channel geometry and associated excavation depths); dispose of excavated materials off-Site.

- Within the channel, line excavated subgrade surface with RCM to inhibit potential migration of creosote-like product and sheens into the restored channel, install wire mesh over the RCM to reduce potential for damage by and exposure to burrowing animals, place and compact 1 foot of clay.

- Outside of the restored channel, within the remainder of Area B (**Figure 7**), install a geotextile demarcation/separation layer, place and compact 8 inches of general fill, and place 4 inches of vegetated topsoil.

Post-installation monitoring would be performed to evaluate the integrity of the restored tributary and floodplain cover and identify signs of erosion. As necessary, maintenance activities would be performed based on observations from these monitoring events. This may include placement of additional clay if washed out areas are observed, regrading, or replanting vegetated portions of the engineered cover. For cost estimating purposes, it was assumed that annual inspections would be conducted for 30 years, and maintenance activities would be conducted every 5 years over the 30-year period.

Institutional controls (continuing obligations/GIS Registry) would be required to restrict land and groundwater use to mitigate the potential for future exposure to or disturbance of impacted materials that may remain in place following implementation of "active" corrective actions.

The estimated cost to implement this alternative is $1,201,000. This cost estimate, prepared in accordance with NR 722.07(4)(b), includes estimated capital costs, indirect costs (e.g., pre-design investigations, engineering design), and post-construction operation and maintenance costs associated with this alternative. The alternative-specific cost is summarized in **Table 2** and a detailed estimate is provided in **Appendix B, Table 4**.

6.3.2.2 Alternative B2: Partial Channel Excavation/Backfill, 1-Foot Floodplain Excavation/Backfill

This alternative is a combination removal and in-situ containment approach that includes excavating impacted materials from the bottom and banks of the Tributary to Crawford Creek and the upper 1 foot of materials from within the impacted floodplain, and installing an engineered cover over impacted floodplain materials remaining at depth. By excavating impacted channel and floodplain materials and covering the remaining impacted floodplain materials at depth, the potential for exposure by ecological receptors to the impacted media would be mitigated. Also, the installation of backfill and channel restoration materials would isolate surface water from contact with remaining impacted materials, and mitigate the generation of surface water sheens. Like Alternative B1, the assumed channel restoration media consists of clay to provide a more natural channel character compared to engineered materials (e.g., rip-rap) that might otherwise be used to minimize the potential for future meandering of the channel.

Alternative B2 is depicted in plan and cross-section view on **Figure 8**. Key components of this alternative include the following:

- Build access roads; clear and grub the work area.
- Construct a water management system to handle surface water and groundwater that accumulates in the work area.
- Establish temporary bypass pumping setups to divert surface water flow around a length of channel so that work can be performed in a dewatered condition.
- Excavate Tributary channel bottom sediments and bank materials as necessary for the new channel geometry, and excavate 1 foot of materials from the adjacent floodplain (estimated 5,600 cy combined from channel and floodplain; see **Figure 8** for new channel geometry and associated excavation depths, and floodplain excavation limits and depths). Excavated materials would be transported to the on-property portion of the Site for consolidation in a CAMU containment cell or disposed of off-Site.
- Within the channel excavation, line excavated subgrade surface with RCM to inhibit potential migration of creosote-like product and sheens into the restored channel, install wire mesh over the RCM to minimize the potential for damage by burrowing animals, place and compact 1 foot of clay.

- Within the floodplain excavation, install a geotextile demarcation/separation layer, place and compact 8 inches of general fill, and place 4 inches of vegetated topsoil.

Post-installation monitoring would be performed to evaluate the integrity of the restored tributary and floodplain cover, and identify signs of erosion. As necessary, maintenance activities would be performed based on observations from these monitoring events. This may include placement of additional clay if washed out areas are observed, regrading, or replanting vegetated portions of the engineered cover. For cost estimating purposes, it was assumed that annual inspections would be conducted for 30 years, and maintenance activities would be conducted every 5 years over the 30-year period. CAMU-related operation and maintenance is discussed in Section 6.4.

Institutional controls (continuing obligations/GIS Registry) would be required to restrict land and groundwater use to mitigate the potential for future exposure to or disturbance of impacted materials that may remain in place following implementation of "active" corrective actions.

The estimated cost to implement this alternative ranges from $3,153,000 (on-Site CAMU disposal option) to $7,122,000 (off-Site T&D option). This cost estimate, prepared in accordance with NR 722.07(4)(b), includes estimated capital costs, indirect costs (e.g., pre-design investigations, engineering design), and post-construction operation and maintenance costs associated with this alternative. The alternative-specific cost is summarized in **Table 2** and a detailed estimate is provided in **Appendix B, Table 5**.

6.3.2.3 Alternative B3: Extended Channel and Floodplain Excavation/Backfill

This alternative includes excavating impacted materials from within, below, and adjacent to the existing tributary channel. Although this extended removal alternative has significant short-term effectiveness and implementability issues (as discussed in Section 7), it is included in this FCMS for comparison to Alternatives B1 and B2. The excavation limits and depths are shown on **Figure 9**, and are based on existing soil boring and test pit data (Section 4.1). As shown on **Figure 9**, excavation limits extend up to approximately 250 feet from the edge of the channel to depths up to 15 feet bgs. Note that even under this extended removal alternative, due to the nature and extent of the impacts adjacent to the Tributary to Crawford Creek, removal of all impacted materials is impracticable, and some impacted materials would ultimately be left in place. Excavated materials would be disposed of at either an on-Site CAMU containment cell or an off-Site licensed facility. The excavated channel area would be backfilled and restored to re-establish the existing channel configuration to the extent possible. By excavating impacted channel, bank and floodplain materials, the potential for exposure by ecological receptors to the impacted media and generation of surface water sheens would be mitigated.

Alternative B3 is depicted in plan and cross-section view on **Figure 9**. Key components of this alternative include the following:

- Build access roads; clear and grub the work area.
- Construct a water management system to handle surface water and groundwater that accumulates in the work area.
- Establish temporary bypass pumping setups to divert surface water flow around a length of channel so that work can be performed in a dewatered condition.
- Excavate the Tributary channel and adjacent bank/floodplain materials to the limits and depths shown on **Figure 9** (55,700 cy). Excavated materials would be transported to the on-property portion of the Site for consolidation in a CAMU containment cell or disposed of off-Site.
- Within the channel, place and compact general fill to within 12 inches of final grade, then place and compact 1 foot of clay.
- Outside of the channel, place and compact general fill to within 4 inches of final grade, then install 4 inches of vegetated topsoil.

Post-installation monitoring would be performed to evaluate the integrity of the restored tributary and identify signs of erosion. As necessary, maintenance activities would be performed based on observations from these monitoring events. This may include placement of additional rip-rap or stone-filled gabion mattresses if washed out areas are observed, regrading, or replanting vegetated portions of the engineered cover. For cost estimating purposes, it was assumed that annual inspections would be conducted for 30 years, and maintenance activities would be conducted every 5 years over the 30-year period. CAMU-related operation and maintenance is discussed in Section 6.4.

Due to the nature and extent of the impacts adjacent to the Tributary to Crawford Creek, removal of all impacted materials is impracticable, and some impacted materials would ultimately be left in place. Accordingly, institutional controls (continuing obligations/GIS Registry) would be required to restrict land and groundwater use to mitigate the potential for future exposure to or disturbance of impacted materials that may remain in place following implementation of "active" corrective actions.

The estimated cost to implement this alternative ranges from $22,786,000 (on-Site CAMU disposal option) to $71,724,000 (off-Site T&D option). This cost estimate, prepared in accordance with NR 722.07(4)(b), includes estimated capital costs, indirect costs, and post-construction operation and maintenance costs associated with this alternative. The alternative-specific cost is summarized in **Table 2** and a detailed estimate is provided in **Appendix B, Table 6**.

6.3.3 Area C – Crawford Creek from Tributary to Railroad Embankment

Four corrective action alternatives for Area C have been developed for further evaluation. The scope and estimated cost associated with each alternative are summarized in the following subsections.

6.3.3.1 Alternative C1: Channel Relocation with Armored Channel

This alternative includes constructing a new channel for Crawford Creek in an unimpacted area located west/northwest of the existing channel location, and backfilling the existing channel with clean materials excavated during construction of the new channel. Two sections of the existing channel would be excavated and restored in-place (**Figure 10**):

- An approximately 125 foot long section where the topography precludes relocation
- An approximately 100 foot long section where the relocated channel meets the existing channel just upstream of the railroad embankment culvert

By constructing a new channel in an unimpacted area and backfilling the existing channel, the potential for exposure by ecological receptors to the impacted channel materials and generation of surface water sheens would be mitigated.

Alternative C1 is depicted in plan and cross-section view on **Figure 10**. Key components of this alternative include the following:

- Conduct pre-design investigations to determine the exact location of the new Crawford Creek channel and the hydraulic forces that the new channel must be designed to withstand.
- Build access roads; clear and grub the work area.
- Construct a water management system to handle surface water and groundwater that accumulates in the work area.

- Establish temporary bypass pumping setups to divert surface water flow around a length of channel so that work can be performed in a dewatered condition.

- Excavate a new creek channel in an unimpacted area along the western/northwestern edge of the Crawford Creek floodplain. The new channel route is shown on **Figure 10**, and was selected based on existing investigation data.

- Line the new creek channel with geotextile overlain by 1 foot of gravel/stone armoring to provide long-term erosion protection. In addition, install RCM and 1 foot of general fill where new channel connects back into the existing channel just upstream of the railroad embankment (a known impacted area) and any other areas as necessary based on findings of the pre-design investigations or during-construction observations.

- Line the existing creek channel with a geotextile demarcation/separation layer, place and compact general fill (soils excavated from the new creek channel) to within 4 inches of final grade, then install 4 inches of vegetated topsoil.

- For portions of the existing creek channel to remain in place (**Figure 10**), excavate channel bottom sediments and bank materials as necessary for the new channel geometry (estimated 500 cy; see section A-A’ on **Figure 10** for new channel geometry and associated excavation depths). Excavated materials would be disposed of off-Site. Line excavated subgrade surface with RCM to inhibit potential migration of creosote-like product and sheens into the restored channel, overlain by 1 foot of gravel/stone armoring to provide long-term erosion protection.

Post-installation monitoring would be performed to evaluate the integrity of the new channel and filled existing channel, and identify signs of erosion. As necessary, maintenance activities would be performed based on observations from these monitoring events. This may include placement of additional armor stone if washed out areas are observed, regrading, or replanting vegetated portions of the backfilled existing channel. For cost estimating purposes, it was assumed that annual inspections would be conducted for 30 years, and maintenance activities would be conducted every 5 years over the 30-year period.

Institutional controls (continuing obligations/GIS Registry) would be required to restrict land and groundwater use to mitigate the potential for future exposure to or disturbance of impacted materials that may remain in place following implementation of "active" corrective actions.

The estimated cost to implement this alternative is $4,056,000. This cost estimate, prepared in accordance with NR 722.07(4)(b), includes estimated capital costs, indirect costs, and post-construction operation and maintenance costs associated with this alternative. The alternative-specific cost is summarized in **Table 2** and a detailed estimate is provided in **Appendix B, Table 7**.

6.3.3.2 Alternative C2: Channel Relocation with Clay-Lined Channel

This alternative is similar to Alternative C1, in that it includes constructing a new channel for Crawford Creek in an unimpacted area located west/northwest of the existing channel location. However, relative to Alternative C1, Alternative C2 includes relocation of less of the existing channel, with in-place excavation/restoration of more of the existing channel. Under this alternative, approximately 2,185 linear feet of channel would be relocated and approximately 1,365 linear feet would be restored in its existing location (portions of the creek where investigation data indicate that visibly impacted bank/floodplain materials are not present immediately adjacent to the existing creek channel were designated for in-place restoration). Other differences between Alternatives C1 and C2 include:

- Alternative C2 includes increased sinuosity and channel length for the relocated channel, which more closely matches that of the existing (natural) channel.
- Under Alternative C2, the relocated channel bottom and banks would be comprised of clay to the extent possible, rather than being fully covered with geotextile and armor stone as in Alternative C1. It is anticipated that some erosion control features, such as armoring the outside bends of the new channel and/or use of natural erosion control measures (e.g., log structures) would be added to minimize the potential for undesirable meandering of the new channel.

By constructing a new channel in an unimpacted area, backfilling portions of the existing channel, and excavating/restoring the remaining portions of the existing channel, the potential for exposure by ecological receptors to the impacted sediment and generation of surface water sheens would be mitigated.

Alternative C2 is depicted in plan and cross-section view on **Figure 11**. Key components of this alternative include the following:

- Conduct pre-design investigations to determine the exact location of the new Crawford Creek channel and the hydraulic forces that the new channel must be designed to withstand.

- Build access roads; clear and grub the work area.

- Construct a water management system to handle surface water and groundwater that accumulates in the work area.

- Establish temporary bypass pumping setups to divert surface water flow around a length of channel so that work can be performed in a dewatered condition.

- Excavate sections of the new creek channel in an unimpacted area along the western/northwestern edge of the Crawford Creek floodplain. The new channel route is shown on **Figure 11**, and was selected based on existing investigation data.

- Install erosion control features at designated locations within the new creek channel.

- Install RCM and 1 foot of general fill where new channel connects back into the existing channel just upstream of the railroad embankment (a known impacted area) and any other areas as necessary based on findings of the pre-design investigations or during-construction observations.

- For portions of the existing creek channel to be backfilled (**Figure 11**), line the existing channel with a geotextile demarcation/separation layer, place and compact general fill (soils excavated from the new creek channel) to within 4 inches of final grade, then install 4 inches of vegetated topsoil.

- For portions of the existing creek channel to remain in place (**Figure 11**), excavate channel bottom sediments and bank materials as necessary for the new channel geometry (estimated 2,700 cy; see section B-B' on **Figure 11** for new channel geometry and associated excavation depths). Excavated materials would be transported to the on-property portion of the Site for consolidation in a CAMU containment cell or disposed of off-Site. Line excavated subgrade surface with RCM to inhibit potential migration of creosote-like product and sheens into the restored channel, install wire mesh over the RCM to prevent damage by burrowing animals, place and compact 1 foot of clay similar to the existing, natural creek channel.

Post-installation monitoring would be performed to evaluate the integrity of the new channel, the filled existing channel and restored existing channel, and to identify signs of erosion. As necessary, maintenance activities would be performed based on observations from these monitoring events. This may include placement of additional clay if washed out areas are observed, regrading, or replanting vegetated portions of the backfilled existing channel. For cost estimating purposes, it was assumed that annual inspections would be conducted for 30 years, and maintenance activities would be conducted every 5 years over the 30-year period. CAMU-related operation and maintenance is discussed in Section 6.4.

Institutional controls (continuing obligations/GIS Registry) would be required to restrict land and groundwater use to mitigate the potential for future exposure to or disturbance of impacted materials that may remain in place following implementation of "active" corrective actions.

The estimated cost to implement this alternative ranges from $3,918,000 (on-Site CAMU disposal option) to $5,351,000 (off-Site T&D option). This cost estimate, prepared in accordance with NR 722.07(4)(b), includes estimated capital costs, indirect costs, and post-construction operation and maintenance costs associated with this alternative. The alternative-specific cost is summarized in **Table 2** and a detailed estimate is provided in **Appendix B, Table 8**.

6.3.3.3 Alternative C3: Partial Channel Excavation/Backfill

This alternative is a combination removal and in-situ containment approach that includes excavation of impacted sediments and bank materials from the existing Crawford Creek channel and restoring the channel with an engineered cover. By removing impacted sediments and bank soils and installing an engineered cover, the potential for exposure by ecological receptors to the impacted media would be mitigated. In addition, installation of cover materials would isolate surface water from contact with remaining impacted sediments and bank materials, and provide a separation between the surface water flow and any residual creosote-like material that could otherwise serve as a source of surface water sheens.

Alternative C3 is depicted in plan and cross-section view on **Figure 12**. Key components of this alternative include the following:

- Build access roads; clear and grub the work area.

- Construct a water management system to handle surface water and groundwater that accumulates in the work area.

- Establish temporary bypass pumping setups to divert surface water flow around a length of channel so that work can be performed in a dewatered condition.

- Excavate channel bottom sediments and bank materials as necessary for the new channel geometry (estimated 3,200 cy; see sections A-A' and B-B' on **Figure 12** for new channel geometry and associated excavation depths). Excavated materials would be transported to the on-property portion of the Site for consolidation in a CAMU containment cell or disposed of off-Site.

- Line excavated subgrade surface with RCM to inhibit potential migration of creosote-like product and sheens into the restored channel, install wire mesh over the RCM to prevent damage by burrowing animals, place and compact 1 foot of clay similar to the existing, natural creek channel.

- Install erosion control features at designated locations within the restored creek channel.

- On each side of the new channel, install a layer of geotextile as a demarcation layer, then place and compact 8 inches of general fill and 4 inches of vegetated topsoil to taper new channel banks into existing side slopes.

Post-installation monitoring would be performed to evaluate the integrity of the restored creek and identify signs of erosion. As necessary, maintenance activities would be performed based on observations from these monitoring events. This may include placement of additional clay if washed out areas are observed. For cost estimating purposes, it was assumed that annual inspections would be conducted for 30 years, and maintenance activities would be conducted every five years over the 30-year period. CAMU-related operation and maintenance is discussed in Section 6.4.

Institutional controls (continuing obligations/GIS Registry) would be required to restrict land and groundwater use to mitigate the potential for future exposure to or disturbance of impacted materials that may remain in place following implementation of "active" corrective actions.

The estimated cost to implement this alternative ranges from $3,576,000 (on-Site CAMU disposal) to $5,321,000 (off-Site T&D option). This cost estimate, prepared in accordance with NR 722.07(4)(b), includes estimated capital costs, indirect costs, and post-construction operation and maintenance costs associated with this alternative. The alternative-specific cost is summarized in **Table 2** and a detailed estimate is provided in **Appendix B, Table 9**.

6.3.3.4 Alternative C4: Extended Channel and Floodplain Excavation/Backfill

This alternative includes excavating impacted materials from within, below, and adjacent to the existing Crawford Creek channel. Although this extended removal alternative has significant short-term effectiveness and implementability issues (as discussed in Section 7), it is included in this FCMS for comparison to Alternatives C1 through C3 The excavation limits and depths are shown on **Figure 13**, and are based on existing soil boring and test pit data (Section 4.1). As shown on **Figure 13**, excavation limits extend up to approximately 300 feet from the edge of the channel and to depths up to 30 feet bgs. Note that even under this extended removal alternative, due to the nature and extent of the impacts adjacent to the Tributary to Crawford Creek, removal of all impacted materials is impracticable, and some impacted materials would ultimately be left in place. Excavated materials would be disposed at either an on-Site CAMU containment cell or an off-Site licensed facility. The excavated channel area would be backfilled and restored to re-establish the existing channel configuration to the extent possible. By excavating impacted channel, bank and floodplain materials, the potential for exposure by ecological receptors to the impacted media and generation of surface water sheens would be mitigated.

Alternative C4 is depicted in plan and cross-section view on **Figure 13**. Key components of this alternative include the following:

- Build access roads; clear and grub the work area.
- Construct a water management system to handle surface water and groundwater that accumulates in the work area.
- Establish temporary bypass pumping setups to divert surface water flow around a length of channel so that excavation can be performed in a dewatered condition.
- Excavate Crawford Creek channel and adjacent bank/floodplain materials to the limits and depths shown on **Figure 13** (95,200 cy). Excavated materials would be transported to the on-property portion of the Site for consolidation in a CAMU containment cell or disposed of off-Site.
- Within the channel, place and compact general fill to within 12 inches of final grade, then install a layer of geotextile, followed by 1 foot of compacted clay to provide long-term erosion protection.
- Outside of the channel, place and compact general fill to within 4 inches of final grade, then install 4 inches of vegetated topsoil.

Post-installation monitoring would be performed to evaluate the integrity of the restored tributary and identify signs of erosion. As necessary, maintenance activities would be performed based on observations from these monitoring events. This may include placement of additional rip-rap or stone-filled gabion mattresses if washed out areas are observed, regrading, or replanting vegetated portions of the engineered cover. For cost estimating purposes, it was assumed that annual inspections would be conducted for 30 years, and maintenance activities would be conducted every 5 years over the 30-year period. CAMU-related operation and maintenance is discussed in Section 6.4.

Due to the nature and extent of the impacts adjacent to the Tributary to Crawford Creek, removal of all impacted materials is impracticable, and some impacted materials would ultimately be left in place. Accordingly, institutional controls (continuing obligations/GIS Registry) would be required to restrict land and groundwater use to mitigate the potential for future exposure to or disturbance of impacted materials that may remain in place following implementation of "active" corrective actions.

The estimated cost to implement this alternative ranges from $41,898,000 (on-Site CAMU disposal) to $126,112,000 (off-Site T&D). This cost estimate, prepared in accordance with NR 722.07(4)(b), includes estimated capital costs, indirect costs, and post-construction operation and maintenance costs associated with this alternative. The alternative-specific cost is summarized in **Table 2** and a detailed estimate is provided in **Appendix B, Table 10**.

6.4 On-Property CAMU

NR 664 Subchapter S defines a CAMU as “an area within a facility used only for managing remediation wastes for implementing corrective action or cleanup at the facility.” As indicated in the alternative descriptions in Section 6.3, several alternatives (A3, B2, B3, C2, C3 and C4) include provisions for possible placement of excavated materials within an on-property CAMU containment cell. As discussed in Section 6.3, a final decision on whether a CAMU would be the preferred method for long-term management of materials excavated from the off-property portion of the Site, would depend on the actual volume of materials generated, the available CAMU capacity, CAMU design/operational requirements, and the cost of off-Site T&D at the time of generation.

With the expectation that corrective actions for the off-property portion of the Site may involve the excavation of impacted media, Beazer submitted a *Request for Modification of the Closure and Long-Term Care Plan Approval and Corrective Action Management Unit (“CAMU”) Demonstration* (CAMU Demonstration Document; BBL 2000) to WDNR in May 2000. The CAMU Demonstration Document proposed an approach whereby a containment cell would be constructed within a designated CAMU area and used for the long-term management of materials generated during the corrective action activities at the Site. The purpose of the CAMU Demonstration Document was to provide necessary information to support the designation of a CAMU at the Site, including justification that the proposed approach would provide a reliable, effective, protective and cost-effective means of managing these materials. The WDNR issued a letter to Beazer dated November 1, 2000, indicating that the CAMU application was "substantially in the approval process" and was, therefore, "grandfathered" under the 1993 CAMU regulations (NR 664.0551). The applicability of the 1993 CAMU regulations was further documented in a February 10, 2014 letter from Beazer to WDNR (Beazer 2014). In accordance with the 1993 CAMU regulations, placement of remediation wastes in a CAMU does not constitute creation of a unit or "land disposal" subject to RCRA Land Disposal Restrictions or Minimum Technology Requirements (MTRs).

While the specific CAMU design parameters are yet to be finalized, the general approach considered for this Off-Property FCMS includes construction of a lined, bermed containment cell with a leachate collection system located within a designated CAMU area. Excavated materials would be placed into the containment cell, compacted, and graded to achieve appropriate slopes. Once all of the remediation materials are placed, a surface cover (cap) would be installed on top of the consolidated materials. Additional details regarding this approach are as follows:

- The location of the CAMU proposed in the CAMU Demonstration Document is the former landfill/landfarm area. Additionally, the closed surface impoundment area is also considered a potentially viable location for a CAMU.

- The aerial extent and configuration of the containment cell would be determined during detailed design, in consideration of size limitations and the anticipated volume of materials targeted for consolidation in the CAMU.

- As indicated above, MTRs (e.g., liner and leachate collection system and engineered cap) do not apply for CAMUs grandfathered under the 1993 CAMU regulations. However, for this Off-Property FCMS, the containment cell is assumed to meet the landfill design requirements of NR 504. This includes a bottom liner, leachate collection system and multi-layer cap. These design requirements are reflected in the alternative-specific cost estimates provided in **Appendix B**. The actual design requirements are subject to further evaluation and modification as part of the CAMU design and approval process.

If a CAMU is determined to be needed for the off-property corrective actions, the May 2000 CAMU Demonstration Document would be amended and submitted to WDNR. The amended CAMU Demonstration Document would reflect the proposed CAMU location (if modified from the May 2000 proposed location), address WDNR comments regarding the May 2000 document, and provide conceptual design details for the containment cell. This would also include an assessment of the applicability and appropriateness of landfill siting criteria and performance standards of NR 504.04(4), as suggested by WDNR in its January 22, 2004 letter to Beazer. The amended CAMU Demonstration Document would, therefore, serve as a basis for WDNR approval of the proposed CAMU design and subsequent detailed design of the containment cell.

If constructed, CAMU-specific operation, monitoring and maintenance activities would be performed. Such activities would depend, in part, on the final design of the containment cell. Examples of potential CAMU-specific operation, maintenance and monitoring activities may include:

- Periodic inspections to verify the integrity of the surface cover and the proper functioning of ancillary components (e.g., surface-water diversion measures)

- Periodic mowing of the vegetated cover to prevent the establishment of deep-rooted vegetation that could affect the cover system

- Repairing and reseeding any areas with excessive settlement or erosion of surface cover materials

- CAMU-specific groundwater monitoring to satisfy the requirements of NR 664, Subpart S

- Operation and maintenance of any leachate collection system that may be a component of the final containment cell design

The CAMU component is considered in the detailed evaluation of the applicable alternatives presented in Section 7.

7. Evaluation of Corrective Action Alternatives

7.1 Overview

As required by NR 722.07, this section presents a comparative evaluation of the corrective action alternatives identified and described in Section 6. The following evaluation criteria, described in NR 722.07(4), are discussed in Section 7.2:

- Long-term effectiveness
- Short-term effectiveness
- Implementability
- Restoration time frame
- Economic feasibility
- Compliance with laws, standards and permitting requirements

In addition to the six criteria listed above, "sustainability" was also evaluated as a seventh criteria, in accordance with NR 722.09(2m) and the WDNR's January 2012 Green & Sustainable Remediation Manual (Pub-RR-911; WDNR 2012). The sustainability criterion is further described in Section 7.2.

The purpose of this evaluation is to identify the relative advantages and disadvantages of the various corrective action alternatives, and thereby support the selection of the preferred alternatives for the off-property portion of the Site. Specifically, the comparative evaluation is intended to identify which corrective action alternative(s) for the targeted off-property areas "constitutes the most appropriate…combination of technologies to restore the environment, to the extent practicable, within a reasonable period of time…" [NR 722.07(3)(a)].

Alternatives for Areas A, B and C were assessed based on how well each would perform relative to the evaluation criteria described in Section 7.2 and relative to the other alternatives considered for a given area. Site-specific considerations that affect an alternative's performance relative to the other options were incorporated; for example, although all alternatives may be technically implementable, factors that impact the relative ease or difficulty of implementation under these specific circumstances were considered. To aid in assessing the relative performance and summarizing the results of the comparative evaluation, this Off-Property FCMS incorporates a numerical ranking system. For each evaluation criterion, each alternative is assigned a score ranging from 1 (low) to 5 (high). The scores are intended to reflect the relative comparisons among the alternatives considered, as well as the extent to which an alternative satisfies each criterion. The scores are presented in **Table 3**. The use of the numerical ranking system is consistent with the ranking system used for the On-Property FCMS.

Separate comparative evaluations are provided in Sections 7.3, 7.4 and 7.5 for off-property Areas A, B and C, respectively. Results of these evaluations are used to identify a selected corrective action alternative for each off-property area. Based on these evaluations, the proposed overall corrective action approach is identified in Section 8.

7.2 Evaluation Criteria

The comparative evaluation of the various corrective action alternatives was based on an assessment of the performance of the alternatives relative to the technical and economic feasibility criteria identified and described in NR 722.07(4), as well as the NR 722.09(2) requirement for compliance with applicable environmental laws and standards. Based on the parameters outlined in the Wisconsin Administrative Code, the evaluation criteria used in this Off-Property FCMS are described below.

- **Long-Term Effectiveness [NR 722.07(4)(a)(1)]:** This criterion considers the long-term effectiveness of the alternative, including the degree to which a reduction in toxicity, mobility and volume of COPCs is achieved and the degree to which the alternative will protect public health and the environment over time. It also considers the alternative's effectiveness in achieving the established CAOs (Section 5).

- **Short-Term Effectiveness [NR 722.07(4)(a)(2)]:** This criterion considers the potential for and magnitude of adverse impacts on public health, safety, welfare and the environment during the alternative's construction and implementation period. Such impacts include, but are not limited to, noise, dust generation, potential for releases, and potential risks associated with on- and off-Site equipment traffic. Potential impacts on workers and the community are assessed, as well as the length of time the impacts are expected to last and the extent to which engineering and/or operational controls can be used to mitigate potential impacts.

- **Implementability [NR 722.07(4)(a)(3)]:** This criterion considers the relative ease or difficulty of implementing the various corrective action alternatives in accordance with alternative- and Site-specific considerations. Both technical and administrative implementability are considered. Because all of the corrective action alternatives carried through the Off-Property FCMS process to this point include proven technologies, no pilot- or bench-scale testing will be required and there is a limited possibility for implementation issues to arise strictly due to the choice of technology. Specific implementability considerations included in this evaluation are:

  - Technical feasibility of constructing and implementing the alternative at the Site
  - Availability of materials, equipment, technologies and workers needed to implement the alternative
  - Potential difficulties and constraints associated with construction activities
  - Difficulties associated with monitoring the effectiveness of the alternative
  - Administrative feasibility of the alternative, including activities and time needed to obtain any necessary licenses, permits or approvals
  - Presence of any federal or state threatened or endangered species
  - Technical feasibility of recycling, treatment, engineering controls or disposal

- **Restoration Time Frame [NR 722.07(4)(a)(4)]:** This criterion considers the time required until CAOs for the various media are achieved. Because no known sensitive receptors or threatened/endangered species are present within the areas addressed by this Off-Property FCMS, Site conditions are generally not conducive to short-term changes or migration of COPCs. The targeted corrective action areas are consistent among the alternatives for each area and the qualitative considerations identified in NR 722.07(a)(4)(a-f) are not a point of differentiation among the alternatives considered. Accordingly, this criterion primarily focuses on the construction and implementation time frame associated with each alternative, as well as the time required to restore trees that need to be cleared to access the work areas and conduct the work.

- **Economic Feasibility [NR 722.07(4)(b)]:** This criterion considers the economic feasibility of a corrective action alternative by considering its cost relative to the long-term effectiveness, short-term effectiveness, implementability, and restoration time frame. Cost components considered include capital costs (including both direct and indirect costs), initial costs (including design and testing costs), and annual operation and maintenance costs.

- **Compliance with Environmental Laws, Standards and Permitting Requirements [NR 722.09(2)]:** This criterion considers the extent to which the corrective action alternatives are expected to comply with applicable laws, standards and permits. **Table 4** identifies the various environmental laws, standards and permitting requirements potentially applicable to the alternatives considered within this Off-Property FCMS.

In addition to the six criteria listed above, "sustainability" was also evaluated as a seventh criteria, in accordance with NR 722.09(2m) and the WDNR's January 2012 Green & Sustainable Remediation Manual (Pub-RR-911). Per NR 722.09(2m) and Section 2.3 of Pub-RR-911, the sustainability criterion includes a qualitative evaluation of the following "Green and Sustainable Remediation Drivers":

- **Energy Consumption [NR 722.09(2m)(a)]:** Considers total energy use and the potential to use renewable energy.

- **Greenhouse Gas Generation [NR 722.09(2m)(b)]:** Considers the generation of air pollutants, including particulate matter and greenhouse gas (GHG) emissions.

- **Water Use and Reuse [722.09(2m)(c)]:** Considers water use and the impacts to water resources.

- **Land Use [NR 722.09(2m)(d)]:** Considers the future land use and enhancement of ecosystems, including minimizing unnecessary soil and habitat disturbance and destruction (NR 722.09(2m)(d) and Pub-RR-911 Section 2.3).

- **Waste and Material Use and Recycling [NR 722.09(2m)(e)]:** Considers reducing, reusing and recycling materials and wastes, including investigative or sampling wastes and considers concerns regarding limited landfill space, introduction of pollution into the environment and the need to conserve natural resources.

For the purposes of this Off-Site FCMS, GHG Generation and Energy Consumption were evaluated based on the number of truckloads of materials imported to and exported from the work area for a given alternative, and the construction duration of the alternative (i.e., increased truckloads of material hauled and construction duration, correlates to increased GHG emissions and energy consumption from hauling trucks, construction vehicles, office trailers, etc.). Water Use and Reuse was evaluated based on potential impacts to water resources. Land Use was evaluated based on the total acreage of land that would require clearing/grubbing to implement the alternative. Waste and Material Use and Recycling was evaluated based on the volume of excavated material that would need to be managed in an on-Site CAMU or transported off-Site for treatment and/or disposal.

7.3 Area A – Tributary from Hammond Avenue to Crawford Creek Floodplain

As described in Section 6.3.1, the following three corrective action alternatives were developed for Area A:

- Alternative A1: Channel and Bank Cover
- Alternative A2: Channel and Bank Cover with DNAPL Collection Provisions
- Alternative A3: Extended Channel and Bank Excavation/Backfill

The following subsections present a comparative evaluation of these alternatives with respect to the seven criteria identified in Section 7.2 for the purpose of recommending a corrective action approach for Area A. Scores developed for each alternative (using the numerical system described in Section 7.1) are presented in **Table 3**.

7.3.1 Long-Term Effectiveness

All three corrective action alternatives developed for Area A would equally achieve the Site-specific CAOs (mitigate the potential for exposure by ecological receptors to COPC-impacted tributary channel sediment and bank materials; and mitigate the generation of COPC-related surface water sheens) and would, therefore, provide for protection of public health and the environment.

In addition, all three Area A alternatives would reduce the volume and/or mobility and COPCs. It should be noted that creosote-like product is present in isolated cracks/fractures within the clay bank materials along the Tributary to Crawford Creek (product is estimated to occupy less than 1 percent of the soil matrix). Because of this, under Alternative A3, an estimated 99 percent of the bank soil removal volume would be “clean” soils, highlighting the inefficiency of the removal process at this Site.

Materials excavated under Alternative A3 may be consolidated in a CAMU containment cell located on the on-property portion of the Site[8]. If applicable, the CAMU containment cell would be designed and maintained to minimize the potential for migration of consolidated materials out of the cell, thereby contributing to the reduction in COPC mobility for Alternative A3. Toxicity reductions associated with all alternatives would be limited to that which occurs over time as a result of ongoing natural attenuation and biodegradation processes.

Impacted materials would remain in Area A with implementation of all three Area A alternatives. Although Alternative A3 targets excavation of impacted materials within, below, and adjacent to the tributary channel, due to the nature and extent of the impacts, removal of all impacted materials is impracticable, therefore, some impacted materials would ultimately be left in place. Proper design and maintenance would effectively mitigate the potential for future exposure to or migration of COPCs. Both Alternatives A1 and A2 include a layer of RCM to mitigate the potential migration of remaining COPCs into the restored channel. And all three alternatives include restoration of the tributary channel in a manner that provides for long-term protection against potential channel migration or erosion of clean fill materials. All three Area A alternatives are assumed to require 30 years of monitoring and maintenance to ensure their effectiveness. The CAMU containment cell (a material disposal option for Alternative A3) is also assumed to require 30 years of monitoring and maintenance.

Under all three alternatives, it is anticipated that institutional controls (Continuing obligations/GIS Registry) would be required to restrict land and groundwater use to mitigate the potential for future exposure to or disturbance of impacted materials that may remain in place following implementation of "active" corrective actions.

In summary, through proper design and maintenance, all three Area A alternatives would achieve CAOs and offer an acceptable level of long-term protection, and would result in a reduction in both the mobility and volume of COPCs. Because some level of impacted materials would remain following implementation of all three alternatives, all three alternatives were assigned a score of 4. Because impacted materials would be left in place with the potential for re-impacting the Tributary, more removal in Alternative A3 does not increase long-term effectiveness).

[8] Off-Site T&D and consolidation in an on-Site CAMU are both possible options for disposal of excavated materials.

7.3.2 Short-Term Effectiveness

Construction- and implementation-related short-term impacts exist for all three Area A alternatives and would last for the duration of construction activities. Such impacts potentially include (but are not limited to) the following:

- Working with and around construction equipment
- Noise generation from operating construction equipment
- Increased vehicular traffic associated with delivery of equipment and materials, and for Alternative A3, transportation of excavated materials to either an off-Site disposal facility or an on-Site CAMU
- Dust generation
- Potential odor generation from excavation/grading of impacted sediments and bank materials
- Potential for exposure to sediments and bank materials impacted by COPCs
- Potential disruption to local residents and private land owners
- Potential disruption of facility operations (if an on-Site CAMU is used for material disposal for Alternative A3)
- Surface-water impacts

To the extent possible, short-term impacts would be minimized by engineering controls and access controls during implementation, use of dust suppression measures (as needed), use of proper health and safety practices, detailed design, and coordination with the facility and affected property owners during the planning and implementation stages. Bypass pumping and erosion/sedimentation controls would be used to minimize the potential for surface-water impacts associated with work within the Tributary.

Implementation of Alternatives A1 and A2 would result in similar short-term impacts. Both Alternatives A1 and A2 would involve the removal and handling of a manageable volume of impacted materials (estimated 500 cy for both Alternatives A1 and A2). Both Alternatives A1 and A2 require the transportation and placement of imported materials, resulting in the potential for construction worker/traffic accidents. For Alternative A1, an estimated 480 truckloads[9] would be required for the anticipated volumes of general fill, topsoil, and riprap and an estimated 25 truckloads for handling excavated sediment and bank materials. For Alternative A2, an estimated 460 truckloads would be required for the anticipated volumes of general fill, topsoil, and riprap and an estimated 25 truckloads for handling excavated materials. Additional deliveries would be required for the RCM, geotextile, and erosion control mat. Both Alternatives A1 and A2 would generate noise/dust/odor, resulting in potential exposures to COPCs. Both Alternatives A1 and A2 would disrupt local residents and private landowners generally equally, as the durations of Alternatives A1 and A2 are estimated to be approximately 18 weeks and 19 weeks, respectively.

Alternative A3 would result in a much higher degree of short-term impacts associated with the additional impacted sediment and bank material handling. Specifically, the alternative involves the excavation of impacted sediment and bank material (60,700 cy) and installation of an approximately equal volume of backfill materials. An estimated 3,040 truckloads of general fill, topsoil, and riprap would be delivered for implementation of Alternative A3 (additional deliveries would be required for the geotextile and erosion control mat), and an estimated 3,040 truckloads for handling excavated materials, resulting in higher potential for construction worker/traffic accidents, noise/dust/odor generation, potential exposures to COPCs, and disruption to local residents and private land owners. Furthermore, the anticipated duration for Alternative A3 is 40 weeks, resulting in a significantly longer duration of these disruptions relative to Alternatives A1 and A2, and necessitating two construction seasons. The required removal depths and associated requirements for engineering controls (e.g., trench boxes) and water management, in addition to the potential for a significant rainfall/runoff event to cause catastrophic inundation of the excavation area, results in additional significant potential short-term impacts for Alternative A3.

It should be noted that, based on previous experience conducting investigations in this area, weather and flooding conditions could significantly impact the schedule for construction activities, resulting in potentially longer durations than estimated (construction durations specified above do not account for any weather or flooding related delays).

Because the majority of the work to be conducted in Area A is located on privately owned property, acceptance by the affected and surrounding property owners would be a critical component of selecting and implementing a remedy in this area. In addition

[9] Estimated truckloads are based on in-situ volumes for excavated and restoration materials and 20 cy per truck.

to potential noise and odor impacts, and disruptions due to construction traffic, a significant amount of clearing of trees would also be required for each of the alternatives, which is another short-term impact. The clearing required for Alternative A3 (approximately 6.5 acres) is greater than that of Alternatives A1 and A2 (approximately 4.2 acres), resulting in additional short-term impacts for this alternative.

Based on the considerations identified above, Alternatives A1 and A2, which present a similar degree of short-term impacts and similar implementation durations, were assigned a score of 4 with respect to the Short-Term Effectiveness criterion. Because of the significantly greater material handling volumes and implementation duration, Alternative A3 was assigned a score of 1.

7.3.3 Implementability

The corrective action alternatives developed and evaluated in this Off-Property FCMS include only proven technologies; no pilot- or bench-scale testing would be necessary. Each of the three Area A alternatives is technically implementable and all necessary materials, equipment, and workers are expected to be available regardless of the corrective action alternative selected. Implementation of Alternative A3, however, would be the most challenging given the need to excavate to depths of up to 24 feet, which would require excavation controls (e.g., trench boxes, benching/sloping) to conduct the deep excavations safely and could also require extensive groundwater/surface water management and means to divert Tributary flows while excavation occurs into and below the bank slopes. Due to the extent of excavation anticipated under Alternative A3, a significant rainfall/runoff event could result in inundation of the excavation area and substantially impact water management needs for the project.

Adequate monitoring and maintenance activities can be established for each alternative. The implementability issues associated with working on private properties, and establishing staging areas and access routes would apply equally to all the alternatives, and could be addressed through coordination efforts with property owners.

All three Area A alternatives are expected to be administratively feasible and implementable. All of the alternatives are anticipated to comply with applicable environmental laws, standards and permitting requirements (Section 7.3.6). No known threatened or endangered species are present in the work areas. Placement of fill materials within a waterway/wetland would require coordination with and permits from WDNR and USACE. Approval of the CAMU potentially associated with Alternative A3 is expected to require additional administrative efforts, including the development of an amended CAMU Demonstration Document for submittal to WDNR and a RCRA permit modification associated with the establishment of a CAMU at the Site. Coordination with WDNR would also be required to establish the design characteristics of the containment cell. Nonetheless, WDNR has conceptually agreed to the establishment of a CAMU at the Site (WDNR 2000) such that the administrative requirements are not expected to limit the implementability of this alternative.

Based on the considerations identified above, all three Area A alternatives are anticipated to be technically and administratively implementable. However, Alternatives A1 and A2 present the fewest technical and administrative implementability issues, and were assigned a score of 4 with respect to the Implementability criterion. Alternative A3 was assigned a score of 1 due to the increased level of administrative coordination associated with potential CAMU-related approvals, technical challenges associated with conducting deep excavation below the groundwater and flood elevations, and difficulties/risks associated with managing surface water flows around the deep excavation areas.

7.3.4 Restoration Time Frame

As discussed in Section 7.2, this criterion effectively relates to the time required to implement each alternative (i.e., the time required until the Site-specific CAOs are achieved). While other factors may affect the time frame during which construction activities associated with a given alternative could be initiated (e.g., WDNR approval time frame, construction season, weather, need for CAMU design), the primary differentiating factor with regard to this criterion is the estimated length of time necessary for construction of each alternative. Based on the detailed cost estimates included in **Appendix B**, estimated implementation durations for Alternatives A1 and A2 are generally consistent (18 and 19 weeks, respectively) and are anticipated to require only a single construction season to complete. The estimated implementation duration for Alternative A3 is 40 weeks, and would require two construction seasons to implement.

Note that the estimated durations stated above do not include any weather or flooding-related delays. As indicated previously, weather and flooding conditions could significantly impact the schedule for construction activities, resulting in potentially longer durations than estimated.

In addition, a significant amount of clearing of trees for access to work areas would also be required for each of the alternatives. Time to restore the trees is another component of restoration time-frame. While the timeframe required for new tree plantings to reach the size and age of the existing trees is anticipated to be the same for all alternatives, the clearing required for Alternative A3 (approximately 6.5 acres) is greater than that of Alternatives A1 and A2 (approximately 4.2 acres).

Based on the estimated implementation durations and clearing requirements, Alternatives A1, A2 were assigned scores of 4 with respect to the Restoration Time Frame criterion, and Alternative 3 was assigned a score of 1.

7.3.5 Economic Feasibility

Preliminary costs, including capital costs, indirect costs (e.g., pre-design investigation, engineering design), and post-construction operation and maintenance costs, were developed for each of the three Area A alternatives in accordance with NR 722.07(4)(b). The costs are summarized in **Table 2** and detailed estimates are provided in **Appendix B**. Total costs for the three Area A alternatives are as follows:

- Alternative A1: $3,153,000
- Alternative A2: $2,844,000
- Alternative A3: $28,888,000 (on-Site CAMU disposal of excavated materials) to $82,243,000 (off-Site T&D)

As detailed above, all three corrective action alternatives developed for Area A would achieve the Site-specific CAOs and be effective over the long term. However, Alternatives A1 and A2 have significantly fewer short-term effectiveness and implementability issues compared to Alternative A3, and there is a significant increase in cost to implement Alternative A3 (approximately 10 to 29 times more costly than Alternatives A1 and A2).

Based on the above considerations, Alternatives A1 and A2 were assigned scores of 5 with respect to the Economic Feasibility criterion, and Alternative A3 was assigned a score of 1.

7.3.6 Compliance with Environmental Laws, Standards and Permitting

Environmental laws and standards that are potentially applicable to implementing corrective actions in the off-property portion of the Site are summarized in **Table 4**. All three corrective action alternatives developed to address impacted sediments and bank materials in Area A would comply with these laws and standards. Requirements outlined in applicable permits (see **Table 4**) would be addressed during detailed design of the selected alternative. Accordingly, each of the alternatives was assigned a score of 5 with respect to the Compliance with Environmental Laws, Standards and Permitting criterion.

7.3.7 Sustainability

As discussed in Section 7.2, the Green and Sustainable Remediation Drivers were evaluated per NR 722.09(2m) and the WDNR's January 2012 Green & Sustainable Remediation Manual (Pub-RR-911). An evaluation of the Area A alternatives relative to the GHG Generation, Energy Consumption, Land Use and Waste Generation criteria is summarized in the chart below:

Chart 2 Evaluation of Area A Alternatives relative to GHG Generation, Energy Consumption, Land Use and Waste Generation

	Alternative A1	Alternative A2	Alternative A3
GHG Generation/Energy Consumption			
# Truckloads imported general fill, topsoil and stone	480	460	3,040
# Truckloads excavated materials	25	25	3,040
Construction duration (weeks)	18	19	40
Land Use			
Area of Disturbance (acres)	4.2	4.2	6.5
Waste Generation			
Volume of impacted materials (cy)	500	500	60,700

Note: Anticipated truckloads (20 cy each) based on in-situ volumes of excavated and restoration materials.

As summarized in the chart above, Alternative A3 would result in the greatest GHG generation and energy consumption caused by activities such as fossil fuel consumption due to the significantly higher number of anticipated truckloads during construction. Though the construction area for all alternatives would be restored to the existing habitat, the area of land disturbed for implementation of Alternative A3 is much greater than the area of land disturbed for implementation of Alternatives A1 and A2. The restoration design of Alternative A2 (baseline and secondary flow channels, with velocity control structures), is anticipated to enhance the ecological function of the Tributary relative to the Alternatives A1 and A3 restoration approaches. Lastly, Alternative A3 additionally generates a much greater volume of waste material. Should the off-Site disposal option be selected, significantly more landfill space would be required.

With regard to the Water Use criterion, due to the large/deep excavations associated with Alternative A3, potential impacts to water during construction activities and the potential for a significant rainfall/runoff event to cause inundation of the excavation area for this alternative are greater than the other alternatives.

Based on the considerations outlined above, Alternatives A1, A2 and A3 were assigned scores of 3, 4 and 1, respectively, for the Sustainability criterion.

7.4 Area B – Tributary within Crawford Creek Floodplain

As described in Section 6.3.2, the following three corrective action alternatives were developed for Area B:

- Alternative B1: Partial Channel Excavation/Backfill, 1-Foot Floodplain Cover
- Alternative B2: Partial Channel Excavation/Backfill, 1-Foot Floodplain Excavation/Backfill
- Alternative B3: Extended Channel and Floodplain Excavation/Backfill

The following subsections present a comparative evaluation of these alternatives with respect to the seven criteria identified in Section 7.2 for the purpose of recommending a corrective action approach for Area B. Scores developed for each alternative (using the numerical system described in Section 7.1) are presented in **Table 3**.

7.4.1 Long-Term Effectiveness

All three corrective action alternatives developed for Area B would achieve the Site-specific CAOs (mitigate the potential for exposure by ecological receptors to COPC-impacted tributary channel sediment and bank/floodplain material; and mitigate the generation of COPC-related surface water sheens) and would, therefore, provide for protection of public health and the environment.

In addition, all three Area B alternatives would reduce the volume and mobility of COPCs. It should be noted that creosote-like product is present in isolated cracks/fractures within the clay bank materials along the Tributary to Crawford Creek (product is estimated to occupy less than 1 percent of the soil matrix). Because of this, under Alternative B3, an estimated 99 percent of the bank/floodplain removal volume would be “clean” soils, highlighting the inefficiency of the removal process at this Site. Materials excavated under Alternatives B2 and B3 may be removed and consolidated in a CAMU containment cell located on the on-property portion of the Site[10]. If applicable, the CAMU containment cell would be designed and maintained to minimize

[10] Off-Site T&D and consolidation in an on-Site CAMU are both possible options for disposal of excavated materials.

the potential for migration of consolidated materials out of the cell, thereby contributing to the reduction in COPC mobility with Alternatives B2 and B3. Toxicity reductions associated with all alternatives would be limited to that which occurs over time as a result of ongoing natural attenuation and biodegradation processes.

Impacted materials would remain in Area B with implementation of all three Area B alternatives. Although Alternative B3 targets excavation of impacted materials within, below, and adjacent to the tributary channel, due to the nature and extent of the impacts, removal of all impacted materials is impracticable, and some impacted materials would ultimately be left in place. Proper design and maintenance would effectively mitigate the potential for future exposure to or migration of COPCs. Both Alternatives B1 and B2 include a layer of RCM to mitigate the potential migration of remaining COPCs into the restored channel. All three alternatives include restoration of the tributary channel in a manner that provides for long-term protection against potential channel migration or erosion of clean fill materials. All three Area B alternatives are assumed to require 30 years of monitoring and maintenance to ensure their effectiveness. The CAMU containment cell (a material disposal option for Alternatives B2 and B3) is also assumed to require 30 years of monitoring and maintenance.

Under all three alternatives, it is anticipated that institutional controls (Continuing obligations/GIS Registry) would be required to restrict land and groundwater use to mitigate the potential for future exposure to or disturbance of impacted materials that may remain in place following implementation of "active" corrective actions.

In summary, through proper design and maintenance, all three Area B alternatives would achieve CAOs and offer an acceptable level of long-term protection, and would result in a reduction in both the mobility and volume of COPCs. Because some level of impacted materials would remain following implementation of all three alternatives, all three alternatives were assigned a score of 4. Because impacted materials would be left in place with the potential for re-impacting the Tributary, more removal in Alternative B3 does not increase long-term effectiveness).

7.4.2 Short-Term Effectiveness

Construction- and implementation-related short-term impacts exist for all three Area B alternatives and would last for the duration of construction activities. Such impacts potentially include (but are not limited to) the following:

- Working with and around construction equipment

- Noise generation from operating construction equipment
- Increased vehicular traffic associated with delivery of equipment and materials, and, transportation of excavated materials to either an off-Site disposal facility or an on-Site CAMU
- Dust generation
- Potential odor generation from excavation of impacted sediments and bank/floodplain materials
- Potential for exposure to sediments and bank/floodplain materials impacted by COPCs
- Potential disruption to local residents and private land owners
- Potential disruption of facility operations (if an on-Site CAMU is used for material disposal for Alternatives B2 and B3)
- Surface-water impacts

To the extent possible, short-term impacts would be minimized by engineering controls and access controls during implementation, use of odor/dust suppression measures (as needed), use of proper health and safety practices, detailed design, and coordination with the facility and affected property owners during the planning and implementation stages. Bypass pumping and erosion/sedimentation controls would be used to minimize the potential for surface-water impacts associated with work within the Tributary.

Alternative B1 involves the least amount of impacted material handling (excavation to accommodate geometry of new channel; estimated 140 cy). Alternative B2 involves excavation of sediment and bank/floodplain materials (estimated 5,600 cy). Both Alternatives B1 and B2 require transportation and placement of imported materials, resulting in the potential for construction worker/traffic accidents. For Alternative B1, an estimated 340 truckloads[11] would be required for the anticipated volumes of general fill/clay and topsoil, and an estimated seven truckloads for handling excavated materials. For Alternative B2, an estimated 330 truckloads would be required for the

[11] Estimated truckloads are based on in-situ volumes for excavated and restoration materials and 20 cy per truck.

anticipated volumes of general fill/clay and topsoil, and an estimated 280 truckloads for handling excavated materials. Additional deliveries would be required for the RCM, geotextile, and erosion control mat. Alternatives B1 and B2 would generate noise/dust/odor, result in potential exposures to COPCs, and disrupt local residents and private landowners. Alternative B1 would result in slightly less impacts, as the duration of Alternatives B1 and B2 are estimated to be approximately 6 weeks and 8 weeks, respectively.

Alternative B3 would result in a much higher degree of short-term impacts associated with the additional impacted material handling. Specifically, the alternative involves excavation of impacted sediment and bank material (55,700 cy) and installation of an approximately equal volume of backfill materials. An estimated 2,800 truckloads of general fill/clay and topsoil would be delivered for implementation of Alternative B3 (additional deliveries would be required for the geotextile and erosion control mat), and an estimated 2,800 truckloads for handling excavated materials, resulting in higher potential for construction worker/traffic accidents, noise/dust/odor generation, potential exposures to COPCs, and disruption to local residents and private land owners. Furthermore, the anticipated duration of Alternative B3 is 53 weeks, resulting in a longer duration of these disruptions relative to Alternatives B1 and B2, and necessitating two construction seasons. The required removal depths and associated requirements for engineering controls (e.g., trench boxes) and water management, in addition to the potential for a significant rainfall/runoff event to cause inundation of the excavation area, results in additional short-term impacts for Alternative B3.

It should be noted that, based on previous experience conducting investigations in this area, weather and flooding conditions could significantly impact the schedule for construction activities, resulting in potentially longer durations than estimated (construction durations specified above do not account for any weather or flooding related delays).

All three alternatives involve work in a floodplain that is known to flood frequently, which carries a risk for flooding of the work areas and equipment. Procedures would need to be developed to minimize these risks. Due to the large/deep excavations associated with Alternative B3, as well as the longer required duration for this project, the potential flooding-related short-term risks for this alternative are significantly greater than the other alternatives.

Because all of the work to be conducted in Area B is located on privately owned property, acceptance by the affected and surrounding property owners would be a critical component of selecting and implementing a remedy in this area. In addition to potential noise and odor impacts and disruptions due to construction traffic, a limited clearing of trees would also be required for each of the alternatives, which is another short-term impact. The clearing required for Alternative B3 (approximately 4.9 acres) is greater than that of Alternatives B1 and B2 (approximately 4.4 acres), resulting in additional short-term impacts for this alternative.

Based on the considerations identified above, Alternative B1, which presents the fewest short-term impacts and the shortest implementation duration, was assigned a score of 4 with respect to the Short-Term Effectiveness criterion. Alternative B2 was assigned a score of 3 due to the increased level of short-term impacts associated with greater impacted material handling volumes and implementation duration relative to B1. Finally, because of the significantly greater impacted material handling volumes and implementation duration, Alternative B3 was assigned a score of 1.

7.4.3 Implementability

The corrective action alternatives developed and evaluated in this Off-Property FCMS include only proven technologies; no pilot- or bench-scale testing would be necessary. Each of the three Area B alternatives is technically implementable and all the necessary materials, equipment and workers are expected to be available regardless of the corrective action alternative selected. Implementation of Alternative B3, however, would be the most challenging given the need to excavate to depths of up to 15 feet, which would require excavation controls (e.g., trench boxes, benching/sloping) to conduct the deep excavations safely and could also require extensive groundwater/surface water management and means to divert Tributary flows while excavation occurs into and below the bank slopes. Due to the extent of excavation anticipated under Alternative B3, a significant rainfall/runoff event could result in inundation of the excavation area and substantially impact water management needs for the project.

Adequate monitoring and maintenance activities can be established for each alternative. The implementability issues associated with working on private properties, and establishing staging areas and access routes would apply equally to all the alternatives, and could be addressed through coordination efforts with property owners.

All three Area B alternatives are expected to be administratively feasible and implementable. All of the alternatives are anticipated to comply with applicable environmental laws, standards, and permitting requirements (Section 7.3.6). No known threatened or endangered species are present in the work areas. Placement of fill materials within a waterway/wetland would require coordination with and permits from WDNR and USACE. Approval of the CAMU potentially associated with Alternatives B2 and B3 is expected to require additional administrative efforts, including the development of an amended CAMU Demonstration Document for submittal to WDNR and a RCRA permit modification associated with the establishment of a CAMU at the

Site. Coordination with WDNR would also be required to establish the design characteristics of the containment cell. Nonetheless, WDNR has conceptually agreed to the establishment of a CAMU at the Site (WDNR 2000) such that the administrative requirements are not expected to limit the implementability of these alternatives.

Based on the considerations identified above, all three Area B alternatives are anticipated to be technically and administratively implementable. Based on an anticipated increased level of effort for evaluating potential flood storage capacity associated with installing a 1-foot cover over the floodplain, and associated administrative coordination, Alternative B1 was assigned a score of 3 with respect to the Implementability criterion. Alternative B2 was assigned a score of 3 due to the increased level of administrative coordination associated with potential CAMU-related approvals. Alternative B3 was assigned a score of 1 due to the increased level of administrative coordination associated with potential CAMU-related approvals, technical challenges associated with conducting deep excavation below the groundwater and flood elevations, and difficulties/risks associated with managing surface water flows around the deep excavation areas.

7.4.4 Restoration Time Frame

As discussed in Section 7.2, this criterion effectively relates to the time required to implement each alternative (i.e., the time required until the Site-specific CAOs are achieved). While other factors may affect the time frame during which construction activities associated with a given alternative could be initiated (e.g., WDNR approval time frame, construction season, weather, need for CAMU design), the primary differentiating factor with regard to this criterion is the estimated length of time necessary for construction of each alternative. Based on the detailed cost estimates included in **Appendix B**, estimated implementation durations for Alternatives B1, B2 and B3 are 6, 8, and 53 weeks, respectively. Based on these durations, Alternative B3 would require two construction seasons to implement, whereas Alternatives B1 and B2 are anticipated to require only a single construction season to complete.

Note that the estimated durations stated above do not include any weather or flooding-related delays. As indicated previously, weather and flooding conditions could significantly impact the schedule for construction activities, resulting in potentially longer durations than estimated.

Based on the estimated implementation durations, Alternatives B1, B2 and B3 were assigned scores of 4, 4, and 1, respectively, for the Restoration Time Frame criterion.

7.4.5 Economic Feasibility

Preliminary costs, including capital costs, indirect costs (e.g., pre-design investigation, engineering design) and post-construction operation and maintenance costs, were developed for each of the three Area B alternatives in accordance with NR 722.07(4)(b). The costs are summarized in **Table 2** and detailed estimates are provided in **Appendix B**. Total costs for the three Area B alternatives are as follows:

- Alternative B1: $1,201,000
- Alternative B2: $3,153,000 (on-Site CAMU disposal of excavated materials) to $7,122,000 (off-Site T&D)
- Alternative B3: $22,786,000 (on-Site CAMU disposal) to $71,724,000 (off-Site T&D)

As detailed above, all three corrective action alternatives developed for Area B would achieve the Site-specific CAOs and be effective over the long term. Alternatives B1 has fewer short-term effectiveness and implementability issues compared to Alternative B2, both Alternatives B1 and B2 have significantly fewer short-term effectiveness and implementability issues compared to Alternative B3, and there is a significant increase in cost to implement Alternative B2 (approximately 3 to 6 times more costly than Alternative B1) and Alternative B3 (approximately 18 to 60 times more costly than Alternative B1).

Based on the above considerations, Alternatives B1, B2 and B3 were assigned scores of 5, 4 and 1, respectively, for the Economic Feasibility criterion.

7.4.6 Compliance with Environmental Laws, Standards and Permitting

Environmental laws and standards that are potentially applicable to implementing corrective actions in the off-property portion of the Site are summarized in **Table 4**. All three corrective action alternatives developed to address impacted sediments and bank/floodplain materials in Area B would comply with these laws and standards. Requirements outlined in applicable permits (see **Table 4**) would be addressed during detailed design of the selected alternative. Accordingly, each of the alternatives was assigned a score of 5 with respect to the Compliance with Environmental Laws, Standards and Permitting criterion.

7.4.7 Sustainability

As discussed in Section 7.2, the Green and Sustainable Remediation Drivers were evaluated per NR 722.09(2m) and the WDNR's January 2012 Green & Sustainable Remediation Manual (Pub-RR-911). An evaluation of the Area B alternatives relative to the GHG Generation, Energy Consumption, Land Use and Waste Generation criteria is summarized in the chart below:

Chart 3 Evaluation of Area B Alternatives relative to GHG Generation, Energy Consumption, Land Use and Waste Generation

	Alternative B1	Alternative B2	Alternative B3
GHG Generation/Energy Consumption			
# Truckloads imported general fill, topsoil and stone	330	330	2,800
# Truckloads excavated materials	7	280	2,800
Construction duration (weeks)	6	8	53
Land Use			
Area of Disturbance (acres)	4.4	4.4	4.9
Waste Generation			
Volume of impacted materials (cy)	140	5,600	55,700

Note: Anticipated truckloads (20 cy each) based on in-situ volumes of excavated and restoration materials.

As summarized in the chart above, Alternative B3 would result in the greatest GHG generation and energy consumption caused by activities such as fossil fuel consumption due to the significantly higher number of anticipated truckloads during construction. The area of land disturbed for implementation of all Area B alternatives is the same. Lastly, Alternative B3 additionally generates a much greater volume of waste material. Should the off-Site disposal option be selected, significantly more landfill space would be required.

With regard to the Water Use criterion, due to the large/deep excavations associated with Alternative B3, potential impacts to water during construction activities and the potential for a significant rainfall/runoff event to cause inundation of the excavation area for this alternative are greater than the other alternatives.

Based on the considerations outlined above, Alternatives B1, B2 and B3 were assigned scores of 4, 3 and 1, respectively, for the Sustainability criterion.

7.5 Area C – Crawford Creek from Tributary to Railroad Embankment

As described in Section 6.3.3, the following four corrective action alternatives were developed for Area C:

- Alternative C1: Channel Relocation with Armored Channel
- Alternative C2: Channel Relocation with Clay-Lined Channel
- Alternative C3: Partial Channel Excavation/Backfill
- Alternative C4: Extended Channel and Floodplain Excavation/Backfill

The following subsections present a comparative evaluation of these alternatives with respect to the seven criteria identified in Section 7.2 for the purpose of recommending a corrective action approach for Area C. Scores developed for each alternative (using the numerical system described in Section 7.1) are presented in **Table 3**.

7.5.1 Long-Term Effectiveness

All four corrective action alternatives developed for Area C would achieve the Site-specific CAOs (mitigate the potential for exposure by ecological receptors to COPC-impacted creek channel sediment; and mitigate the generation of COPC-related surface water sheens) and would, therefore, provide for protection of public health and the environment.

In addition, all four Area C alternatives would reduce the volume and/or mobility and COPCs. It should be noted that creosote-like product is present in isolated cracks/fractures within the clay floodplain materials along Crawford Creek (product is estimated to occupy less than 1 percent of the soil matrix). Because of this, under Alternative C4, an estimated 99 percent of the bank material removal volume would be “clean” materials, which would minimize the overall reduction in volume of COPCs under this alternative. Further, materials excavated under Alternatives C2, C3 and C4 may be removed and consolidated in a CAMU containment cell located on the on-property portion of the Site[12]. If applicable, the CAMU containment cell would be designed and maintained to minimize the potential for migration of consolidated materials out of the cell, thereby contributing to the reduction in COPC mobility with

[12] Off-Site T&D and consolidation in an on-Site CAMU are both possible options for disposal of excavated materials.

Alternatives C2, C3 and C4. Toxicity reductions associated with all alternatives would be limited to that which occurs over time as a result of ongoing natural attenuation and biodegradation processes.

Impacted materials would remain in Area C with implementation of all four Area C alternatives. Although Alternative C4 targets excavation of impacted materials within, below, and adjacent to the tributary channel, due to the nature and extent of the impacts, removal of all impacted materials is impracticable, and some impacted materials would ultimately be left in place. Proper design and maintenance would effectively mitigate the potential for future exposure to or migration of COPCs. Alternatives C1, C2 and C3 include a layer of RCM to mitigate the potential migration of remaining COPCs into the restored channel where necessary.

All four alternatives include restoration of the creek channel in a manner that provides for long-term protection against potential channel migration or erosion of clean fill materials. However, given the extent of impacted materials in the floodplain, it is anticipated that relocation of the creek in an unimpacted area (Alternatives C1 and C2) would offer more long term protection (i.e., less risk of becoming re-impacted) relative to excavating a limited amount of material from the existing channel/banks, and restoring the channel in its current location (Alternative C3).

Alternatives C1, C2 and C3 are assumed to require 30 years of monitoring and maintenance to ensure their effectiveness. By comparison, Alternative C4 is only assumed to require 3 years of monitoring and maintenance (because a substantial volume of buffer soils would exist between the channel and residual impacted materials following implementation of this alternative because thicker cover over impacted materials would be in place following implementation of this alternative). The CAMU containment cell (a material disposal option for Alternatives C2, C3 and C4) is also assumed to require 30 years of monitoring and maintenance.

Under all four alternatives, it is anticipated that institutional controls (continuing obligations/GIS Registry) would be required to restrict land and groundwater use to mitigate the potential for future exposure to or disturbance of impacted materials that may remain in place following implementation of "active" corrective actions.

In summary, through proper design and maintenance, all four Area C alternatives would achieve CAOs and offer an acceptable level of long-term protection, and would result in a reduction in both the mobility and volume of COPCs. Because some level of impacted materials would remain following implementation of all four alternatives, none of the four alternatives were assigned a score of 5. Alternatives C1 and C2 were assigned scores of 4, due to the relocation of the creek to an unimpacted area of the floodplain and the associated reduced risk of the creek channel becoming re-impacted.

Alternative C3 was assigned a score of 3 due to the potential for the creek channel to become re-impacted. Alternative C4 was assigned a score of 4. Because impacted materials would be left in place with the potential for re-impacting the Tributary, more removal in Alternative C4 does not increase long-term effectiveness).

7.5.2 Short-Term Effectiveness

Construction- and implementation-related short-term impacts exist for all four Area C alternatives and would last for the duration of construction activities. Such impacts potentially include (but are not limited to) the following:

- Working with and around construction equipment
- Noise generation from operating construction equipment
- Increased vehicular traffic associated with delivery of equipment and materials, and for Alternatives C2, C3 and C4, transportation of excavated materials to either an off-Site disposal facility or an on-Site CAMU
- Dust generation
- Potential odor generation from excavation of impacted sediments and bank/floodplain materials (Alternative C2, C3 and C4)
- Potential for exposure to COPC-impacted sediments and bank/floodplain materials
- Potential disruption to local residents and private land owners
- Potential disruption of facility operations (if an on-Site CAMU is used for material disposal for Alternatives C2, C3 and C4)
- Surface-water impacts

To the extent possible, short-term impacts would be minimized by engineering controls and access controls during implementation, use of odor/dust suppression measures (as needed), use of proper health and safety practices, detailed design, and coordination with the facility and affected property owners during the planning and implementation stages. Bypass pumping and erosion/sedimentation controls would be used to minimize the potential for surface-water impacts associated with work within the Creek.

Alternatives C1 and C2 require excavation of creek channel sediment (estimated at 500 cy and 2,700 cy, respectively) in portions of the existing channel to remain in place. Alternative C3 requires excavation of creek channel sediment and bank/floodplain materials (estimated at 3,200 cy) as necessary for the restored channel geometry. In addition, Alternatives C1, C2 and C3 require the transportation and placement of imported materials, resulting in the potential for construction worker/traffic accidents. For Alternative C1, an estimated 540 truckloads[13] would be required for the anticipated volumes of general fill and stone for construction of the new channel, and an estimated 25 truckloads for handling excavated sediment and bank materials. For Alternative C2, an estimated 241 truckloads would be required for the anticipated volumes of general fill/clay and topsoil for backfilling/restoring the channel excavation areas, and an estimated 135 truckloads for handling excavated sediment and bank/floodplain materials. For Alternative C3, an estimated 160 truckloads would be required for the anticipated volumes of general fill/clay and topsoil for backfilling/restoring the channel excavation, and an estimated 160 truckloads for handling excavated sediment and bank/floodplain material. Additional deliveries would be required for the RCM, geotextile and erosion control mat, and material for erosion control features on channel bends for Alternatives C2 and C3. Alternatives C1, C2 and C3 would generate noise/dust/odor, result in potential exposures to COPCs and disrupt local residents and private landowners. The anticipated duration of Alternatives C1 and C2 is 18 weeks. The anticipated duration of Alternative C3 is 12 weeks.

Alternative C4 would result in a much higher degree of short-term impacts associated with the additional impacted sediment and bank/floodplain material handling. An estimated 4,760 truckloads of general fill/clay and topsoil would be delivered for implementation of Alternative C4 (additional deliveries would be required for the geotextile and erosion control mat) and an estimated 4,760 truckloads for handling excavated sediment and bank/floodplain materials, resulting in higher potential for construction worker/traffic accidents, noise/dust/odor generation, potential exposures to COPCs, and disruption to local residents and private land owners. Furthermore, the anticipated duration of Alternative C4 is 72 weeks, resulting in a significantly longer duration of these disruptions relative to Alternatives C1, C2 and C3, and necessitating three construction seasons. The required removal depths and associated requirements for engineering controls (e.g., trench boxes) and water management, in addition to the potential for a significant rainfall/runoff event to cause inundation of the excavation area, results in additional short-term impacts for Alternative C4.

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[13] Estimated truckloads are based on in-situ volumes for excavated and restoration materials and 20 cy per load.

It should be noted that, based on previous experience conducting investigations in this area, weather and flooding conditions could significantly impact the schedule for construction activities, resulting in potentially longer durations than estimated (construction durations specified above do not account for any weather or flooding related delays).

All four alternatives involve work in a floodplain that is known to flood frequently, which carries a risk for flooding of the work areas and equipment. Procedures would need to be developed to minimize these risks. Due to the large/deep excavations associated with Alternative C4, as well as the longer duration of the project, the potential flooding-related short-term risks for this alternative are significantly greater than the other alternatives.

Because all of the work to be conducted in Area C is located on privately owned property, acceptance by the affected and surrounding property owners would be a critical component of selecting and implementing a remedy in this area. In addition to potential noise and odor impacts and disruptions due to construction traffic, a limited clearing of trees would also be required for each of the alternatives, which is another short-term impact. The estimated amount of clearing required for Alternatives C1, C2, C3 and C4 is 17, 17, 9.4 and 10.2 acres, respectively (a small portion of which is tree covered).

Based on the considerations identified above, Alternative C1, which presents the fewest short-term impacts and the shortest implementation duration, was assigned a score of 4 with respect to the Short-Term Effectiveness criterion. Alternative C2 was also assigned a score of 4 because even though more impacted materials are excavated, less transportation and placement of imported material is required. Alternative C3 was also assigned a score of 4 because even though more impacted materials are excavated, the construction duration is shorter than Alternatives C1 and C2. Finally, because of the significantly greater impacted material handling volumes and implementation duration, Alternative C4 was assigned a score of 1.

7.5.3 Implementability

The corrective action alternatives developed and evaluated in this Off-Property FCMS include only proven technologies; no pilot- or bench-scale testing would be necessary. Each of the four Area C alternatives is technically implementable and all the necessary materials, equipment, and workers are expected to be available regardless of the corrective action alternative selected. Implementation of Alternative C4, however, would be the most challenging given the need to excavate to depths of up to 30 feet, which would require excavation controls (e.g., trench boxes, benching/sloping) to conduct the deep excavations safely and could also require extensive groundwater/surface water management and means to divert Crawford Creek flows while excavation occurs into and below the bank slopes. Due to the extent of excavation anticipated under Alternative C4, a significant rainfall/runoff event could result in inundation of the excavation area and substantially impact water management needs for the project.

Adequate monitoring and maintenance activities can be established for each alternative. The implementability issues associated with working on private properties, and establishing staging areas and access routes would apply equally to all the alternatives, and could be addressed through coordination efforts with property owners.

All four Area C alternatives are expected to be administratively feasible and implementable. All of the alternatives are anticipated to comply with applicable environmental laws, standards, and permitting requirements (Section 7.3.6). No known threatened or endangered species are present in the work areas. Placement of fill materials within a waterway/wetland would require coordination with and permits from WDNR and USACE. It is anticipated that the linear nature of the relocated channel under Alternative C1 may not be acceptable to WDNR. Approval of the CAMU potentially associated with Alternatives C2, C3 and C4 is expected to require additional administrative efforts, including the development of an amended CAMU Demonstration Document for submittal to WDNR and a RCRA permit modification associated with the establishment of a CAMU at the Site. Coordination with WDNR would also be required to establish the design characteristics of the containment cell. Nonetheless, WDNR has conceptually agreed to the establishment of a CAMU at the Site (WDNR 2000) such that the administrative requirements are not expected to limit the implementability of these alternatives.

Based on the considerations identified above, all four Area C alternatives are anticipated to be technically and administratively implementable. Due to the potential WDNR/USACE permitting issues associated with the linear nature of the relocated channel, Alternative C1 was assigned a score of 3. Alternatives C2 and C3 were assigned scores of 4. Alternative C4 was assigned a score of 1 due to the increased level of administrative coordination associated with potential CAMU-related approvals, technical challenges associated with conducting deep excavation below the groundwater and flood elevations, and difficulties/risks associated with managing surface water flows around the deep excavation areas.

7.5.4 Restoration Time Frame

As discussed in Section 7.2, this criterion effectively relates to the time required to implement each alternative (i.e., the time required until the site-specific CAOs are achieved). While other factors may affect the time frame during which construction activities associated with a given alternative could be initiated (e.g., WDNR approval time frame, construction season, weather, need for CAMU design), the primary differentiating factor with regard to this criterion is the estimated length of time necessary for construction of each alternative. Based on the detailed cost estimates included in **Appendix B**, estimated implementation durations for Alternatives C1, C2, C3 and C4 are 18, 18, 12 and 72 weeks, respectively. Based on these durations, Alternative C4 would require three construction seasons to implement, whereas Alternatives C1, C2 and C3 are anticipated to require only a single construction season to complete.

Note that the estimated durations stated above do not include any weather or flooding-related delays. As indicated previously, weather and flooding conditions could significantly impact the schedule for construction activities, resulting in potentially longer durations than estimated.

Based on the estimated implementation durations, Alternatives C1, C2, C3 were assigned scores of 4 with respect to the Restoration Time Frame criterion, and Alternative C4 was assigned a score of 1.

7.5.5 Economic Feasibility

Preliminary costs, including capital costs, indirect costs (e.g., pre-design investigation, engineering design), and post-construction operation and maintenance costs, were developed for each of the four Area C alternatives in accordance with NR 722.07(4)(b). The costs are summarized in **Table 2** and detailed estimates are provided in **Appendix B**. Total costs for the four Area C alternatives are as follows:

- Alternative C1: $4,056,000
- Alternative C2: $3,918,000 (on-Site CAMU disposal) to $5,351,000 (off-Site T&D)
- Alternative C3: $3,576,000 (on-Site CAMU disposal) to $5,321,000 (off-Site T&D)
- Alternative C4: $41,898,000 (on-Site CAMU disposal) to $126,112,000 (off-Site T&D)

As detailed above, all four corrective action alternatives developed for Area C would achieve the Site-specific CAOs and be effective over the long-term. Alternatives C1, C2 and C3 have fewer short-term effectiveness and implementability issues compared to Alternative C4. Accordingly, there is a significant increase in cost to implement Alternative C4 (approximately 11 to 36 times more costly than Alternatives C1, C2 and C3).

Based on the above considerations, Alternatives C1, C2, C3 were assigned scores of 4 with respect to the Economic Feasibility criterion, and Alternative C4 was assigned a score of 1.

7.5.6 Compliance with Environmental Laws, Standards and Permitting

Environmental laws and standards that are potentially applicable to implementing corrective actions in the off-property portion of the Site are summarized in **Table 4**. All four corrective action alternatives developed to address impacted sediments in Area C would comply with these laws and standards. Requirements outlined in applicable permits (see **Table 4**) would be addressed during detailed design of the selected alternative. Accordingly, each of the alternatives was assigned a score of 5 with respect to the Compliance with Environmental Laws, Standards and Permitting criterion.

7.5.7 Sustainability

As discussed in Section 7.2, the Green and Sustainable Remediation Drivers were evaluated per NR 722.09(2m) and the WDNR January 2012 Green & Sustainable Remediation Manual (Pub-RR-911). An evaluation of the Area C alternatives relative to the GHG Generation, Energy Consumption, Land Use and Waste Generation criteria is summarized in the chart below:

Chart 4 Evaluation of Area C Alternatives relative to GHG Generation, Energy Consumption, Land Use and Waste Generation

	Alternative C1	Alternative C2	Alternative C3	Alternative C4
GHG Generation/Energy Consumption				
# Truckloads imported general fill, topsoil and stone	540	240	160	4,760
# Truckloads excavated materials	25	135	160	4,760
Construction duration (weeks)	18	18	12	72
Land Use				
Area of Disturbance (acres)	17	17	9.4	10.2
Waste Generation				
Volume of impacted materials (cy)	500	2,700	3,200	95,200

Note: Anticipated truckloads (20 cy each) based on in-situ volumes of excavated and restoration materials.

As summarized in the chart above, Alternative C4 would result in the greatest GHG generation and energy consumption caused by activities such as fossil fuel consumption due to the significantly higher number of anticipated truckloads during construction. The area of land disturbed for implementation of Alternatives C3 and C4 is less than the area of land disturbed for Alternatives C1 and C2. Alternatives C2, C3, and C4 mimic the existing channel sinuosity. Lastly, Alternative C4 generates a much greater volume of waste material. Should the off-Site disposal option be selected, significantly more landfill space would be required.

With regard to the Water Use criterion, due to the large/deep excavations associated with Alternative C4, potential impacts to water during construction activities and the potential for a significant rainfall/runoff event to cause inundation of the excavation area for this alternative are greater than the other alternatives.

Based on the considerations outlined above, Alternatives C1, C2, C3, and C4 were assigned scores of 3, 4, 4, and 1, respectively, for the Sustainability criterion.

8. Selected Corrective Action Approach

8.1 Overview

Results of the comparative analyses presented in Section 7 were used as a basis for selecting an overall corrective action approach for the off-property portion of the Site that complies with the requirements described in NR 722.07 and NR 722.09. The selected approach includes the following components:

- **Tributary from Facility Property Boundary and Hammond Avenue.** Install an engineered liner system,, pending coordination with an approval by the property owners.

- **Area A (Tributary from Hammond Avenue to Crawford Creek Floodplain) – Alternative A2: Channel and Bank Cover, with DNAPL Collection Provisions.** This alternative (depicted on **Figure 5**) is an in-situ containment approach that includes installing an engineered cover (with RCM) over impacted Tributary to Crawford Creek sediments and bank materials. Channel restoration includes the creation of baseline and secondary flow channels. The baseline flow channel (sized to accommodate 2-year flood events) would be completed with soil-choked stone gabions to reduce the potential for future channel incision. The secondary flow channel (sized to accommodate 25-year flood events) would be completed with topsoil and riparian vegetation. Velocity control structures, such as wedge dams or rock weirs, would be installed at locations matching existing features and as necessary to reduce the velocity of surface water flows within the channel. In addition, a collection trench would be installed upgradient of the railroad crossing (**Figure 5**) to provide a means for collecting potentially mobile creosote-like product (DNAPL), if any, that may be migrating downstream through the subsurface along the Tributary channel.

- **Area B (Tributary within Crawford Creek Floodplain) – Alternative B1: Partial Channel Excavation/Backfill, 1-Foot Floodplain Cover.** This alternative (depicted on **Figure 7**) is a combination removal and in-situ containment approach that includes excavating impacted materials from the bottom and banks of the Tributary to Crawford Creek, and installing an engineered cover over impacted floodplain materials outside of the excavation area. The channel excavation would be restored with RCM and 1 foot of compacted clay.

- **Area C (Crawford Creek from Tributary to Railroad Embankment) – Alternative C2: Channel Relocation with Clay-Lined Channel.** This alternative (depicted on **Figure 11**) includes constructing a new channel for Crawford Creek in an unimpacted area located west/northwest of the existing channel location (the sinuosity and length of the relocated channel would be consistent with natural characteristics and generally match that of the existing channel), and backfilling a portion of the existing channel (approximately 2,385 linear feet) with clean materials excavated during construction of the new channel. For the remainder of the existing channel (approximately 1,365 linear feet), sediment and bank materials would be excavated and the channel restored in its existing location. The relocated channel bottom and banks would remain clay and erosion control features would be added, as necessary.

- Establishing and implementing long-term monitoring and maintenance plans to verify the corrective actions and restored areas are functioning as designed.

- Establishing and implementing institutional controls (continuing obligations/GIS Registry) to restrict land and groundwater use to mitigate the potential for future exposure to or disturbance of impacted materials that remain in place following implementation of "active" corrective actions.

Based on the comparative evaluation of alternatives, this combination of measures would achieve the Site-specific CAOs, offers long-term protection to human health and the environment, results in minimal/controllable short-term risks, is technically and administratively implementable, is cost effective, and can be designed/implemented to comply with applicable laws, standards and permits. Specific rationale for selecting each component of this approach is summarized in the following subsections.

Under this proposed corrective action approach, the total volume of impacted materials generated from all three corrective action areas is anticipated to be approximately 3,340 cy. As discussed in Sections 6.3 and 6.4, a final decision on whether a CAMU would be the preferred method for long-term management of the excavated materials would depend on the actual volume of materials generated, the available CAMU capacity, CAMU design/operational requirements, and the cost of off-Site T&D at the time of generation. Accordingly, at this time, Beazer would like to maintain both on-Site CAMU disposal and off-Site T&D as potentially applicable options.

8.2 Area A – Tributary from Hammond Avenue to Crawford Creek Floodplain

As indicated in Section 8.1, Alternative A2 was identified as the preferred corrective action alternative to address COPC-impacted media and surface water sheens in Area A. This alternative, which is described in Section 6.3.1.2 and depicted on **Figure 5**, generally includes installing engineered cover over impacted Tributary sediments and bank materials, installing a collection trench for potentially mobile creosote-like product, conducting periodic post-construction inspection and maintenance, and establishing land and groundwater use restrictions.

Selection of Alternative A2 is appropriate based on its ability to quickly (a construction period of approximately 19 weeks) and cost-effectively achieve the Site-specific CAOs and long-term protectiveness, with minimal short-term impacts, implementability and sustainability concerns. Other benefits of this approach include:

- Had the highest total evaluation score (**Table 3**) of the three evaluated alternatives

- With proper design, implementation and monitoring, would be effective in the long-term

- Minimizes handling of impacted sediments and bank materials, and associated short-term risks, relative to the other alternatives

- Minimizes the need for extensive transport of impacted materials on public roadways and generation of GHGs

- Minimizes the need for handling and management of impacted water within the work area and the potential for water impacts

- Minimizes potential delays and risks associated with flooding during construction

- Minimizes impacts to private property owners because less clearing is required and the construction timeframe is shorter relative to other alternatives

- Meets requirements of applicable laws and standards; permitting requirements would be met during detailed design

8.3 Area B – Tributary within Crawford Creek Floodplain

As indicated in Section 8.1, Alternative B1 was identified as the preferred corrective action alternative to address COPC-impacted media and surface water sheens in Area B. This alternative, which is described in Section 6.3.2.1 and depicted on **Figure 7**, generally includes excavating impacted materials from the bottom and banks of the Tributary channel, restoring the Tributary channel with engineered fill materials consisting of RCM and clayey general fill, installation of a cover in the impacted adjacent floodplain, conducting periodic post-construction inspection and maintenance, and establishing land and groundwater use restrictions.

Selection of Alternative B1 is appropriate based on its ability to quickly (a construction period of approximately 6 weeks) and cost-effectively achieve the Site-specific CAOs and long-term protectiveness, with minimal short-term impacts, implementability and sustainability concerns. Other benefits of this approach include:

- Had the highest total evaluation score (**Table 3**) of the three evaluated alternatives
- With proper design, implantation and monitoring, would be effective in the long-term
- Minimizes handling of impacted sediments and bank materials, and associated short-term risks, relative to the other alternatives
- Minimizes the need for extensive transport of impacted materials on public roadways and generation of GHGs
- Minimizes the need for handling and management of impacted water within the work area and the potential for water impacts
- Minimizes potential delays and risks associated with flooding during construction
- Minimizes impacts to private property owners because the construction timeframe is shorter relative to other alternatives
- Meets requirements of applicable laws and standards; permitting requirements would be met during detailed design

8.4 Area C – Crawford Creek from Tributary to Railroad Embankment

As indicated in Section 8.1, Alternative C2 was identified as the preferred corrective action alternative to address COPC-impacted media and surface water sheens in Area C. This alternative, which is described in Section 6.3.3.2 and depicted on **Figure 11**, generally includes constructing a new channel for Crawford Creek (portions of the existing channel would be backfilled, while the remainder would be excavated and restored in-place), conducting periodic post-construction inspection and maintenance, and establishing land and groundwater use restrictions.

Selection of Alternative C2 is appropriate based on its ability to quickly (a construction period of approximately 18 weeks) and cost-effectively achieve the Site-specific CAOs and long-term protectiveness, with minimal short-term impacts, implementability, and sustainability concerns. Other benefits of this approach include:

- Had the highest total evaluation score (**Table 3**) of the three evaluated alternatives
- Has greater certainty than Alternatives C3 and C4 because it relocates a significant portion of the channel out of the impacted zone
- Mimics the existing channel sinuosity (relative to Alternative C1)
- With proper design, implantation and monitoring, would be effective in the long-term
- Minimizes handling of impacted sediments and bank materials, and associated short-term risks, relative to the other alternatives
- Minimizes the need for extensive transport of impacted materials on public roadways and generation of GHGs
- Minimizes the need for handling and management of impacted water within the work area and the potential for water impacts
- Minimizes the need for handling and management of impacted water within the work area
- Minimizes potential delays and risks associated with flooding during construction

- Minimizes impacts to private property owners because the construction timeframe is shorter relative to other alternatives

- Meets requirements of applicable laws and standards; permitting requirements would be met during detailed design

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ARCADIS

Tables

Table 1
Technology Screening Summary

Off-Property Focused Corrective Measures Study
Former Koppers Inc. Facility - Superior, Wisconsin

General Response Action	Corrective Action Technology	Process Option	Description	Screening Result
Area A - Tributary from Hammond Avenue to Crawford Creek Floodplain				
Institutional Controls	Institutional Controls	Land/Groundwater Use Restrictions	Institutional controls could include legal or administrative controls that mitigate the potential for exposure to or disturbance of impacted materials that may remain in place following implementation of "active" corrective actions. Such controls could include property owner notifications for continuing obligations, residual contamination, and associated land/groundwater use restrictions, as well as filing applicable forms/data tables/figures/etc. on the WDNR GIS Registry.	**Retained.** Applicable for use in conjunction with an active corrective action (not as a stand-alone option).
Monitoring	Monitoring	Field Observation, Sampling and Analysis	Depending on the nature of the selected alternative, monitoring could involve the collection and analysis of samples to determine the effectiveness of engineering controls, performance of visual reconnaissance to track Site conditions and remedy integrity after implementation is complete, or other similar monitoring-related measures to verify the continued effectiveness of the corrective action.	**Retained.** Applicable for use in conjunction with an active corrective action (not as a stand-alone option).
Removal	Excavation	Mechanical Excavation	This technology involves physical removal of impacted media targeted for corrective action. Typical excavation equipment includes backhoes, loaders and/or dozers. Excavated materials are then managed using one or more other technologies (e.g., ex-situ treatment, solidification/on-site disposal, solidification/off-site disposal). Excavated areas are backfilled with clean materials and vegetated/armored for erosion protection.	**Retained.** Applicable to Site conditions and for achieving Site-specific CAOs. Feasibility dependent on excavation limits/depths.
In-Situ Containment	Physical Barrier	Capping	This technology involves the placement of clean backfill/cover materials (e.g., soils, synthetics such as geotextiles, liners, Reactive Core Mat) over impacted media to serve as a barrier to potential exposures and minimize erosion/migration of impacted materials. Systems could be installed as part of the caps to collect potentially mobilize materials. Placement of fill could occur over existing grades, or following sediment/soil removal such that final grades match existing grades. Backfill/cover materials are vegetated/armored for erosion protection.	**Retained.** Applicable to Site conditions and for achieving Site-specific CAOs. Could be used as a stand-alone technology, or combined with a removal technology (e.g., partial excavation and restoration).

Table 1
Technology Screening Summary

Off-Property Focused Corrective Measures Study
Former Koppers Inc. Facility - Superior, Wisconsin

General Response Action	Corrective Action Technology	Process Option	Description	Screening Result
In-Situ Containment	Physical Barrier	Culvert Installation	Install culvert piping and bedding materials within the tributary so that water flows through the culvert rather than the open channel. This would prevent erosion/migration of impacted sediments/bank materials and contact between surface water and impacted sediments/bank materials.	Not retained. High potential for damage to culvert due to freeze/thaw and buoyant forces. High potential for localized flooding due to ice accumulation.
In-Situ Containment	Physical Barrier	Channel Relocation	Excavate a new channel through an unimpacted area and backfill the existing channel. The new channel could be restored with stone armoring to provide long-term erosion protection. Potentially impacted materials along the existing channel would be contained beneath the fill material used to backfill the channel.	Not retained. Topography along Tributary to Crawford Creek not conducive to implementation of this option.
In-Situ Treatment	Bioremediation Immobilization Chemical Thermal	Natural/enhanced biodegradation, stabilization/ solidification, chemical extraction, etc.	Various in-situ treatment technologies are frequently considered for the COPCs identified for this Site. These technologies are applied to impacted materials without removing the materials from their present location. This is typically achieved through adding and mixing chemical reagents, adding or enhancing the biodegradation catalysts (e.g., oxygen, nutrients), heating, or other technology-specific applications.	Not retained based on Beazer's experience at numerous other similar sites, climatic considerations, typically high costs, shallow groundwater and surface-water presence, and other Site-specific considerations (e.g., clayey soils). Also, treatment of these materials is not necessary to achieve CAOs for this area.
Ex-Situ Treatment	Bioremediation Immobilization Chemical Thermal	Enhanced biodegradation, stabilization/solidification, chemical extraction, etc.	Various ex-situ treatment technologies, including those listed at left, are frequently considered for the COPCs identified for this Site. These technologies are applied to impacted materials that have been removed from their present location. The materials are then processed to apply the selected technology, which can be achieved either on site or at a permitted off-site treatment facility. Based on Site- and constituent-specific considerations, materials would likely require disposal at an off-Site commercial land disposal facility.	Not retained based on Beazer's experience at numerous other similar sites, climatic considerations, typically high costs, shallow groundwater and surface-water presence, and other Site-specific considerations (e.g., clayey soils). Also, treatment of these materials is not necessary to achieve CAOs for this area.
Disposal	On-Site Disposal	On-Site Consolidation in a CAMU	Excavated materials are solidified and transported to the facility and consolidated in an engineered containment cell within a designated CAMU. The engineered containment cell includes provisions to mitigate the potential for exposure to or migration of consolidated materials.	**Retained.** A CAMU has been proposed to and conceptually approved by WDNR. Consolidation in a containment cell is applicable for the types of materials to be excavated from the off-property areas, and is a proven and frequently used approach. Feasibility dependent on quantity of materials excavated due to space limitations at the facility.

Table 1
Technology Screening Summary

Off-Property Focused Corrective Measures Study
Former Koppers Inc. Facility - Superior, Wisconsin

General Response Action	Corrective Action Technology	Process Option	Description	Screening Result
Disposal	Off-Site Disposal	Off-Site Commercial Facility	Excavated materials are solidified and transported to an off-Site permitted landfill for disposal. Depending on constituent concentrations and waste classification, land disposal may require treatment (e.g., incineration) prior to disposal to meet RCRA land disposal restrictions.	**Retained.** Off-Site disposal at a commercial facility is applicable to the types of materials to be excavated from the off-property areas, and is a proven and frequently used approach. Feasibility dependent on quantity of materials excavated due to high transportation and disposal costs.
Area B - Tributary within Crawford Creek Floodplain				
Institutional Controls	Institutional Controls	Land/Groundwater Use Restrictions	Institutional controls could include legal or administrative controls that mitigate the potential for exposure to or disturbance of impacted materials that may remain in place following implementation of "active" corrective actions. Such controls could include property owner notifications for continuing obligations, residual contamination, and associated land/groundwater use restrictions, as well as filing applicable forms/data tables/figures/etc. on the WDNR GIS Registry.	**Retained.** Applicable for use in conjunction with an active corrective action (not as a stand-alone option).
Monitoring	Monitoring	Field Observation, Sampling and Analysis	Depending on the nature of the selected alternative, monitoring could involve the collection and analysis of samples to determine the effectiveness of engineering controls, performance of visual reconnaissance to track Site conditions and remedy integrity after implementation is complete, or other similar monitoring-related measures to verify the continued effectiveness of the corrective action.	**Retained.** Applicable for use in conjunction with an active corrective action (not as a stand-alone option).
Removal	Excavation	Mechanical Excavation	This technology involves physical removal of impacted media targeted for corrective action. Typical excavation equipment includes backhoes, loaders and/or dozers. Excavated materials are then managed using one or more other technologies (e.g., ex-situ treatment, solidification/on-site disposal, solidification/off-site disposal). Excavated areas are backfilled with clean materials and vegetated/armored for erosion protection.	**Retained.** Applicable to Site conditions and for achieving Site-specific CAOs. Feasibility dependent on excavation limits/depths.

Table 1
Technology Screening Summary

Off-Property Focused Corrective Measures Study
Former Koppers Inc. Facility - Superior, Wisconsin

General Response Action	Corrective Action Technology	Process Option	Description	Screening Result
In-Situ Containment	Physical Barrier	Capping	This technology involves the placement of clean backfill/cover materials (e.g., soils, synthetics such as geotextiles, liners, Reactive Core Mat) over impacted media to serve as a barrier to potential exposures and minimize erosion/migration of impacted materials. Systems could be installed as part of the caps to collect potentially mobilize materials. Placement of fill could occur over existing grades, or following sediment/soil removal such that final grades match existing grades. Backfill/cover materials are vegetated/armored for erosion protection.	**Retained.** Applicable to Site conditions and for achieving Site-specific CAOs. Could be used as a stand-alone technology, or combined with a removal technology (e.g., partial excavation and restoration).
In-Situ Containment	Physical Barrier	Culvert Installation	Install culvert piping and bedding materials within the tributary so that water flows through the culvert rather than the open channel. The prevents erosion/migration of impacted sediments/bank materials and contact between surface water and impacted sediments/bank materials.	Not retained. High potential for damage to culvert due to freeze/thaw and buoyant forces. High potential for localized flooding due to ice accumulation.
In-Situ Containment	Physical Barrier	Channel Relocation	Excavate a new channel through an unimpacted area and backfill the existing channel. The new channel could be restored with stone armoring to provide long-term erosion protection. Potentially impacted materials along the existing channel would be contained beneath the fill material used to backfill the channel.	Not retained. Topography along Tributary to Crawford Creek not conducive to implementation of this option.
In-Situ Treatment	Bioremediation Immobilization Chemical Thermal	Natural/enhanced biodegradation, stabilization/solidification, chemical extraction, etc.	Various in-situ treatment technologies are frequently considered for the COPCs identified for this Site. These technologies are applied to impacted materials without removing the materials from their present location. This is typically achieved through adding and mixing chemical reagents, adding or enhancing the biodegradation catalysts (e.g., oxygen, nutrients), heating, or other technology-specific applications.	Not retained based on Beazer's experience at numerous other similar sites, climatic considerations, typically high costs, shallow groundwater and surface-water presence, and other Site-specific considerations (e.g., clayey soils). Also, treatment of these materials is not necessary to achieve CAOs for this area.

Table 1
Technology Screening Summary

Off-Property Focused Corrective Measures Study
Former Koppers Inc. Facility - Superior, Wisconsin

General Response Action	Corrective Action Technology	Process Option	Description	Screening Result
Ex-Situ Treatment	Bioremediation Immobilization Chemical Thermal	Enhanced biodegradation, stabilization/solidification, chemical extraction, etc.	Various ex-situ treatment technologies, including those listed at left, are frequently considered for the COPCs identified for this Site. These technologies are applied to impacted materials that have been removed from their present location. The materials are then processed to apply the selected technology, which can be achieved either on site or at a permitted off-site treatment facility. Based on Site- and constituent-specific considerations, materials would likely require disposal at an off-Site commercial land disposal facility.	Not retained based on Beazer's experience at numerous other similar sites, climatic considerations, typically high costs, shallow groundwater and surface-water presence, and other Site-specific considerations (e.g., clayey soils). Also, treatment of these materials is not necessary to achieve CAOs for this area.
Disposal	On-Site Disposal	On-Site Consolidation in a CAMU	Excavated materials are solidified and transported to the facility and consolidated in an engineered containment cell within a designated CAMU. The engineered containment cell includes provisions to mitigate the potential for exposure to or migration of consolidated materials.	**Retained.** A CAMU has been proposed to and conceptually approved by the WDNR. Consolidation in a containment cell is applicable for the types of materials to be excavated from the off-property areas, and is a proven and frequently used approach. Feasibility dependent on quantity of materials excavated due to space limitations at the facility.
Disposal	Off-Site Disposal	Off-Site Commercial Facility	Excavated materials are solidified and transported to an off-Site permitted landfill for disposal. Depending on constituent concentrations and waste classification, land disposal may require treatment (e.g., incineration) prior to disposal to meet RCRA land disposal restrictions.	**Retained.** Off-Site disposal at a commercial facility is applicable to the types of materials to be excavated from the off-property areas, and is a proven and frequently used approach. Feasibility dependent on quantity of materials excavated due to high transportation and disposal costs.
Area C - Crawford Creek from Tributary to Railroad Embankment				
Institutional Controls	Institutional Controls	Land/Groundwater Use Restrictions	Institutional controls could include legal or administrative controls that mitigate the potential for exposure to or disturbance of impacted materials that may remain in place following implementation of "active" corrective actions. Such controls could include property owner notifications for continuing obligations, residual contamination, and associated land/groundwater use restrictions, as well as filing applicable forms/data tables/figures/etc. on the WDNR GIS Registry.	**Retained.** Applicable for use in conjunction with an active corrective action (not as a stand-alone option).

Table 1
Technology Screening Summary

Off-Property Focused Corrective Measures Study
Former Koppers Inc. Facility - Superior, Wisconsin

General Response Action	Corrective Action Technology	Process Option	Description	Screening Result
Monitoring	Monitoring	Field Observation, Sampling and Analysis	Depending on the nature of the selected alternative, monitoring could involve the collection and analysis of samples to determine the effectiveness of engineering controls, performance of visual reconnaissance to track Site conditions and remedy integrity after implementation is complete, or other similar monitoring-related measures to verify the continued effectiveness of the corrective action.	**Retained.** Applicable for use in conjunction with an active corrective action (not as a stand-alone option).
Removal	Excavation	Mechanical Excavation	This technology involves physical removal of impacted media targeted for corrective action. Typical excavation equipment includes backhoes, loaders and/or dozers. Excavated materials are then managed using one or more other technologies (e.g., ex-situ treatment, solidification/on-site disposal, solidification/off-site disposal). Excavated areas are backfilled with clean materials and vegetated/armored for erosion protection.	**Retained.** Applicable to Site conditions and for achieving Site-specific CAOs. Feasibility dependent on excavation quantity.
In-Situ Containment	Physical Barrier	Capping	This technology involves the placement of clean backfill/cover materials (e.g., soils, synthetics such as geotextiles, liners, Reactive Core Mat) over impacted media to serve as a barrier to potential exposures and minimize erosion/migration of impacted materials. Systems could be installed as part of the caps to collect potentially mobilize materials. Placement of fill could occur over existing grades, or following sediment/soil removal such that final grades match existing grades. Backfill/cover materials are vegetated/armored for erosion protection.	**Retained.** Applicable to Site conditions and for achieving Site-specific CAOs. Could be used as a stand-alone technology (i.e., partial backfill), or combined with a removal technology (i.e., partial excavation and restoration).
In-Situ Containment	Physical Barrier	Culvert Installation	Install culvert piping and bedding materials within the creek so that water flows through the culvert rather than the open channel. The prevents erosion/migration of impacted sediments/bank materials and contact between surface water and impacted sediments/bank materials.	Not retained. High potential for damage to culvert due to freeze/thaw and buoyant forces. High potential for localized flooding due to ice accumulation. Property owners and wetland/water permitting agencies unlikely to allow implementation of this alternative.
In-Situ Containment	Physical Barrier	Channel Relocation	Excavate a new channel through an unimpacted area and backfill the existing channel. The new channel could be restored with stone armoring to provide long-term erosion protection. Potentially impacted materials along the existing channel would be contained beneath the fill material used to backfill the channel.	**Retained.** Applicable to Site conditions and for achieving Site-specific CAOs.

Table 1
Technology Screening Summary

Off-Property Focused Corrective Measures Study
Former Koppers Inc. Facility - Superior, Wisconsin

General Response Action	Corrective Action Technology	Process Option	Description	Screening Result
In-Situ Containment	Physical Barrier	Enhanced Sedimentation	A series of structures would be constructed within Crawford Creek to increase the rate of deposition of clean materials within Crawford Creek.	Not retained. Long-term effectiveness and ability to achieve Site-specific CAOs questionable.
In-Situ Containment	Physical Barrier	Impoundment	A dam would be installed at the downstream railroad culvert to create a pond/lake to alter gradients and enhance sedimentation within Crawford Creek. Over time, sedimentation would isolate impacted materials beneath clean materials, assuming the upstream tributary source is controlled.	Not retained. Long-term effectiveness and ability to achieve Site-specific CAOs questionable. Property owners unlikely to allow implementation of this option.
In-Situ Treatment	Bioremediation Immobilization Chemical Thermal	Natural/enhanced biodegradation, stabilization/solidification, chemical extraction, etc.	Various in-situ treatment technologies are frequently considered for the COPCs identified for this Site. These technologies are applied to impacted materials without removing the materials from their present location. This is typically achieved through adding and mixing chemical reagents, adding or enhancing the biodegradation catalysts (e.g., oxygen, nutrients), heating, or other technology-specific applications.	Not retained based on Beazer's experience at numerous other similar sites, climatic considerations, typically high costs, shallow groundwater and surface-water presence, and other Site-specific considerations (e.g., clayey soils). Also, treatment of these materials is not necessary to achieve CAOs for this area.
Ex-Situ Treatment	Bioremediation Immobilization Chemical Thermal	Enhanced biodegradation, stabilization/solidification, chemical extraction, etc.	Various ex-situ treatment technologies, including those listed at left, are frequently considered for the COPCs identified for this Site. These technologies are applied to impacted materials that have been removed from their present location. The materials are then processed to apply the selected technology, which can be achieved either on site or at a permitted off-site treatment facility. Based on Site- and constituent-specific considerations, materials would likely require disposal at an off-Site commercial land disposal facility.	Not retained based on Beazer's experience at numerous other similar sites, climatic considerations, typically high costs, shallow groundwater and surface-water presence, and other Site-specific considerations (e.g., clayey soils). Also, treatment of these materials is not necessary to achieve CAOs for this area.
Disposal	On-Site Disposal	On-Site Consolidation in a CAMU	Excavated materials are solidified and transported to the facility and consolidated in an engineered containment cell within a designated CAMU. The engineered containment cell includes provisions to mitigate the potential for exposure to or migration of consolidated materials.	**Retained.** A CAMU has been proposed to and conceptually approved by the WDNR. Consolidation in a containment cell is applicable for the types of materials to be excavated from the off-property areas, and is a proven and frequently used approach. Feasibility dependent on quantity of materials excavated due to space limitations at the facility.

Table 1
Technology Screening Summary

Off-Property Focused Corrective Measures Study
Former Koppers Inc. Facility - Superior, Wisconsin

General Response Action	Corrective Action Technology	Process Option	Description	Screening Result
Disposal	Off-Site Disposal	Off-Site Commercial Facility	Excavated materials are solidified and transported to an off-Site permitted landfill for disposal. Depending on constituent concentrations and waste classification, land disposal may require treatment (e.g., incineration) prior to disposal to meet RCRA land disposal restrictions.	**Retained.** Off-Site disposal at a commercial facility is applicable to the types of materials to be excavated from the off-property areas, and is a proven and frequently used approach. Feasibility dependent on quantity of materials excavated due to high transportation and disposal costs.

Notes:
1. This screening table focuses on a limited range of response actions and technologies that are considered most applicable for this Site based on Site-specific information and Beazer's experience at other wood-treating sites. The screening was performed based on Site- and technology-specific considerations.
2. Shading indicates that a particular option has not been retained for further evaluation.

Acronyms and Abbreviations:
CAMU = corrective action management unit
CAO = corrective action objective
COPC = constituent of potential concern
GIS = geographic information system
RCRA = Resource Conservation and Recovery Act
WDNR = Wisconsin Department of Natural Resources

Table 2
Summary of Corrective Action Alternative Preliminary Cost Estimates

Off-Property Focused Corrective Measures Study
Former Koppers Inc. Facility - Superior, Wisconsin

Area A - Tributary from Hammond Avenue to Crawford Creek Floodplain
Alternative A1: Channel and Bank Cover
Alternative A2: Channel and Bank Cover, with DNAPL Collection Provisions
Alternative A3: Extended Channel and Bank Excavation/Backfill

Area B - Tributary within Crawford Creek Floodplain
Alternative B1: Partial Channel Excavation/Backfill, 1' Floodplain Cover
Alternative B2: Partial Channel Excavation/Backfill, 1' Floodplain Excavation/Backfill
Alternative B3: Extended Channel and Floodplain Excavation/Backfill

Area C - Crawford Creek from Tributary to Railroad Embankment
Alternative C1: Channel Relocation with Armored Channel
Alternative C2: Channel Relocation with Clay-Lined Channel
Alternative C3: Partial Channel Excavation/Backfill
Alternative C4: Extended Channel and Floodplain Excavation/Backfill

Cost Components	Area A			Area B			Area C			
	Alt. A1	**Alt. A2**	**Alt. A3**	**Alt. B1**	**Alt. B2**	**Alt. B3**	**Alt. C1**	**Alt. C2**	**Alt. C3**	**Alt. C4**
Indirect [2]	$380,000	$340,000	$3,000,000	$155,000	$235,000	$2,255,000	$525,000	$415,000	$320,000	$4,325,000
Construction/Capital [3]	$2,211,108	$1,942,836	$19,826,174	$823,357	$1,358,295	$14,919,781	$2,907,768	$2,133,411	$1,780,784	$28,600,871
O&M [4]	$72,847	$72,847	$72,847	$86,867	$86,867	$86,867	$134,347	$134,347	$134,347	$134,347
Material Disposal [5]										
On-Site CAMU	--	--	$5,989,230	--	$1,472,367	$5,524,308	--	$1,235,490	$1,341,034	$8,837,523
Off-Site T&D	$488,750	$488,750	$59,344,025	$135,764	$5,441,417	$54,462,390	$488,750	$2,668,575	$3,085,461	$93,052,244
Total Costs (On-Site CAMU)	**--**	**--**	**$28,888,000**	**--**	**$3,153,000**	**$22,786,000**	**--**	**$3,918,000**	**$3,576,000**	**$41,898,000**
Total Costs (Off-Site T&D)	**$3,153,000**	**$2,844,000**	**$82,243,000**	**$1,201,000**	**$7,122,000**	**$71,724,000**	**$4,056,000**	**$5,351,000**	**$5,321,000**	**$126,112,000**

Notes:
1. Refer to Tables 1 through 10 in Appendix B for detailed preliminary cost estimates.
2. Indirect costs for all alternatives include pre-design investigation activities, and administration/engineering fees (engineering design, construction oversight, and reporting).
3. Construction/capital costs include a 25% contingency.
4. O&M = Operation and Maintenance (includes inspections, monitoring, and maintenance activities). O&M activities are assumed to occur for 30 years. For alternatives that include an on-Site CAMU (see Note 5), CAMU-related O&M activities are assumed to occur for 30 years and leachate collection/treatment is assumed to occur for 10 years. O&M periods are for CMS evaluation purposes only; actual durations may vary.
5. For alternatives with a relatively small volume of material generated for disposal, transportation to and disposal at a licensed, off-Site facility ("Off-Site T&D") is assumed. For alternatives with a relatively large volume of material generated for disposal, both Off-Site T&D and consolidation at an on-Site Corrective Action Management Unit ("On-Site CAMU") are assumed to be possible material disposal options, and costs are included for both. On-Site CAMU costs include hauling material to CAMU, as well as CAMU construction and long-term O&M. Off-Site T&D costs assume materials are hazardous wastes and transported by rail.

Table 3
Summary of Comparative Evaluation of Corrective Action Alternatives

Off-Property Focused Corrective Measures Study
Former Koppers Inc. Facility - Superior, Wisconsin

Evaluation Criterion	Tributary between Hammond Avenue and the Crawford Creek Foodplain (Area A)		
	A1	A2	A3
	Channel and Bank Capping	Channel and Bank Capping, with NAPL Collection Provisions	Extended Channel and Bank Excavation/Backfill
Long-Term Effectiveness	4	4	4
Short-Term Effectiveness	4	4	1
Implementability	4	4	1
Restoration Time Frame	4	4	1
Economic Feasibility	5	5	1
Compliance with Environmental Laws, Standards and Permits	5	5	5
Sustainability	3	4	1
Total Score	**29**	**30**	**14**

See Notes on Page 4

Table 3
Summary of Comparative Evaluation of Corrective Action Alternatives

Off-Property Focused Corrective Measures Study
Former Koppers Inc. Facility - Superior, Wisconsin

Evaluation Criterion	Tributary within Crawford Creek Floodplain (Area B)		
	B1	B2	B3
	Limited Channel Excavation/Backfill, 1-Foot Floodplain Cover	Limited Channel Excavation/Backfill, 1-Foot Floodplain Excavation/Backfill	Extended Channel and Floodplain Excavation/Backfill
Long-Term Effectiveness	4	4	4
Short-Term Effectiveness	4	3	1
Implementability	3	3	1
Restoration Time Frame	4	4	1
Economic Feasibility	5	4	1
Compliance with Environmental Laws, Standards and Permits	5	5	5
Sustainability	4	3	1
Total Score	**29**	**26**	**14**

See Notes on Page 4

Table 3
Summary of Comparative Evaluation of Corrective Action Alternatives

Off-Property Focused Corrective Measures Study
Former Koppers Inc. Facility - Superior, Wisconsin

Evaluation Criterion	Crawford Creek from Tributary to Railroad Embankment (Area C)			
	C1	C2	C3	C4
	Channel Relocation with Armored Channel	Channel Relocation with Clay-Lined Channel	Limited Channel Excavation	Extended Channel and Floodplain Excavation/Backfill
Long-Term Effectiveness	4	4	3	4
Short-Term Effectiveness	4	4	4	1
Implementability	3	4	4	1
Restoration Time Frame	4	4	4	1
Economic Feasibility	4	4	4	1
Compliance with Environmental Laws, Standards and Permits	5	5	5	5
Sustainability	3	4	4	1
Total Score	**27**	**29**	**28**	**14**

See Notes on Page 4

Table 3
Summary of Comparative Evaluation of Corrective Action Alternatives

Off-Property Focused Corrective Measures Study
Former Koppers Inc. Facility - Superior, Wisconsin

Notes:

1. Each alternative was assigned a score ranging from 1 to 5 for each criterion, with 1 representing the low end of the performance scale and 5 representing the high end. The scores are intended to reflect the relative comparisons among the alternatives considered, as well as the extent to which an alternative satisfies each criterion.
2. Evaluation criteria are described in Section 7.2 of the Off-Property FCMS.

NAPL = non-aqueous phase liquid

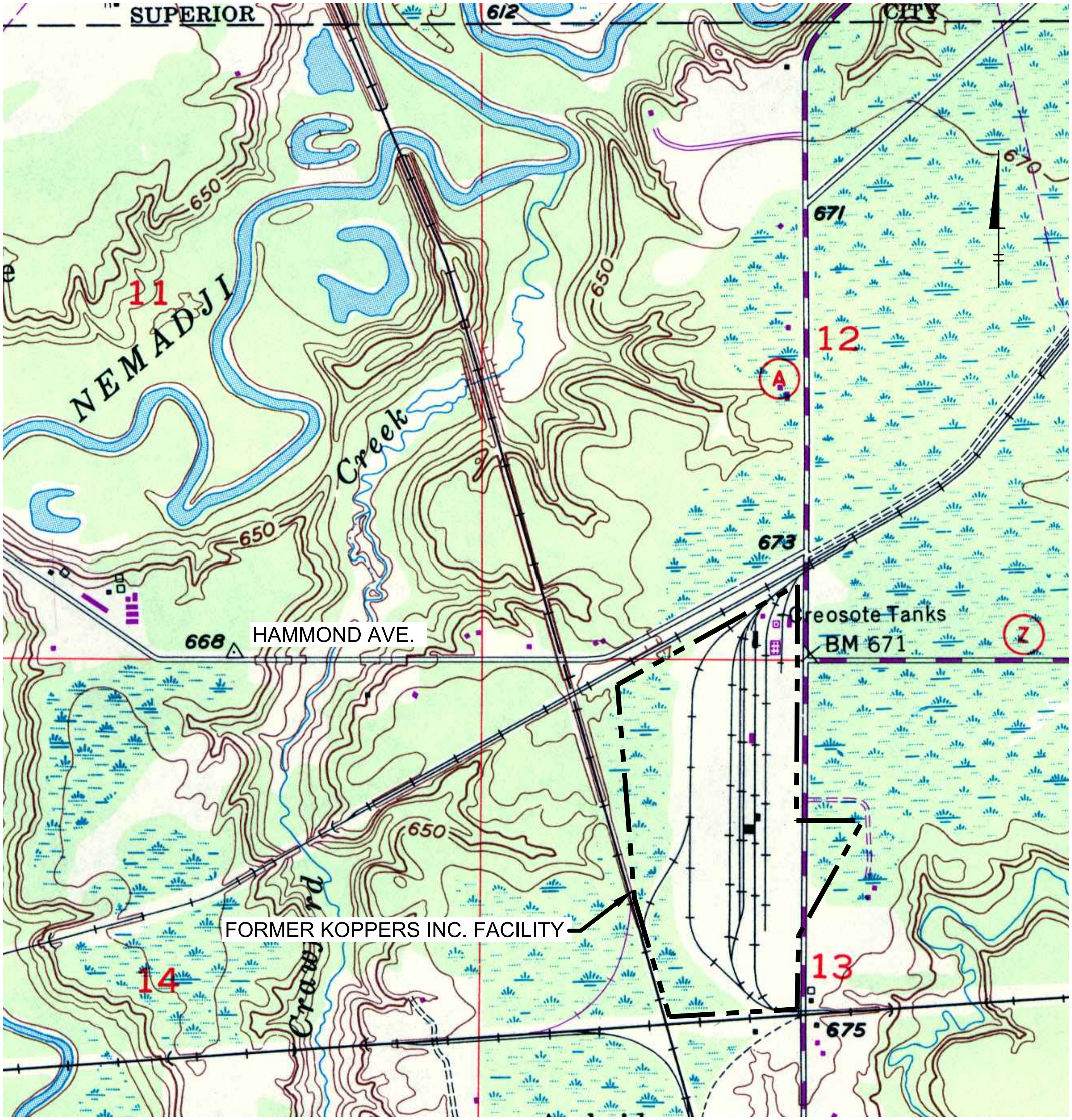
Table 4
Potentially Applicable Environmental Laws, Standards and Permits

Off-Property Focused Corrective Measures Study
Former Koppers Inc. Facility - Superior, Wisconsin

Requirements	Citation	Description
Federal		
Resource Conservation and Recovery Act (RCRA)	42 USC 6901-6992k	
Corrective Action Management Unit (CAMU) [1]	40 CFR 264.552	Establishes the requirements for use of a CAMU to support the implementation of corrective action activities.
State		
Wisconsin State Environmental Protection — General:	NR 100	
Water Quality Standards for Wetlands	NR 103	Establishes water-quality standards for wetlands.
Nonmetallic Mining Reclamation	NR 135	Establishes applicable standards, procedures and requirements for nonmetallic mining permit applications (potentially applicable in the event a local borrow source is established).
Wisconsin State Environmental Protection — Hazardous Waste Management:	NR 660	Provides definitions, general permit application information, incorporation by reference citations and general information concerning the hazardous waste management program.
Identification and Listing of Hazardous Waste	NR 661	Establishes criteria for identifying the characteristics of hazardous waste to determine if the waste is subject to regulation.
CAMU [1]	NR 664 Subpart S	Establishes the requirements for use of a CAMU to support the implementation of corrective action activities.
Wisconsin State Environmental Protection — Investigation and Remediation of Environmental Contamination	NR 700	Establishes standards and procedures that allow for site-specific flexibility, pertaining to the identification, investigation and remediation of sites and facilities that are subject to regulation under s. 144.442, 144.76, or 144.77 Stats.
Permits		
Wisconsin Pollutant Discharge Elimination System — General Storm Water Permit	NR 216	Defines the conditions under which storm water associated with specific (industrial, municipal or construction) activities can be discharged.
Industrial Storm Water Discharge Permit	NR 216.20-32	
Construction Site Storm Water Discharge Permit	NR 216.41-55	
Clean Water Act Permit (United States Army Corps of Engineers [USACE])	Section 404	Grants USACE approval to discharge dredged or fill material into wetlands and other waters of the United States at specified disposal sites (33 U.S.C. Ch. 1344).
Wisconsin Department of Natural Resources (WDNR) — Water Quality Certification Permit	NR 103, 299 (WDNR) Section 401 (CWA)	Establishes procedures and criteria for the application, processing and review of state water-quality certifications (for surface waters and wetlands) required by the provisions of the federal water pollution control act, 33 U.S.C. ss. 1251 et seq.
Douglas County Nonmetallic Mining Permit	NR 135 Douglas County Ordinances, Chapter VII	Required for use of any mining area greater than 1 acre, covering the removal of stone, sand, gravel, clay and topsoil. Potentially applicable if a local borrow source for fill material.
Hazardous Waste Facility Operation License/ Closure and Long-Term Care Plan Approval	N/A	WDNR "permit" covering closure and long-term care of the closed RCRA surface impoundments, and also Site-wide corrective action activities.

1. As acknowledged by WDNR in a letter to Beazer dated November 1, 2000, the use of a CAMU at the Site is "grandfathered" under the 1993 CAMU regulations.

Figures

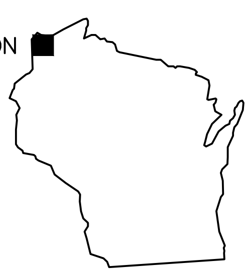


BASE MAP SOURCE: USGS 7.5 MIN TOPO QUAD., SUPERIOR, WIS–MINN., 1954 (PHOTO REVISED 1993)

0 1000' 2000'
APPROXIMATE GRAPHIC SCALE

LEGEND:

APPROXIMATE PROPERTY BOUNDARY



BEAZER EAST, INC.
FORMER KOPPERS INC. FACILITY
SUPERIOR, WISCONSIN

OFF-PROPERTY
FOCUSED CORRECTIVE MEASURES STUDY

SITE LOCATION MAP

ARCADIS

FIGURE
1

CITY: SYRACUSE DIV/GROUP: ENVCAD DB: L. FORAKER LD: PIC: J. HOLDEN PM: D. BESSINGPAS TM: D. BESSINPAS LYR: ON=*; OFF=*REF*
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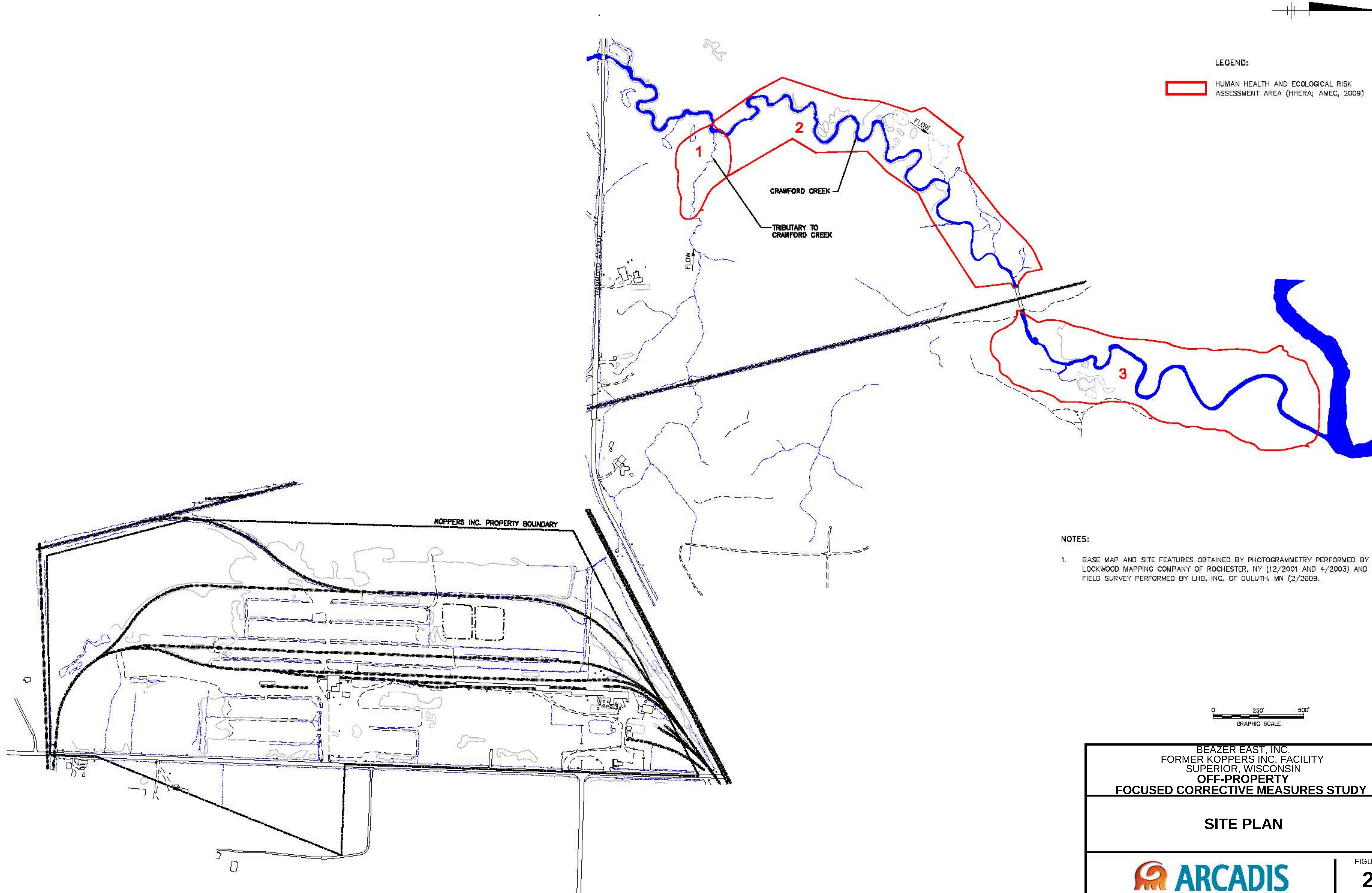
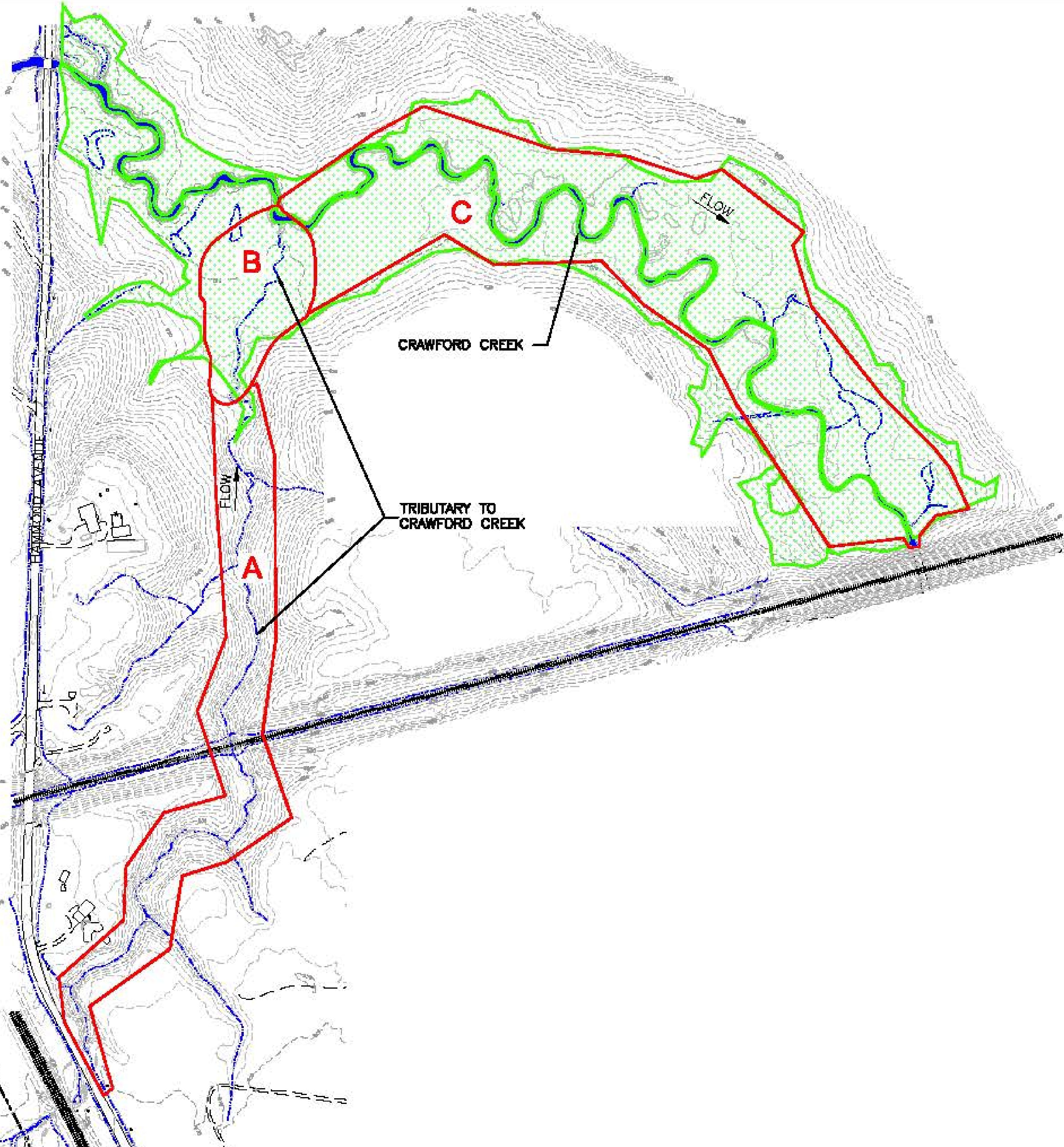


BEAZER EAST, INC.
FORMER KOPPERS INC. FACILITY
SUPERIOR, WISCONSIN
OFF-PROPERTY
FOCUSED CORRECTIVE MEASURES STUDY

SITE PLAN

ARCADIS

FIGURE
2



LEGEND:

- CORRECTIVE ACTION AREA (SEE NOTE 2)
- IDENTIFIED WETLAND BOUNDARY (SEE NOTE 3)

NOTES:

1. BASE MAP AND TOPOGRAPHY OBTAINED FROM FIELD SURVEY PERFORMED BY LSH. INC. OF DULUTH, MN (2/9/09).
2. THE AREAS DEPICTED ON THIS FIGURE ARE INTENDED TO REPRESENT THE GENERAL CORRECTIVE ACTION AREAS FOR WHICH POTENTIAL CORRECTIVE ACTION ALTERNATIVES ARE EVALUATED IN THE OFF-PROPERTY FCMS, AND DO NOT NECESSARILY REPRESENT THE LIMITS OF THE POTENTIAL CORRECTIVE ACTIONS, WHICH ARE MORE ACCURATELY SHOWN ON FIGURES 4-13. AREA A INCLUDES THE TRIBUTARY TO CRAWFORD CREEK CHANNEL AND ADJACENT BANK MATERIALS BETWEEN HAMMOND AVENUE AND THE CRAWFORD CREEK FLOODPLAIN (THIS AREA WAS NOT EVALUATED IN THE HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENT (HHERA; AMEC, 2009). AREA B INCLUDES THE TRIBUTARY TO CRAWFORD CREEK CHANNEL AND ADJACENT BANK/FLOODPLAIN MATERIALS LOCATED WITHIN THE CRAWFORD CREEK FLOODPLAIN (CORRESPONDS TO AREA 1 FROM THE HHERA). AREA C INCLUDES THE CRAWFORD CREEK CHANNEL FROM THE CONFLUENCE WITH THE TRIBUTARY TO CRAWFORD CREEK DOWNSTREAM TO THE RAILROAD EMBANKMENT (CORRESPONDS TO HHERA AREA 2).
3. IDENTIFIED WETLAND BOUNDARIES BASED ON GPS COORDINATES RECORDED DURING A DELINEATION BY ARCADIS IN OCTOBER 2008 AND SURVEY PERFORMED BY LHB IN OCTOBER/NOVEMBER 2008.

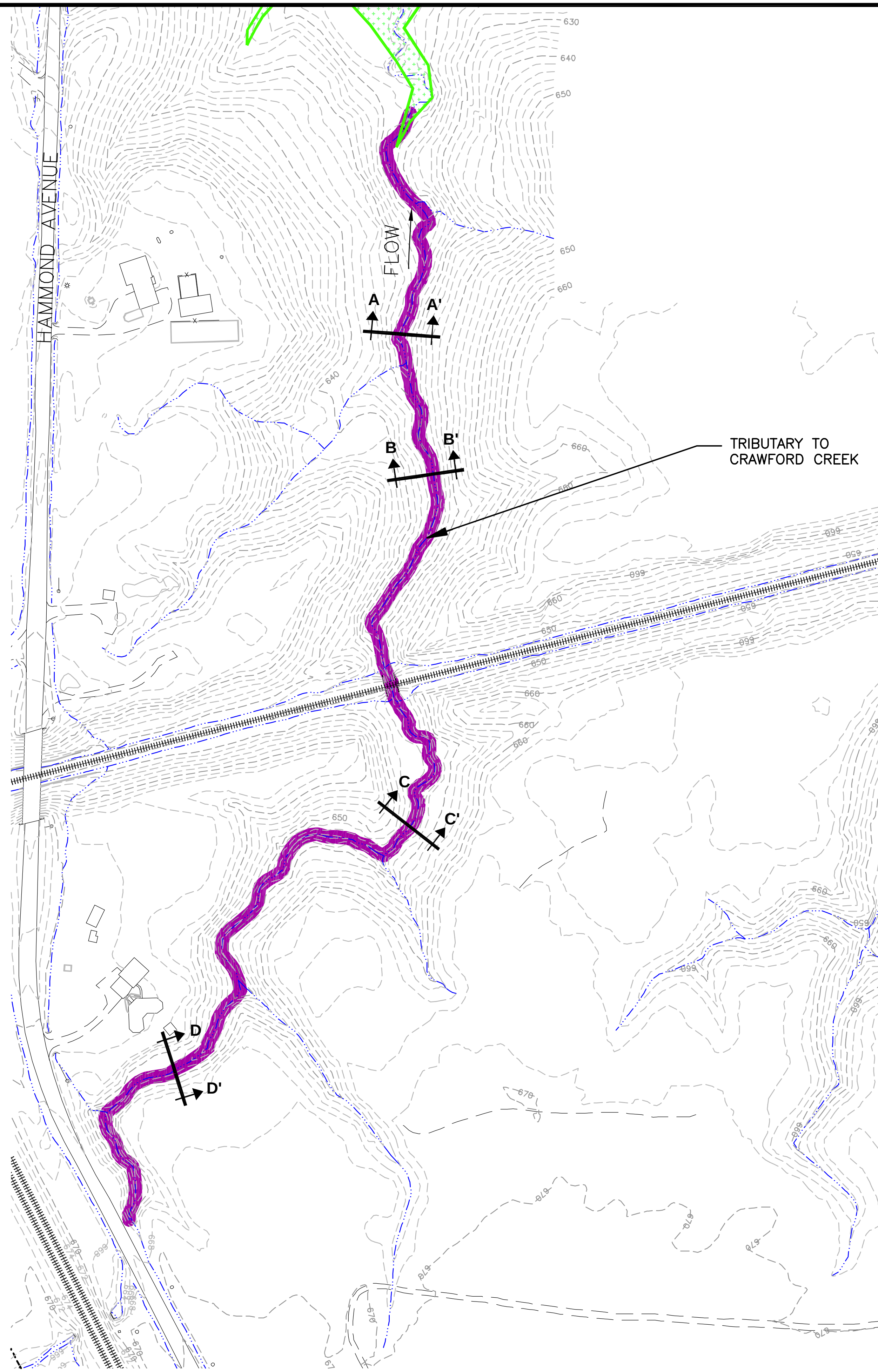
0 150' 300'
GRAPHIC SCALE

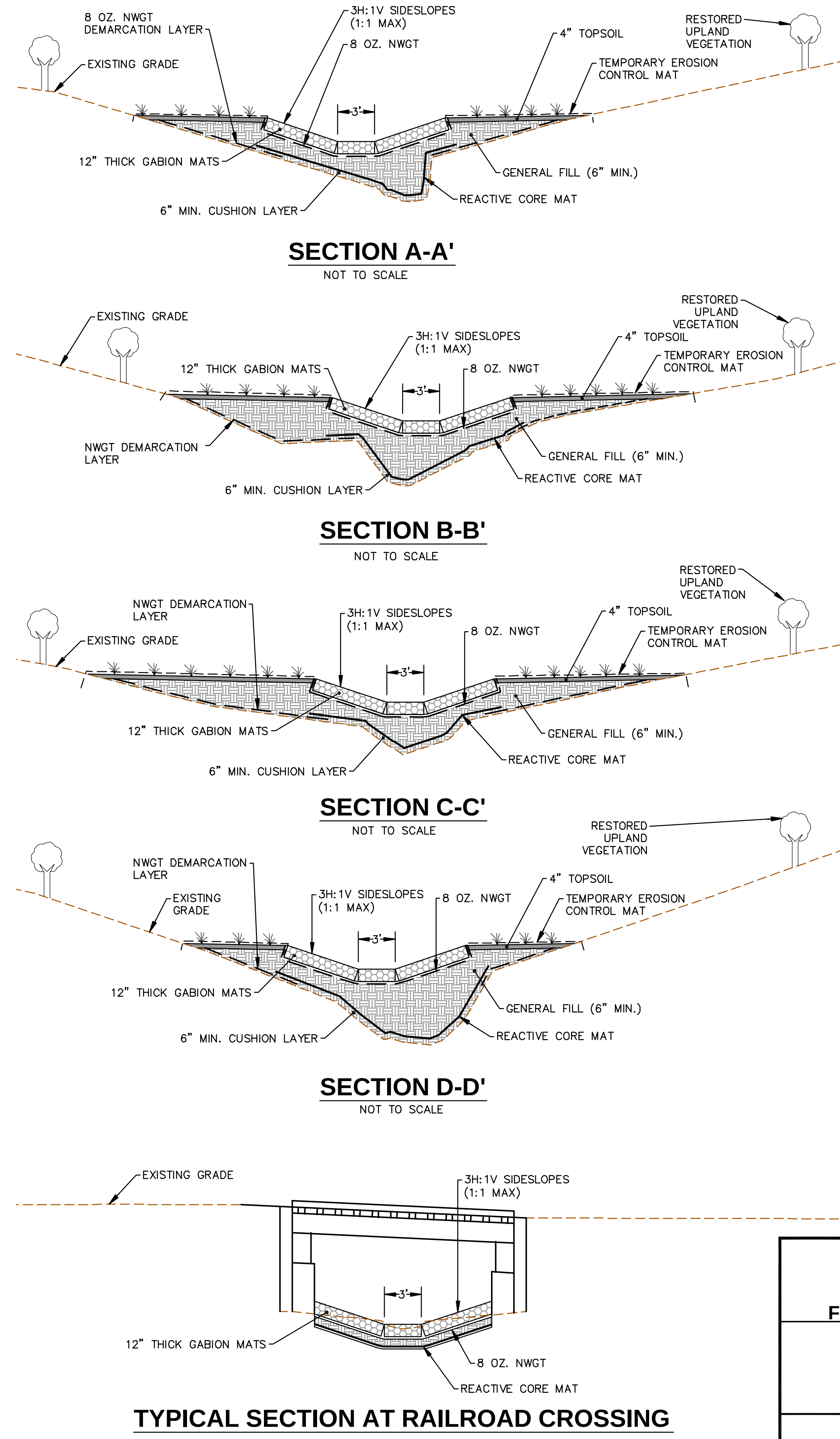
BEAZER EAST, INC.
FORMER KOPPERS INC. FACILITY
SUPERIOR, WISCONSIN
OFF-PROPERTY
FOCUSED CORRECTIVE MEASURES STUDY

CORRECTIVE ACTION AREAS

ARCADIS

FIGURE
3





LEGEND:

- EXTENT OF CORRECTIVE ACTION
- IDENTIFIED WETLAND BOUNDARY (SEE NOTE 2)

NOTES:

1. BASE MAP AND TOPOGRAPHY OBTAINED FROM FIELD SURVEY PERFORMED BY LBH. INC. OF DULUTH, MN (2/9/09).
2. IDENTIFIED WETLAND BOUNDARIES BASED ON GPS COORDINATES RECORDED DURING A DELINEATION BY ARCADIS IN OCTOBER 2008 AND SURVEY PERFORMED BY LHB IN OCTOBER/NOVEMBER 2008.
3. NWGT – NON-WOVEN GEOTEXTILE.

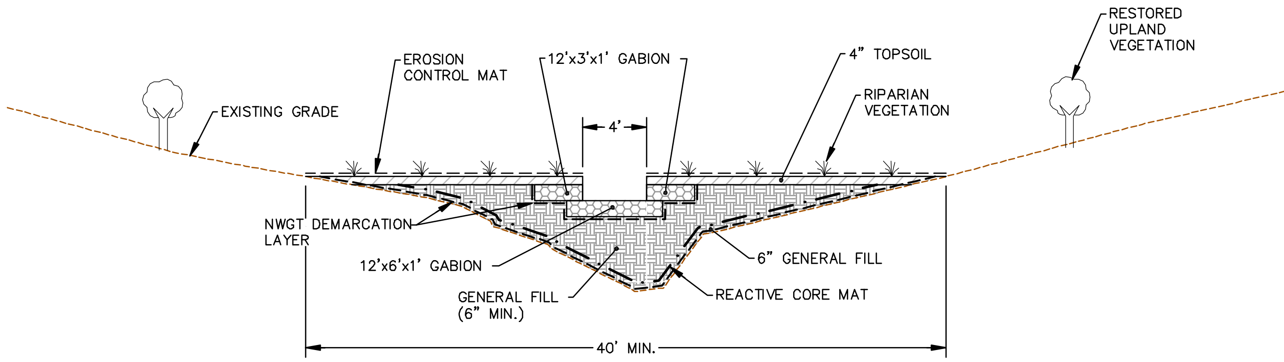
0 100' 200'
GRAPHIC SCALE

BEAZER EAST, INC.
FORMER KOPPERS INC. FACILITY
SUPERIOR, WISCONSIN
OFF-PROPERTY
FOCUSED CORRECTIVE MEASURES STUDY

ALTERNATIVE A1 - CHANNEL & BANK COVER

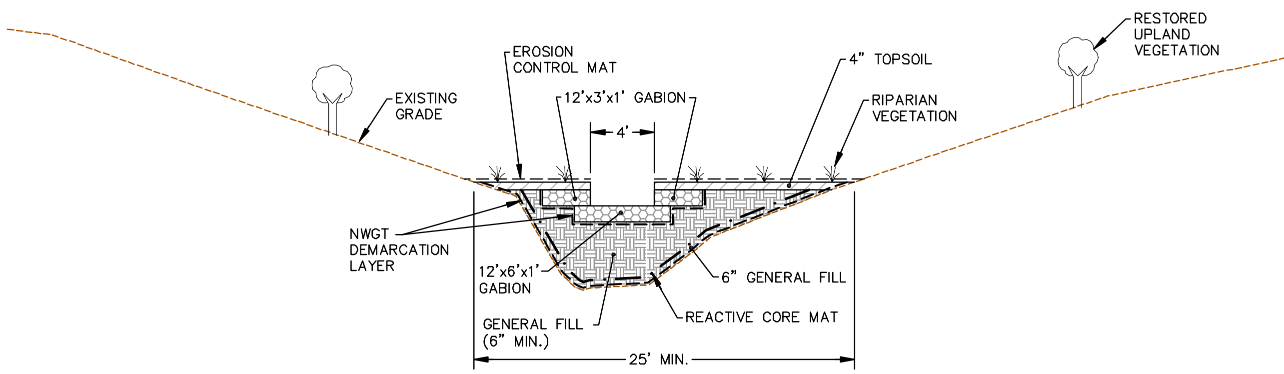
ARCADIS

FIGURE
4



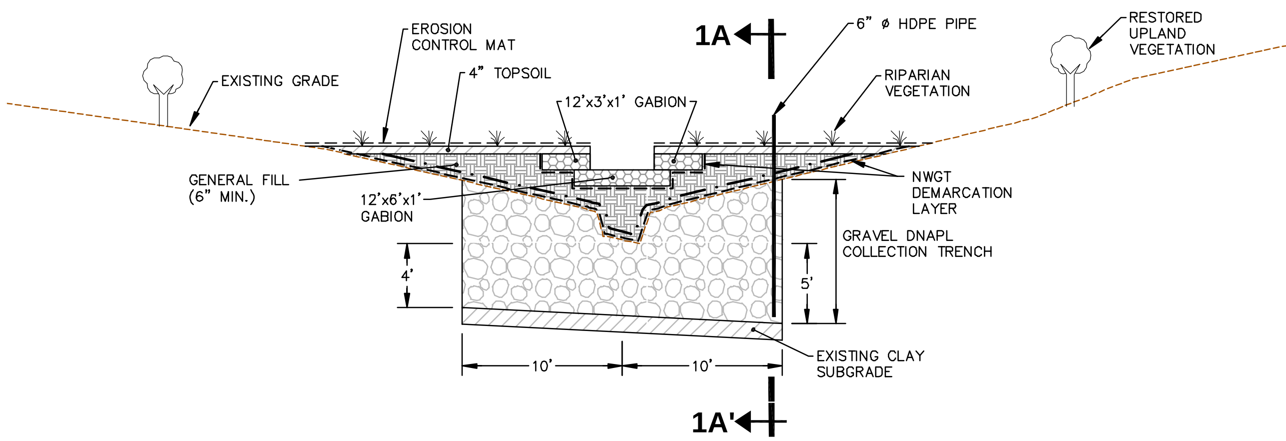
SECTION A-A'

NOT TO SCALE



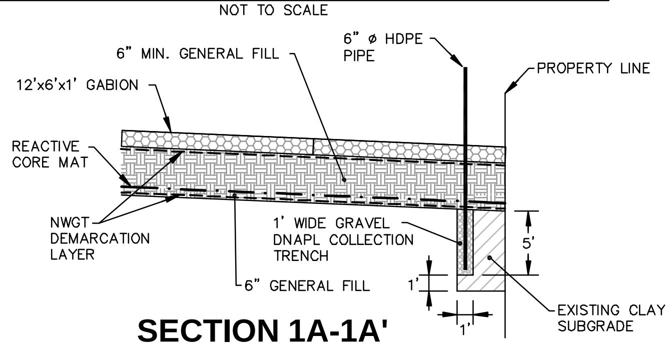
SECTION B-B'

NOT TO SCALE



DETAIL 1 - DNAPL COLLECTION TRENCH

NOT TO SCALE



SECTION 1A-1A'

NOT TO SCALE

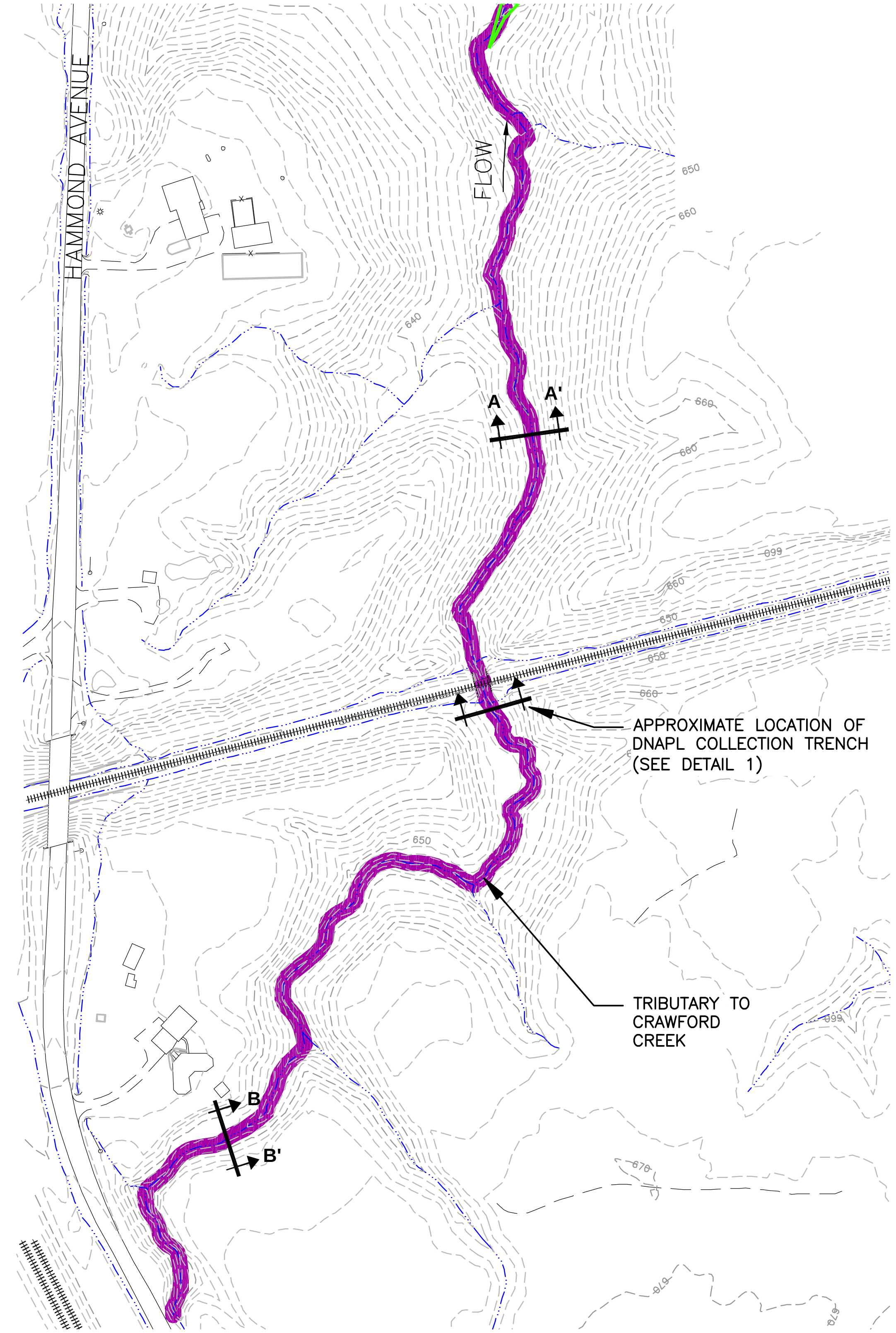
LEGEND:

EXTENT OF CORRECTIVE ACTION

IDENTIFIED WETLAND BOUNDARY (SEE NOTE 2)

NOTES:

1. BASE MAP AND TOPOGRAPHY OBTAINED FROM FIELD SURVEY PERFORMED BY LBH. INC. OF DULUTH, MN (2/9/09).
2. IDENTIFIED WETLAND BOUNDARIES BASED ON GPS COORDINATES RECORDED DURING A DELINEATION BY ARCADIS IN OCTOBER 2008 AND SURVEY PERFORMED BY LHB IN OCTOBER/NOVEMBER 2008.
3. VELOCITY CONTROL STRUCTURES SUCH AS WEDGE DAMS OR ROCK WEIRS WILL BE INSTALLED WITHIN THE RESTORED TRIBUTARY AT LOCATIONS OF EXISTING CHANNEL DROPS OR AS NECESSARY TO CONTROL VELOCITY.
4. NWGT – NON-WOVEN GEOTEXTILE



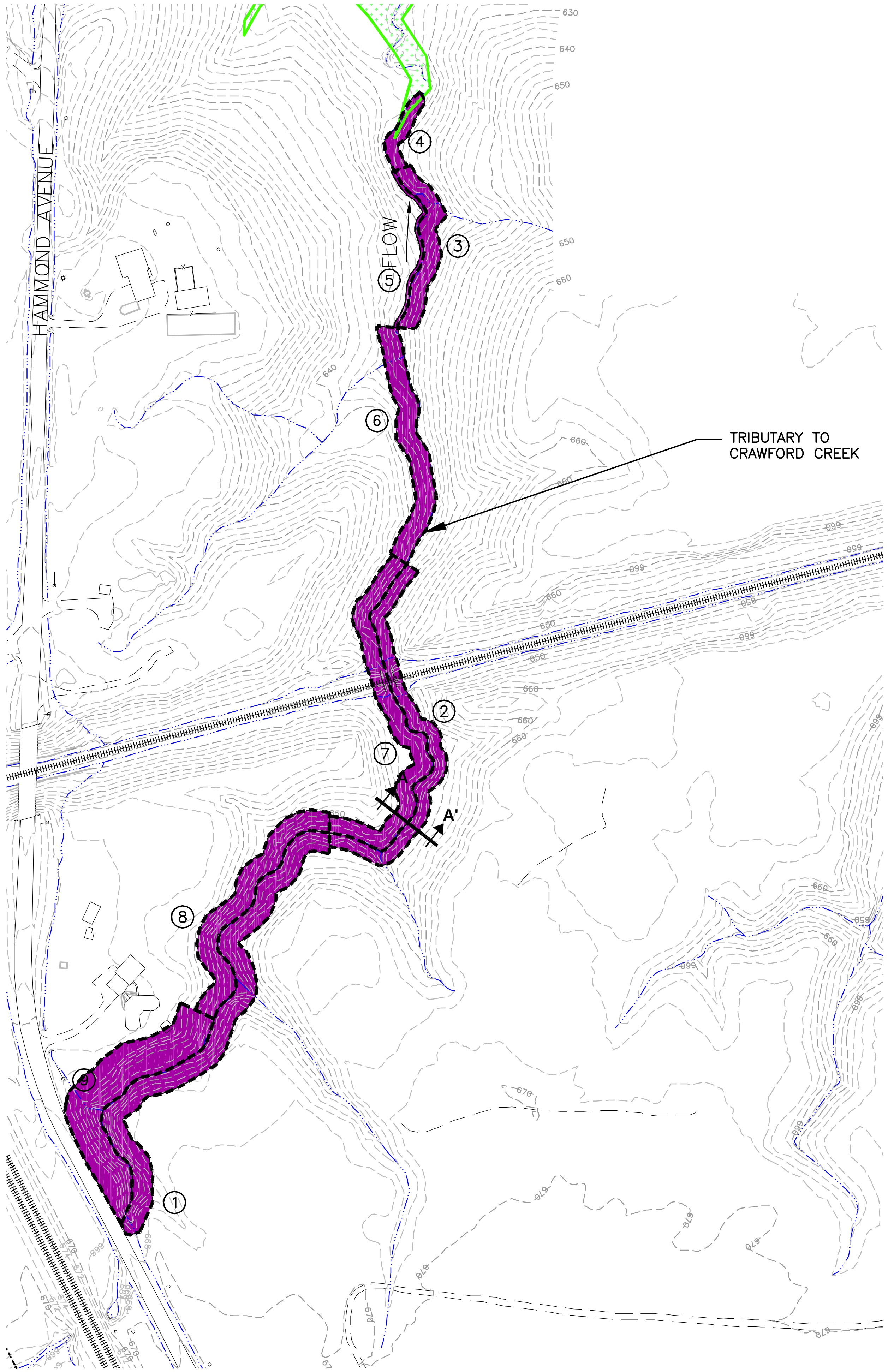
0 100' 200'
GRAPHIC SCALE

BEAZER EAST, INC.
FORMER KOPPERS INC. FACILITY
SUPERIOR, WISCONSIN
OFF-PROPERTY
FOCUSED CORRECTIVE MEASURES STUDY

ALTERNATIVE A2 - CHANNEL AND BANK COVER, WITH DNAPL COLLECTION PROVISIONS

ARCADIS

FIGURE
5

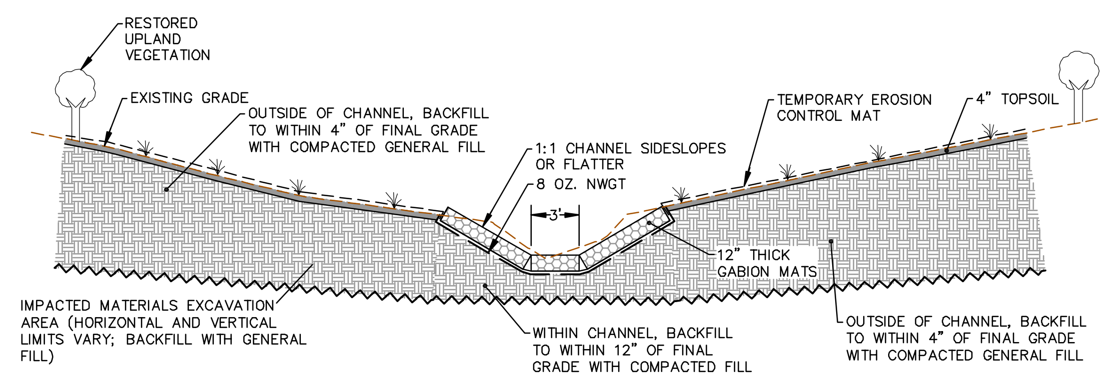


LEGEND:

EXTENT OF CORRECTIVE ACTION

IDENTIFIED WETLAND BOUNDARY (SEE NOTE 2)

SOIL REMOVAL VOLUME (SEE NOTE 4)			
#	REMOVAL AREA (SF)	REMOVAL DEPTH (FT)	REMOVAL VOLUME (CY)
1	23,671	14	12,274
2	12,059	24	10,719
3	6,747	10	2,499
4	2,471	5	458
5	1,306	7	339
6	10,923	24	9,709
7	14,479	13	6,971
8	12,212	14	6,332
9	20,537	15	11,409
TOTAL REMOVAL VOLUME =			60,710



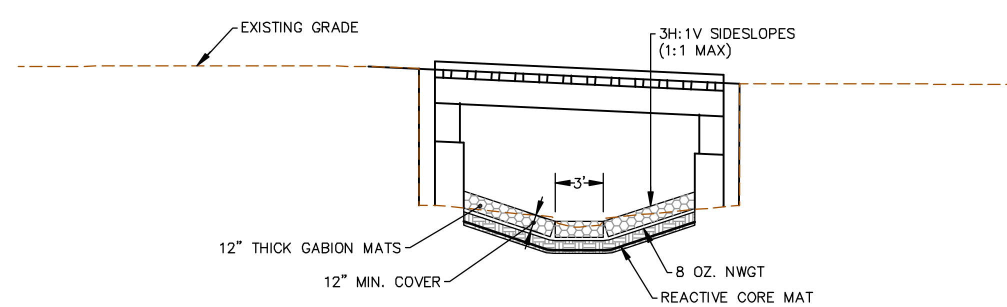
SECTION A-A'

NOT TO SCALE

NOTES:

1. BASE MAP AND TOPOGRAPHY OBTAINED FROM FIELD SURVEY PERFORMED BY LBH. INC. OF DULUTH, MN (2/9/09).
2. IDENTIFIED WETLAND BOUNDARIES BASED ON GPS COORDINATES RECORDED DURING A DELINEATION BY ARCADIS IN OCTOBER 2008 AND SURVEY PERFORMED BY LHB IN OCTOBER/NOVEMBER 2008.
3. NWGT – NON-WOVEN GEOTEXTILE.
4. REMOVAL LIMITS AND DEPTHS BASED ON EXTENT OF IMPACTS OBSERVED IN 2005 TEST PITS AND SOIL BORINGS LOCATED WITHIN THE SUBJECT AREA.

0 100' 200'
GRAPHIC SCALE



TYPICAL SECTION AT RAILROAD CROSSING

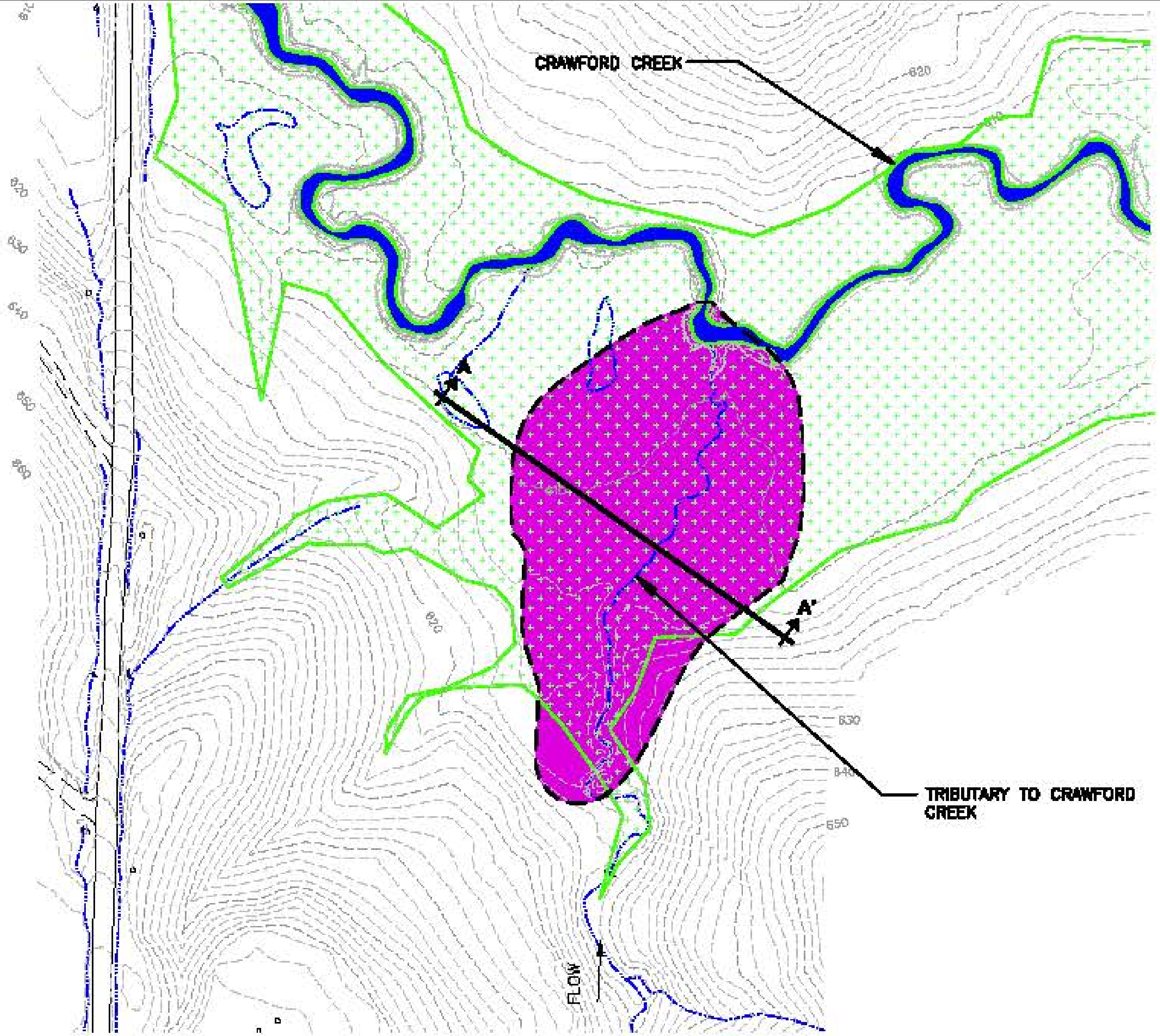
NOT TO SCALE

BEAZER EAST, INC.
FORMER KOPPERS INC. FACILITY
SUPERIOR, WISCONSIN
OFF-PROPERTY
FOCUSED CORRECTIVE MEASURES STUDY

ALTERNATIVE A3 - EXTENDED CHANNEL AND BANK EXCAVATION/BACKFILL

ARCADIS

FIGURE
6

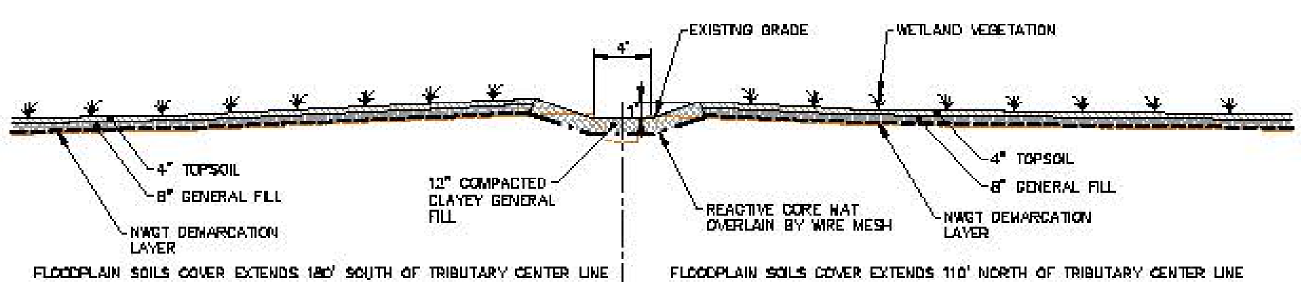


LEGEND:

- EXTENT OF CORRECTIVE ACTION
- IDENTIFIED WETLAND BOUNDARY (SEE NOTE 2)

NOTES:

1. BASE MAP AND TOPOGRAPHY OBTAINED FROM FIELD SURVEY PERFORMED BY LSH. INC. OF DULUTH, MN (2/9/09).
2. IDENTIFIED WETLAND BOUNDARIES BASED ON GPS COORDINATES RECORDED DURING A DELINEATION BY ARCADIS IN OCTOBER 2008 AND SURVEY PERFORMED BY LHB IN OCTOBER/NOVEMBER 2008.
3. CHANNEL EXCAVATION IS AS REQUIRED TO RESTORE TO DEPICTED CHANNEL GEOMETRY.
4. NWGT – NON-WOVEN GEOTEXTILE



SECTION A-A'

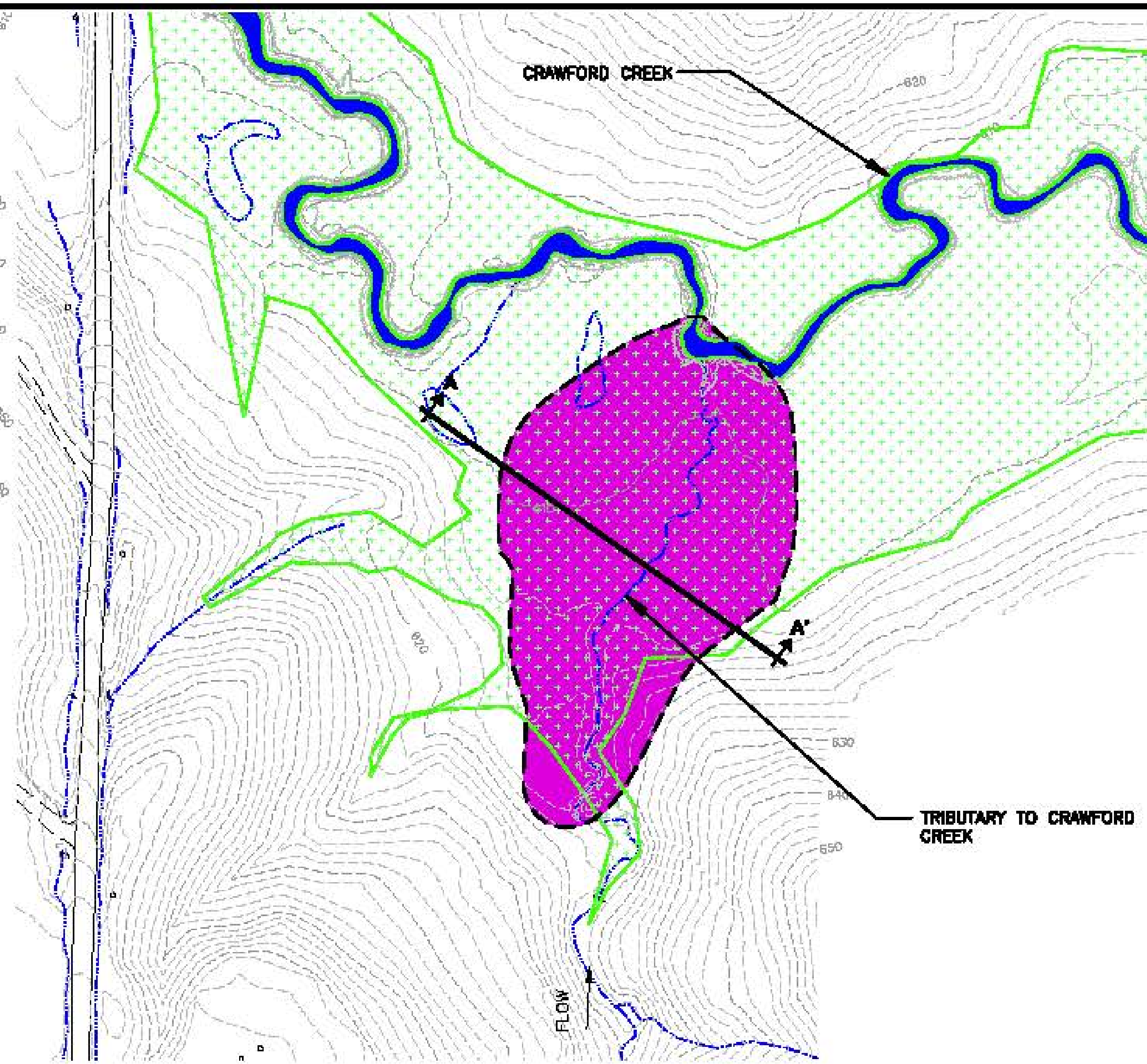
NOT TO SCALE

BEAZER EAST, INC.
FORMER KOPPERS INC. FACILITY
SUPERIOR, WISCONSIN
OFF-PROPERTY
FOCUSED CORRECTIVE MEASURES STUDY

ALTERNATIVE B-1 - PARTIAL CHANNEL EXCAVATION/BACKFILL, 1' FLOODPLAIN COVER

ARCADIS

FIGURE **7**

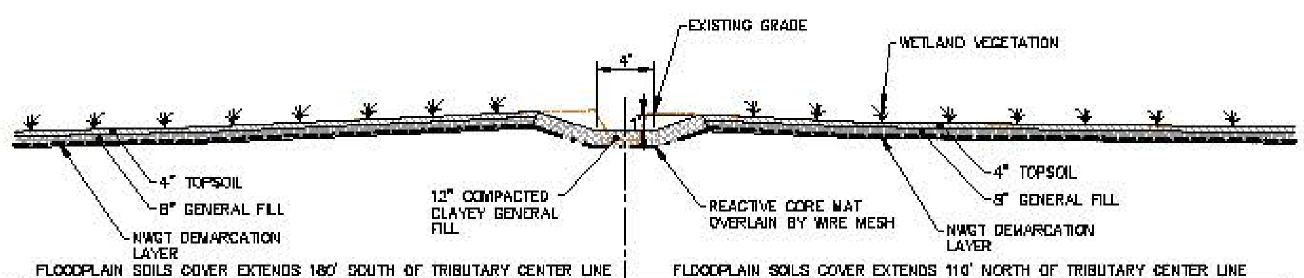


LEGEND:

- EXTENT OF CORRECTIVE ACTION
- IDENTIFIED WETLAND BOUNDARY (SEE NOTE 2)

NOTES:

1. BASE MAP AND TOPOGRAPHY OBTAINED FROM FIELD SURVEY PERFORMED BY LSH, INC. OF DULUTH, MN (2/8/08).
2. IDENTIFIED WETLAND BOUNDARIES BASED ON GPS COORDINATES RECORDED DURING A DELINEATION BY ARCADIS IN OCTOBER 2008 AND SURVEY PERFORMED BY LHB IN OCTOBER/NOVEMBER 2008.
3. CHANNEL EXCAVATION IS AS REQUIRED TO RESTORE TO DEPICTED CHANNEL GEOMETRY.
4. NWGT – NON-WOVEN GEOTEXTILE



SECTION A-A'

NOT TO SCALE

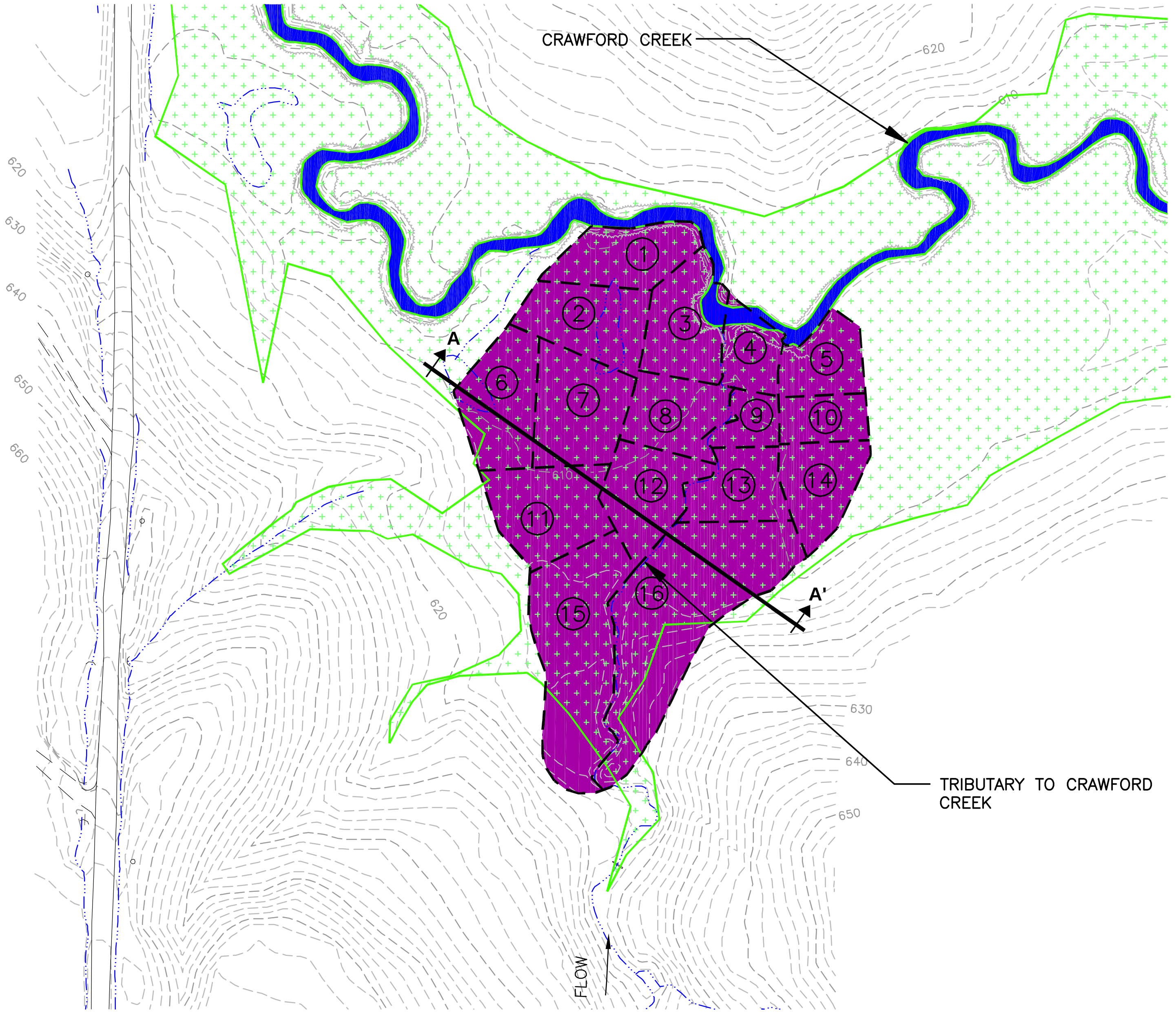
GRAPHIC SCALE

BEAZER EAST, INC.
FORMER KOPPERS INC. FACILITY
SUPERIOR, WISCONSIN
OFF-PROPERTY
FOCUSED CORRECTIVE MEASURES STUDY

ALTERNATIVE B-2 - PARTIAL CHANNEL EXCAVATION/BACKFILL, 1' FLOODPLAIN EXCAVATION/BACKFILL

ARCADIS

FIGURE
8



LEGEND:

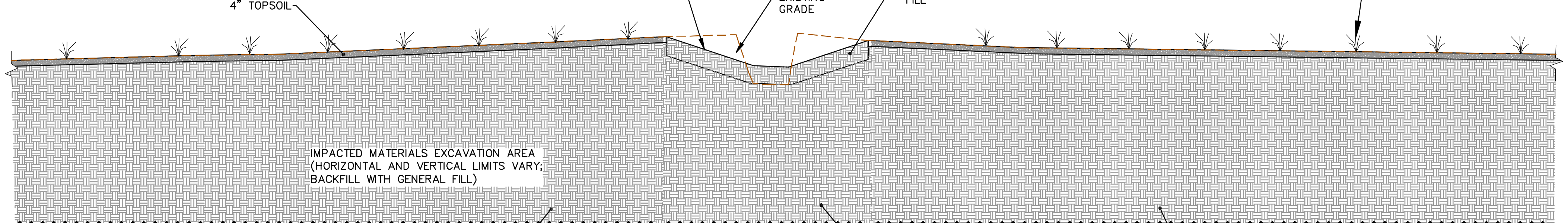
- EXTENT OF CORRECTIVE ACTION
- IDENTIFIED WETLAND BOUNDARY (SEE NOTE 2)

SOIL REMOVAL VOLUME (SEE NOTE 4)			
#	REMOVAL AREA (SF)	REMOVAL DEPTH (FT)	REMOVAL VOLUME (CY)
1	7,877	14	4,084
2	9,095	15	5,053
3	8,877	10	3,288
4	4,720	3	524
5	5,801	5.2	1,117
6	9,326	11	3,799
7	10,304	8	3,053
8	7,348	5	1,361
9	3,258	11	1,327
10	4,324	9	1,441
11	10,183	11	4,149
12	8,169	11	3,328
13	6,642	8	1,963
14	7,196	9	2,399
15	18,612	14	9,651
16	24,783	10	9,179
TOTAL REMOVAL VOLUME =			55,716

NOTES:

1. BASE MAP AND TOPOGRAPHY OBTAINED FROM FIELD SURVEY PERFORMED BY LBH. INC. OF DULUTH, MN (2/9/09).
2. IDENTIFIED WETLAND BOUNDARIES BASED ON GPS COORDINATES RECORDED DURING A DELINEATION BY ARCADIS IN OCTOBER 2008 AND SURVEY PERFORMED BY LHB IN OCTOBER/NOVEMBER 2008.
3. NWGT – NON-WOVEN GEOTEXTILE.
4. REMOVAL LIMITS AND DEPTHS BASED ON EXTENT OF IMPACTS OBERVED IN 2003 TEST PITS LOCATED WITHIN THE SUBJECT AREA.

0 80' 160'
GRAPHIC SCALE



SECTION A-A'

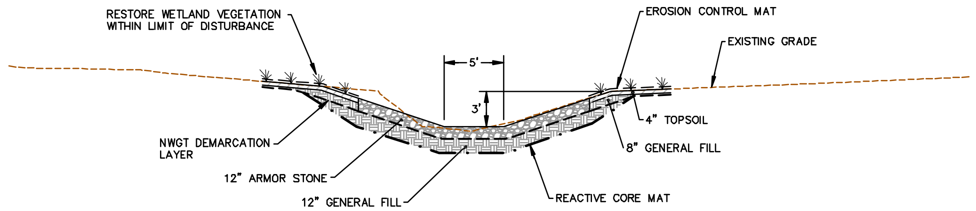
NOT TO SCALE

BEAZER EAST, INC.
FORMER KOPPERS INC. FACILITY
SUPERIOR, WISCONSIN
OFF-PROPERTY
FOCUSED CORRECTIVE MEASURES STUDY

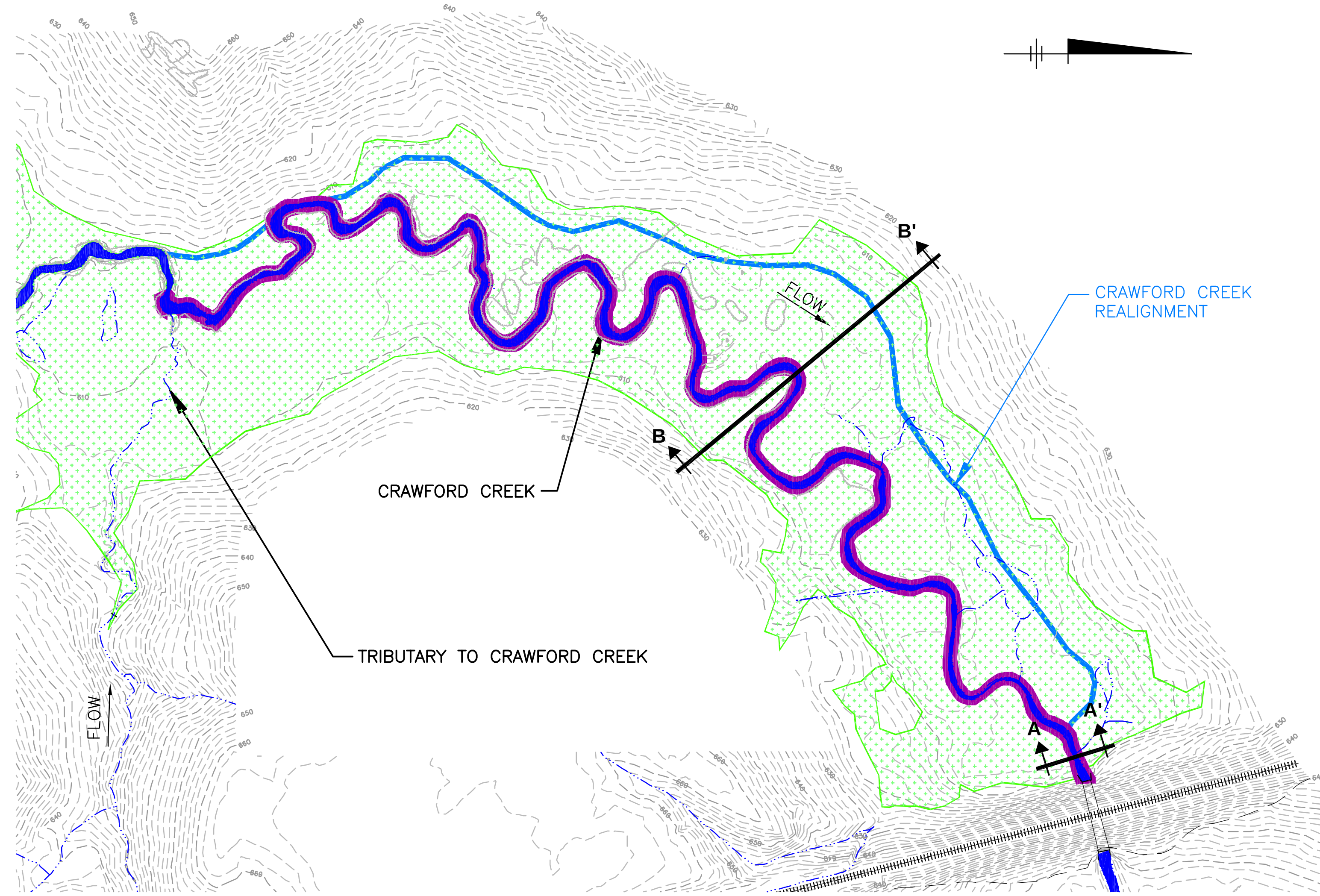
ALTERNATIVE B3 - EXTENDED CHANNEL AND FLOODPLAIN EXCAVATION/BACKFILL

ARCADIS

FIGURE
9



SECTION A-A'
NOT TO SCALE



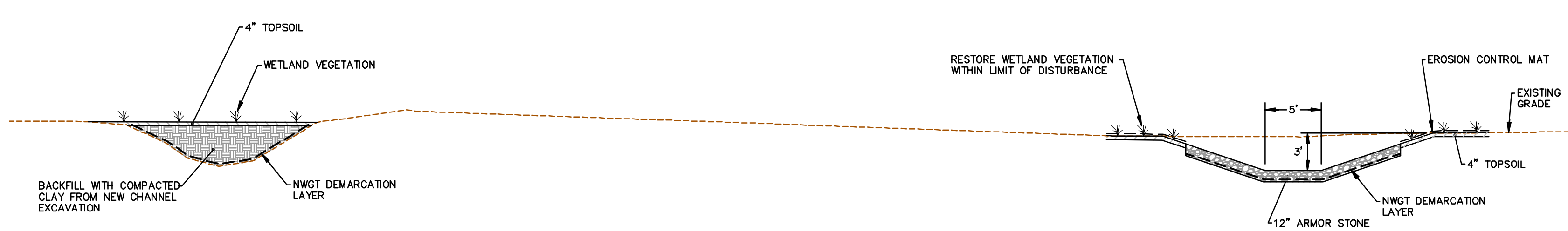
LEGEND:

- EXTENT OF CORRECTIVE ACTION
- IDENTIFIED WETLAND BOUNDARY (SEE NOTE 2)

NOTES:

1. BASE MAP AND TOPOGRAPHY OBTAINED FROM FIELD SURVEY PERFORMED BY LBH. INC. OF DULUTH, MN (2/9/09).
2. IDENTIFIED WETLAND BOUNDARIES BASED ON GPS COORDINATES RECORDED DURING A DELINEATION BY ARCADIS IN OCTOBER 2008 AND SURVEY PERFORMED BY LHB IN OCTOBER/NOVEMBER 2008.
3. NWGT – NON-WOVEN GEOTEXTILE.
4. AT A MINIMUM, REACTIVE CORE MAT (RCM) WILL BE INSTALLED IN THE PORTION OF THE NEW CHANNEL WHERE IT CONNECTS TO THE EXISTING CRAWFORD CREEK CHANNEL.

0 150' 300'
GRAPHIC SCALE



SECTION B-B'
NOT TO SCALE

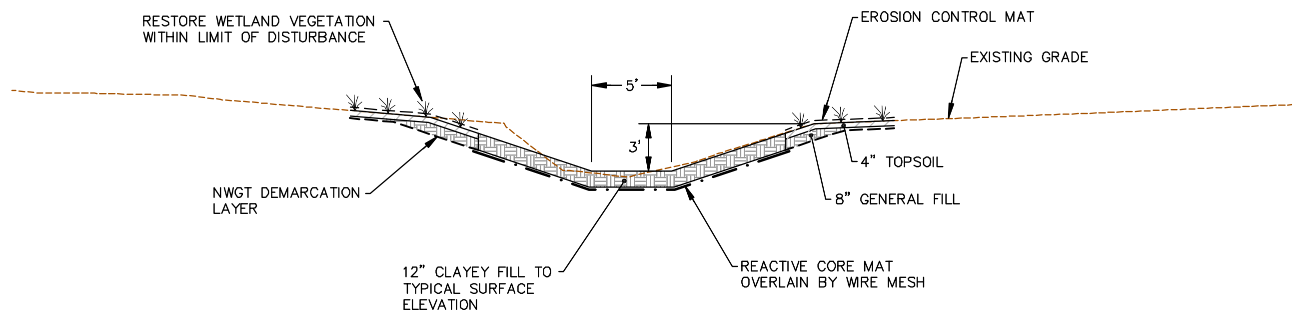
BEAZER EAST, INC.
FORMER KOPPERS INC. FACILITY
SUPERIOR, WISCONSIN
OFF-PROPERTY
FOCUSED CORRECTIVE MEASURES STUDY

ALTERNATIVE C1 - CHANNEL RELOCATION WITH ARMORED CHANNEL

ARCADIS

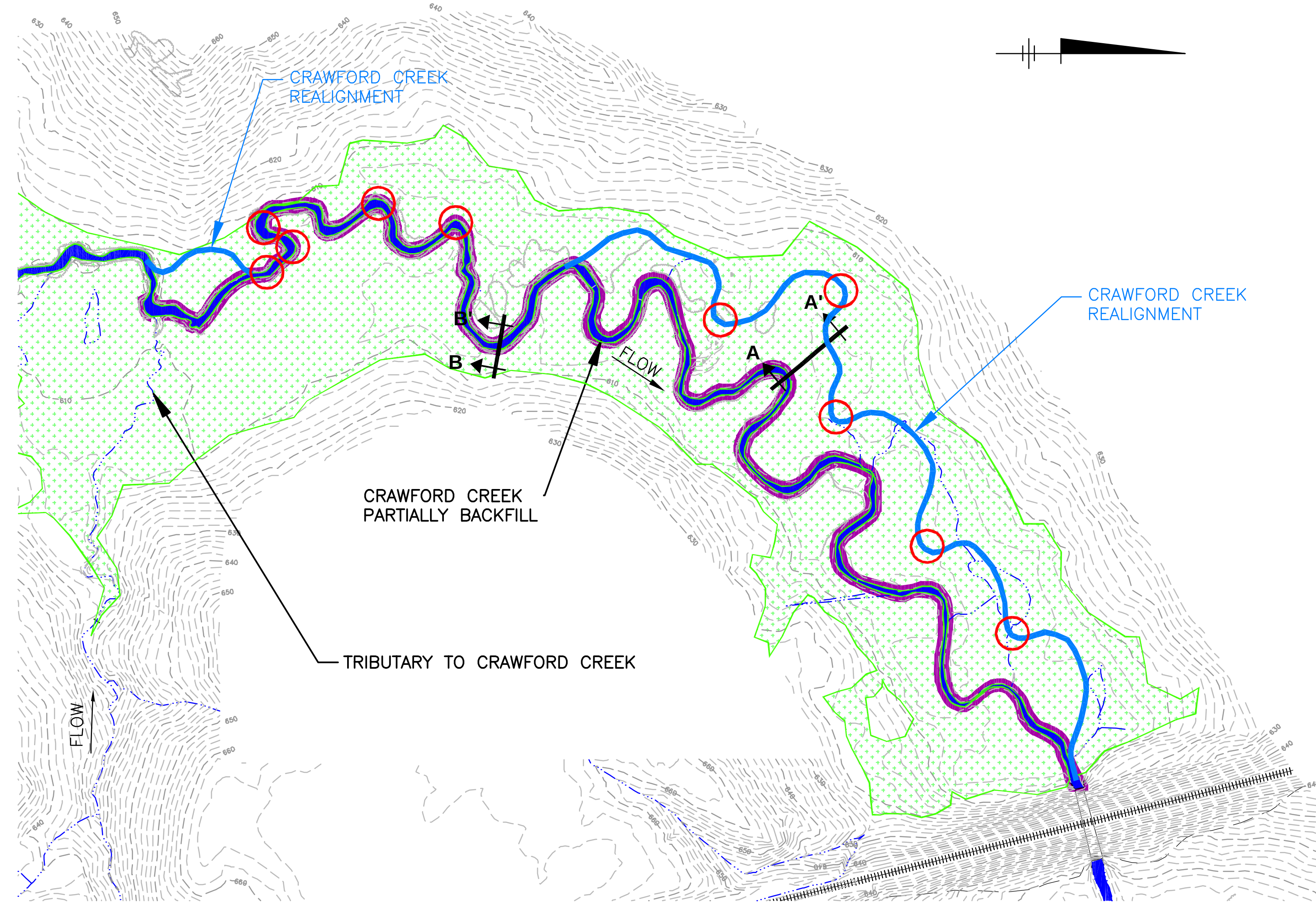
FIGURE
10

CITY: SYRACUSE-NY DIV/GROUP: ENV/141 DB: LJP GMS LAF KLS KEW PM: T. CANSLER LYR: ON=*;OFF=REF*
G:\ENVCAD\BRIGHTON\ACT\B0039307\0000\00001\dwg\39307V05.DWG LAYOUT: 10 SAVED: 8/21/2014 4:36 PM ACADVER: 18.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 8/21/2014 4:36 PM BY: FOX, AARON
XREFS: 39307X01 39307X00 39307X02 IMAGES: PROJECTNAME: ----



SECTION B-B'

NOT TO SCALE



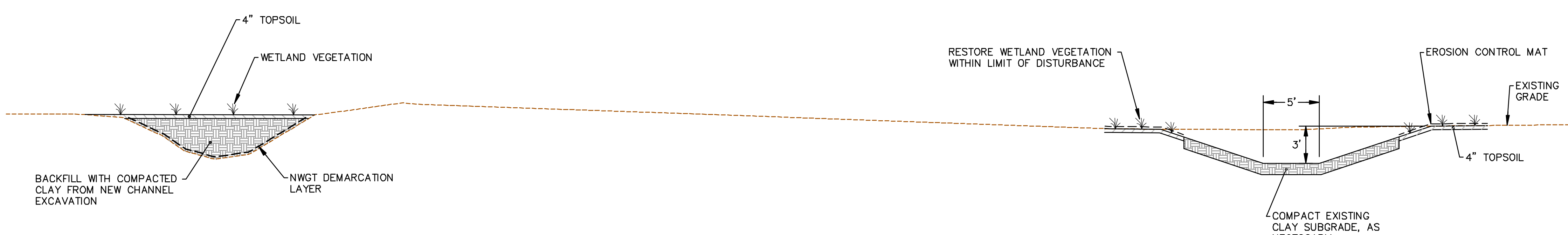
LEGEND:

- EXTENT OF CORRECTIVE ACTION
- IDENTIFIED WETLAND BOUNDARY (SEE NOTE 2)
- APPROXIMATE LOCATIONS OF PROPOSED EROSION CONTROL FEATURES

NOTES:

1. BASE MAP AND TOPOGRAPHY OBTAINED FROM FIELD SURVEY PERFORMED BY LBH. INC. OF DULUTH, MN (2/9/09).
2. IDENTIFIED WETLAND BOUNDARIES BASED ON GPS COORDINATES RECORDED DURING A DELINEATION BY ARCADIS IN OCTOBER 2008 AND SURVEY PERFORMED BY LHB IN OCTOBER/NOVEMBER 2008.
3. NGWT – NON-WOVEN GEOTEXTILE

0 150' 300'
GRAPHIC SCALE



SECTION A-A'

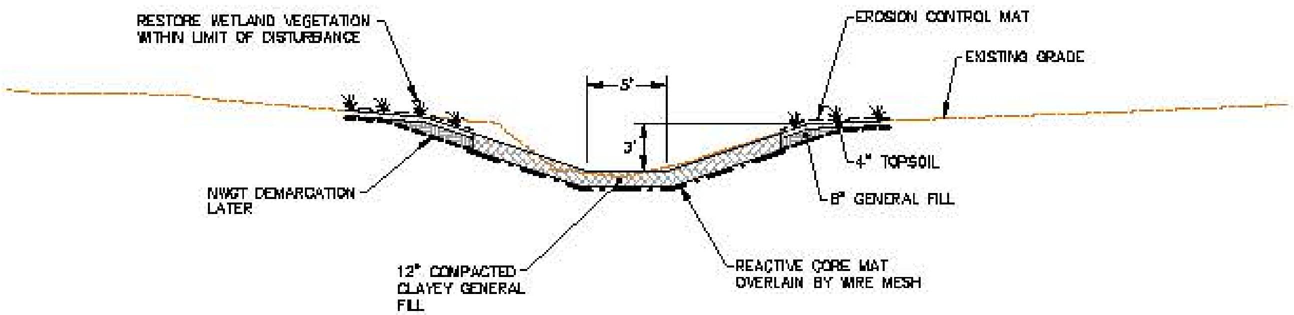
NOT TO SCALE

BEAZER EAST, INC.
FORMER KOPPERS INC. FACILITY
SUPERIOR, WISCONSIN
OFF-PROPERTY
FOCUSED CORRECTIVE MEASURES STUDY

ALTERNATIVE C2 - CHANNEL RELOCATION WITH CLAY-LINED CHANNEL

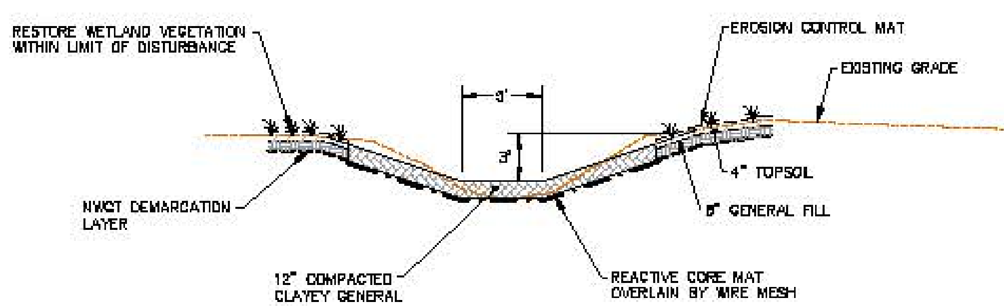
ARCADIS

FIGURE
11



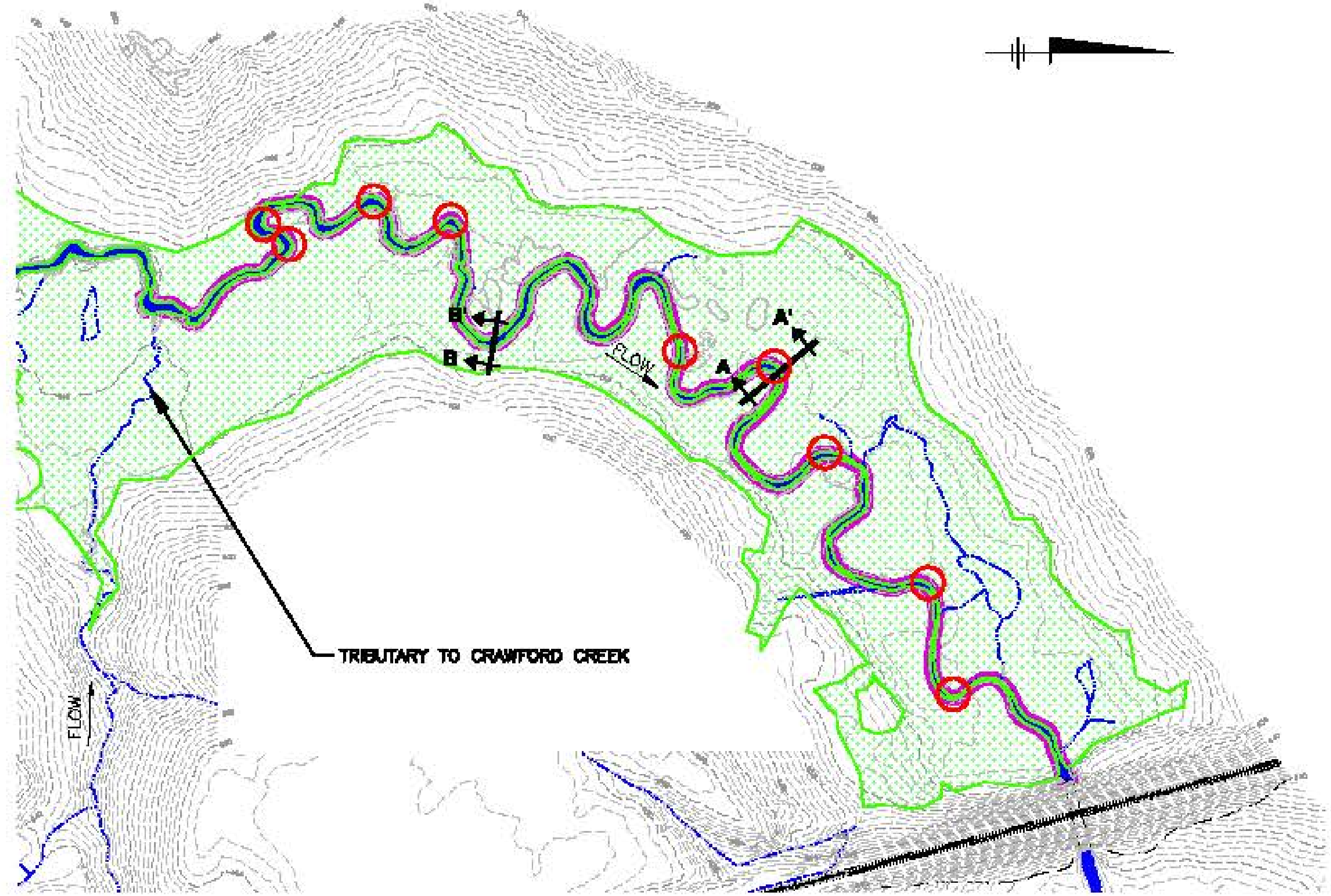
SECTION B-B'

NOT TO SCALE



SECTION A-A'

NOT TO SCALE



LEGEND:

- EXTENT OF CORRECTIVE ACTION
- IDENTIFIED WETLAND BOUNDARY (SEE NOTE 2)
- APPROXIMATE LOCATIONS OF PROPOSED EROSION CONTROL FEATURES

NOTES:

1. BASE MAP AND TOPOGRAPHY OBTAINED FROM FIELD SURVEY PERFORMED BY LSH, INC. OF DULUTH, MN (2/9/09).
2. IDENTIFIED WETLAND BOUNDARIES BASED ON GPS COORDINATES RECORDED DURING A DELINEATION BY ARCADIS IN OCTOBER 2008 AND SURVEY PERFORMED BY LHB IN OCTOBER/NOVEMBER 2008.
3. NWGT – NON-WOVEN GEOTEXTILE

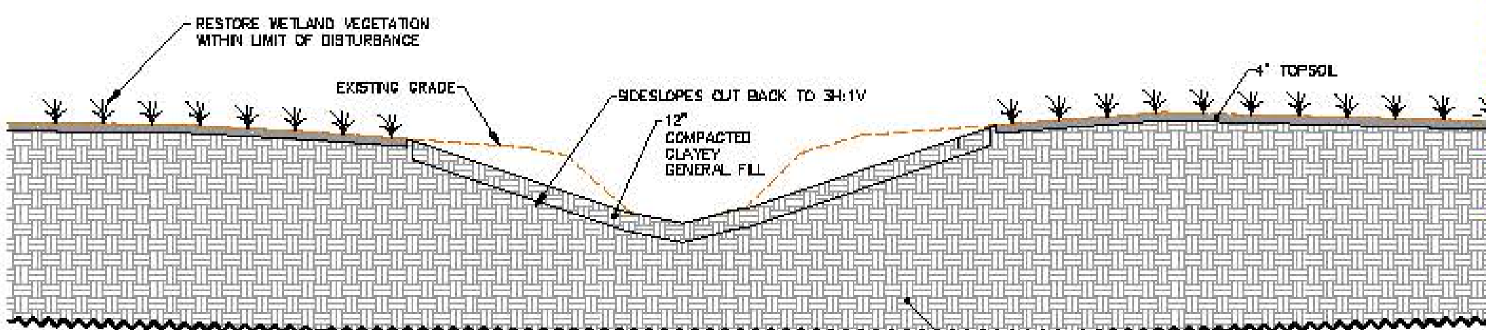
0 150' 300'
GRAPHIC SCALE

BEAZER EAST, INC.
FORMER KOPPERS INC. FACILITY
SUPERIOR, WISCONSIN
OFF-PROPERTY
FOCUSED CORRECTIVE MEASURES STUDY

ALTERNATIVE C3 - PARTIAL CHANNEL EXCAVATION/BACKFILL

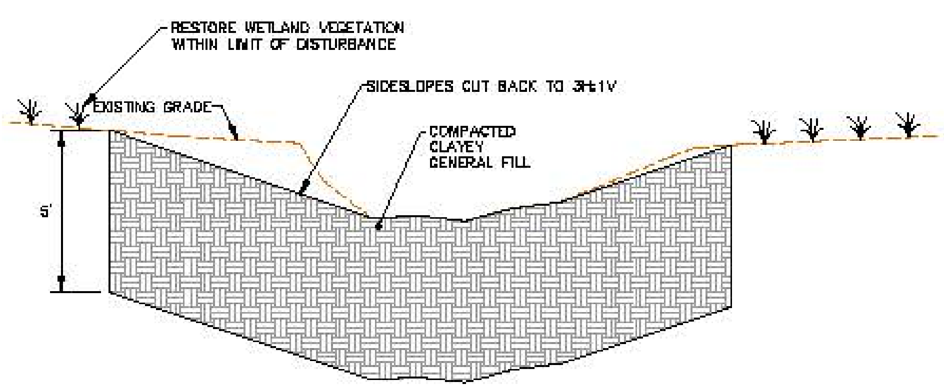
ARCADIS

FIGURE
12



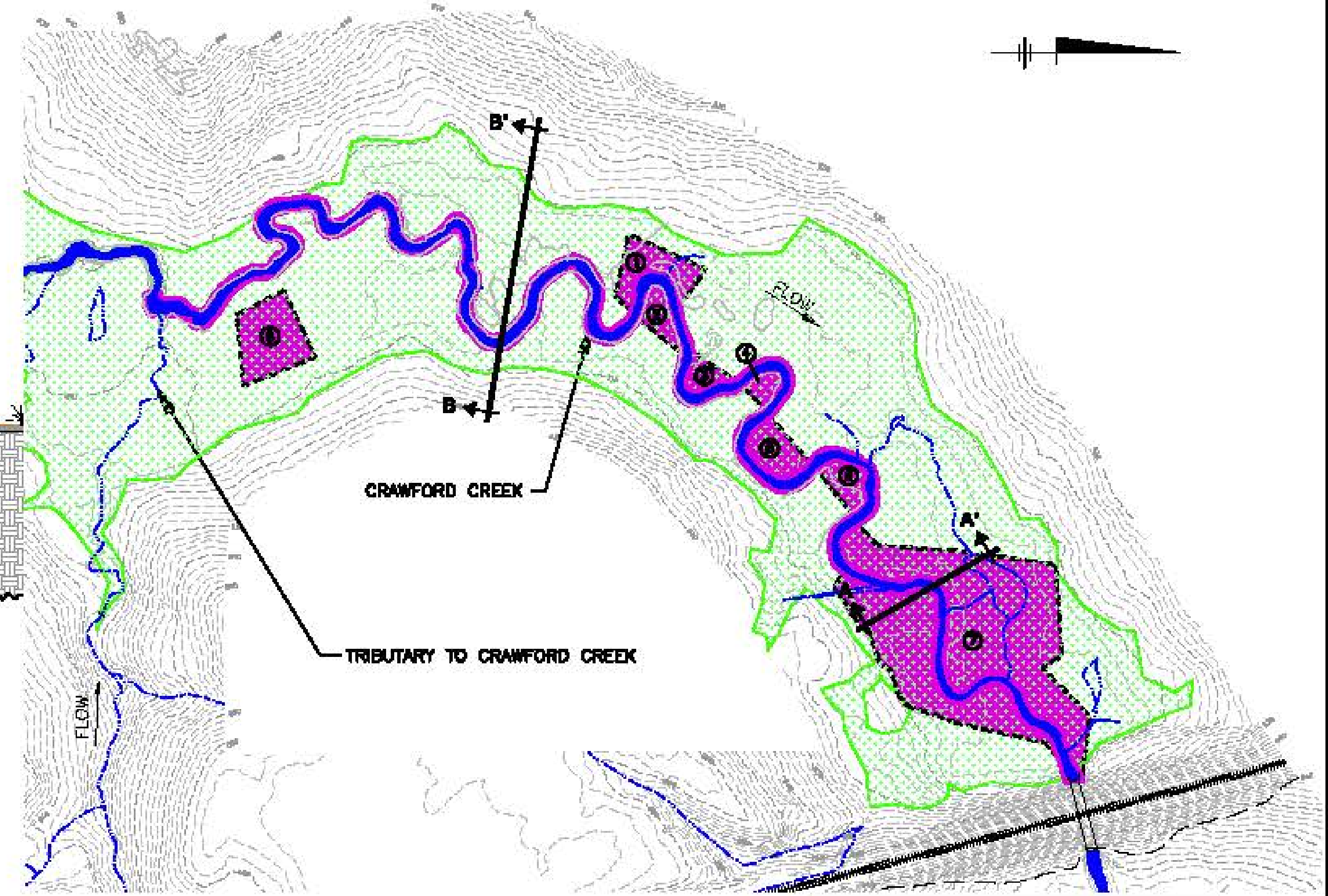
SECTION A-A'

NOT TO SCALE



SECTION B-B'

NOT TO SCALE



SOIL REMOVAL VOLUME			
#	REMOVAL AREA (SF)	REMOVAL DEPTH (FT)	REMOVAL VOLUME (CY)
1	10,840	7.5	2,956
2	5,838	30	6,487
3	7,197	15	3,998
4	6,115	15.5	3,511
5	12,768	15	7,093
6	9,546	15	5,303
7	118,209	10	43,781
8	15,484	30	17,204
			TOTAL REMOVAL VOLUME = 90,333 CY

LEGEND:

- EXTENT OF CORRECTIVE ACTION
- IDENTIFIED WETLAND BOUNDARY (SEE NOTE 2)

NOTES:

1. BASE MAP AND TOPOGRAPHY OBTAINED FROM FIELD SURVEY PERFORMED BY LSH, INC. OF DULUTH, MN (2/3/99).
2. IDENTIFIED WETLAND BOUNDARIES BASED ON GPS COORDINATES RECORDED DURING A DELINEATION BY ARCADIS IN OCTOBER 2005 AND SURVEY PERFORMED BY LHB IN OCTOBER/NOVEMBER 2008.
3. NWGT – NON-WOVEN GEOTEXTILE.
4. REMOVAL AREAS BASED ON EXTENT OF VISUAL IMPACTS OBSERVED IN 2003 TEST PITS AND 2013 SOIL BORINGS LOCATED WITHIN THE SUBJECT AREA. REMOVAL DEPTHS BASED ON AVERAGE DEPTH VISUAL IMPACTS OBSERVED IN 2003 TEST PITS AND 2013 SOIL BORINGS LOCATED WITHIN THE SUBJECT AREA.
5. ALTERNATIVE ALSO INCLUDES THE REMOVAL OF APPROXIMATELY 4,900 CY OF MATERIALS FROM CRAWFORD CREEK BETWEEN THE TRIBUTARY AND THE SHADED REMOVAL AREAS (ASSUMED REMOVAL DEPTH OF 5 FT.)

0 150' 300'

GRAPHIC SCALE

BEAZER EAST, INC.
FORMER KOPPERS INC. FACILITY
SUPERIOR, WISCONSIN
OFF-PROPERTY
FOCUSED CORRECTIVE MEASURES STUDY

ALTERNATIVE C4 - EXTENDED CHANNEL AND FLOODPLAIN EXCAVATION/BACKFILL

ARCADIS

FIGURE
13

ARCADIS

Appendix A

Responses to Agency Comments on the Off-Property Human Health and Ecological Risk Assessment

1. Introduction

On January 15, 2009, on behalf of Beazer East, Inc. (Beazer), AMEC Earth & Environmental, Inc. (AMEC) submitted an *Off-Property Human Health and Ecological Risk Assessment* (HHERA) to the Wisconsin Department of Natural Resources (WDNR). The HHERA documented results of the risk assessments completed for potential human and ecological receptors in the off-property portion of the Former Koppers Inc. Facility in Superior, Wisconsin. The HHERA was prepared in accordance with a WDNR-approved *Work Plan for Outfall 001 Drainage Ditch and Crawford Creek Investigation Activities*, prepared by AMEC/Blasland, Bouck & Lee, Inc. (BBL), dated November 17, 2004, as well as two separate WDNR-approved ecological and human health approach memoranda dated March 2006 and September 2007. These documents laid out the conceptual site model, methods for sample collection, screening benchmarks, constituents of potential concern, receptors of concern, toxicity reference values (TRVs), biotransfer factors, and the assessment and measurement endpoints to conduct the ecological risk assessment. The HHERA also considered WDNR comments on the work plan and the ecological approach memoranda dated October 30, 2006, April 24, 2007, May 12, 2008, May 28, 2008, and July 23, 2008.

On behalf of WDNR, the Wisconsin Department of Health Services (WDHS) provided comments on the human health portion of the HHERA in a memorandum dated August 10, 2011, and the United States Environmental Protection Agency (USEPA) provided comments on the ecological portion of the HHERA in a memorandum dated February 3, 2012 (Beazer received a copy of USEPA's memo via WDNR on March 14, 2012). In February 2012, USEPA released the 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) oral reference dose (RfD) value of 7E-10 mg/kg-day. Hazard Indices (HI) based on non-cancer effects associated with dioxin were not estimated in the off-property HHERA because USEPA did not have a RfD for dioxin at the time of the submittal.

The remainder of this letter summarizes the following:

- WDHS' comment on the human health portion of the HHERA, and Beazer's responses to that comment.
- The effects that the USEPA's new non-cancer toxicity value (oral RfD) for TCDD would have on the conclusion of the human health portion of the HHERA.
- USEPA comments on the ecological portion of the HHERA, and Beazer's responses to those comments.

2. Response to WDHS' Comment on the Human Health Portion of the HHERA

WDHS' 2011 summary comment on the human health portion of the HHERA is listed below in italics and is followed by Beazer's response in bold.

General Comment*: The corrective action determination by the HHERA does not include corrective actions for floodplain soils within Area 2. Prior DNR investigations indicated floodplain soils in this area may have substantial contaminant impacts from creosote product. I recommend that the corrective actions ensure that contamination is addressed for floodplain soils throughout Area 2.*

Response: Potential human health risks associated with exposures to surficial floodplain materials in Area 2 (Crawford Creek from the Tributary to the Railroad Embankment) were evaluated in the HHERA, and were concluded to be within acceptable limits. Note that creosote-like product has not been observed in any surficial floodplain materials in this area as part of any investigations conducted since 2003. We believe that this comment specifically refers to historical observations by WDNR of surficial creosote-like material in the "beaver pond area" a short distance upstream of the railroad embankment. Based on those prior observations, this area was specifically identified by WDNR as a "data gap" in its October 9, 2012 letter to Beazer, and the area was subject to additional targeted visual and chemical characterization as part of supplemental field investigations performed in 2013 and 2014. As summarized in the resulting investigation summary report (ARCADIS, 2014), no surficial product was observed in this area, or any other floodplain area.

Notwithstanding the above, Beazer acknowledges that creosote-like product is present at depth within certain portions of the floodplain, but exposure to these deeper impacts in the floodplain setting is highly unlikely. Nonetheless, these deeper impacts were considered in the Off-Property Focused Corrective Measures Study (FCMS). Also, institutional controls are a component of the corrective actions evaluated in the FCMS, and would include land use restrictions that would further mitigate the potential for exposures to impacted floodplain materials located at depth within the floodplain.

3. Dioxin Toxicity Updates to the Human Health Assessment

The human health risk assessment performed for the off-property portion of the Site was reviewed to see what effects USEPA's new 2,3,7,8-TCDD non-cancer toxicity value (oral RfD = 7E-10 mg/kg-day) would have on conclusions of the previous assessment. Hazard Indices (HI) based on non-cancer effects associated with dioxin were not estimated in the 2009 off-property human health risk assessments because USEPA did not have a RfD for dioxin at the time the HHERA was submitted.

The revised toxicity values were incorporated into the existing risk calculation spreadsheets for dermal contact and incidental ingestion of soil and sediment using both the Beazer and WDNR exposure assumptions for all receptors evaluated in the off-property risk assessment:

- Recreational Visitor;
- Recreational Visitor (adult);
- Hunter;
- Hunter (adult); and
- Trapper (WDNR scenario only).

Results of the revised human health calculations are presented in attached Tables 1 and 2 for the off-property areas/receptors. For comparison, the original risk estimates are presented as well as the revised estimates[1]. Comparison of the two sets of non-cancer risk results indicates there are no major changes in the potential non-cancer risk estimates for any scenario considered in the off-property areas. In no instance did the revised calculation result in a calculated non-cancer HI greater than 1. Accordingly, revision of the prior human health calculations to reflect the new non-cancer oral RfD did not affect the conclusions of the human health risk assessment.

4. Response to Ecological Comments on the HHERA

USEPAs February 3, 2012 comments on the ecological portion of the HHERA are listed below in italics, with Beazer's response following each comment in bold. As noted in the responses below, updated hazard quotients (HQs) are provided in Tables 3 and 4 attached to this response letter. In cases where USEPA comments prompted a revision to the risk calculation, the tables present the "revised" HQs along with the original "previous" HQs that were presented in the 2009 HHERA.

<u>General Comment</u>. *Since birds and mammals with earthworms in their diet (vermivores) are expected at this site, both a woodcock and shrew need to be included in the receptor list. The soil benchmarks need to include values from the USEPA Ecological Soil Screening Levels (http://www.epa.gov/ecotox/ecossl/). For soils, PAH toxicity needs to be addressed as high and low molecular weight compounds (i.e., sum individual PAHs for each molecular weight group).*

> **Response: The list of receptors evaluated in the ecological risk assessment was agreed to with WDNR prior to preparing the HHERA. Note that significant earthworm presence is not expected in the floodplain because it is typically inundated for extended periods of the year likely causing anaerobic conditions.**
>
> **Nonetheless, to address USEPA's comment, a short-tailed shrew (*Blarina brevicauda*) and American woodcock (*Scolopax minor*) were incorporated into the food-web dose model assessment with a diet assumed to consist of 100% soil invertebrates (i.e., earthworms). The exposure parameters assumed for the shrew and the woodcock are presented in Table 5 and HQs are presented in the attached Tables 3 (NOAEL-based HQs) and 4 (LOAEL-based HQs).**

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[1] While updating the off-property human health risk estimates, ARCADIS noted some data entry errors in the spreadsheets (Appendix F of the *Human Health and Ecological Risk Assessment*) used to estimate potential risks presented in Tables 2-23 and Table 2-24 of the January 2009 off-property HHERA. Specifically, exposure assumptions presented in the text of the report and summarized in Table 2-20 and 2-20 were incorrectly entered into the spreadsheets that estimate potential risks (Appendix F) for the recreational visitor and the hunter receptors. ARCADIS has corrected these data entry errors and the estimates of potential risk presented in the attached Tables 1 and 2 of this response ("original risk estimates") reflect these corrections (the attached tables show risk estimates that have been corrected). Although these corrections result in slightly higher potential off-property risk estimates than previously presented in 2009, the conclusions presented in the text of the January 2009 report remain unchanged.

As noted in Table 4, a conservative diet assumed to consist of 100% earthworms shows low potential risk to shrews in Area 1, with LOAEL-based HQs slightly greater than 1.0 (1.5 for total PAHs and HMW PAHs to 1.7 for TCDD TEQ). No other areas pose a potential risk to shrews, and none of the areas indicate a potential risk to the woodcock. Therefore, when viewed on a population level, the floodplain is not expected to pose a risk to shrews, assuming the habitat in the floodplain is even able to support a shrew population, given that it is typically inundated for portions of the year. In addition, shrews are unlikely to have a diet consisting of 100% earthworms because small mammals and other soil invertebrates are also part of their diet (USEPA 1993). If a more representative diet consisting of less than 100% earthworms is used to estimate risks to shrews, a potential risk to shrew populations would not be present in any of the areas of the temporarily inundated floodplain.

A comparison of surficial floodplain sample data to available benchmarks does not indicate any potential risk to soil invertebrates or plants if such benchmarks are used. Higher trophic receptors are evaluated using food web models. The results of these food web models supersede screening benchmark comparisons for those receptors.

As part of this response, the food-web dose model assessment was updated to include LMW and HMW PAHs (refer to Tables 3 and 4). Individual PAHs were also kept in the dose model. The sum of the individual PAH HQs are also presented in Tables 3 and 4.

***Specific Comment 1**. Avian and mammal vermivores (i.e., American woodcock and short-tailed shrew) need to be included as ecological receptors.*

Response: Refer to above response to the General Comment.

***Specific Comment 2**. The wood turtle (Glyptemys insculpta) is a State threatened species and needs to be included in the list of receptors evaluated in the ERA. Since birds and reptiles do not represent the same vertebrate class, an avian toxicity reference value (TRV) cannot serve as a surrogate reptile TRV. This vertebrate class requirement is addressed in the US Army "Standard Practice for Wildlife Toxicity Reference Values" available at: http://usaphcapps.amedd.army.mil/erawg/(see Section 2.1 Data Collection/ Literature Search). On page 45 under the 2nd paragraph, the following two items need to be deleted:*

a. 2nd bullet "the TRVs used for reptiles are often the same for birds because reptile-specific TRVs are usually not available and avian TRVs are used in their stead (due to phylogenetic similarity of birds and reptiles)" and
b. the following sentence "As a result of their higher intake rate per unit body weight, birds...."

***Concern for Discussion**. If turtle TRV data are unavailable, a line of evidence analysis may be appropriate. This approach can consider: absence/ presence of sexually mature wood turtles, successful egg hatching and juvenile wood turtles in the study areas. Are there records of wood turtles observed during the spring/summer 2005 biological sampling of Crawford Creek?*

Response: During a 1999 field survey, a single wood turtle was observed in the Crawford Creek floodplain.

Specific Comment 3. *Additional discussion is needed to explain likely contaminant transport from sediments to aerial feeding insectivores, represented by nocturnal feeding of the little brown bat and tree swallow diurnal feeding (both feed at twilight). Since both the little brown bat (consumes 95-100% aquatic insects, Can J Zoo 1976, vol 54: 1674- 1678) and the tree swallow feed primarily on aquatic insects (e.g., mayflies, caddis flies and stoneflies), the collection and measurement of contaminants in flying insects needs data and discussion to ensure aquatic insects were adequately represented (e.g., relative percent abundance of aquatic insects vs Lepidoptera, sampling distance from stream, and collection dates & time of day).*

Concern for Discussion. *Aquatic insects are expected to have contaminant concentrations the same as sediment or higher. Bioaccumulation studies show aquatic insect contaminant concentrations ranging from 1.4 to 9.4 times higher than sediment values. Also male emergent aquatic insects can bio-amplify contaminants an additional factor of two (see Daley et al. 2011 Environ Toxicol and Chem V30, N9: 2167-2174). Recommend an internal WDNR estimate insect concentration by multiplying sediment concentration times 5.4 (median of bioaccumulation range).*

The little brown bat and tree swallow will consume some terrestrial flying insects with most from the order Lepidoptera (e.g., moths and butterflies). Bats will prey on moths as both are nocturnal, but moths are herbivores with no expected contaminant transport from sediments. Two species of moths are expected in Douglas County with an adult flight as follows:

- *Columbia Silkmoth (Hyalophora columbia) adult flight: one brood, May–July*
- *Common Gluphisia (Gluphisia septentrionis) adult flight: two generations/year, May–August*

Response: The sediment → aquatic flying insect → aerial feeder pathway is complete because aquatic flying insects have infaunal larval/pupae stages with higher lipid content than their adult stages and, thus, have the potential to accumulate sediment constituents during their critical early life stage.

The study cited by USEPA is based on polychlorinated biphenyls (PCBs) which tend to have higher rates of bioaccumulation then do dioxins/furans so its relevance to the Site is unclear. The cited study is also of bioamplification/biomagnification among lifestages and not of bioaccumulation from a known sediment concentration. Regardless, the site-specific collection and analysis of the dioxin concentration in flying insects has accounted for these processes. The approach was agreed to by WDNR during the planning phase of the work.

We disagree with the "concern for discussion" regarding the use of a BAF of 5.4 to estimate emergent aquatic flying insects because we have collected actual Site-specific tissue data for emergent insects to utilize in the food-web dose models. Using a BAF to

estimate potential emergent insect concentrations from sediment concentrations adds a substantial and unnecessary uncertainty to the risk assessment given that we have actual emergent insect tissue concentrations.

Whether or not the collected insects were exclusively from the floodplain or only partially emergent from the floodplain is not critical for the risk assessment. As noted in Section 2.3.1.4 of the HHERA, the constituent concentrations detected in flying insects are representative of the overall population of flying insects in the floodplain. These could have emerged from either the creek or floodplain. Given that constituent concentrations are generally lower in the floodplain than the creek, concentrations in insects emerging from the floodplain may well be lower than concentrations in insects emerging from the creek. Regardless, the aerial insects collected from along the floodplain are representative of the insects available to flying insectivores and, thus, are expected to represent the potential exposures encountered by such receptors.

Specific Comment 4: *Exposure to the American robin, American woodcock, meadow vole and short-tailed shrew (see comment # 1 for woodcock & shrew) begins with an estimate of contaminate transport from soil to food source consumed by these ecological receptors. The report uses biotransfer factors in Table 3-3 to model the amount of contaminate being transferred from soil to the food items (plants & earthworms) ingested. Some of the biotransfer factors, more commonly referred to as bio-accumulation factors (BAFs), were incorrectly selected or need to be updated. Concerns with BAFs presented in Table 3-3 are discussed below.*

Response: Comment noted and further addressed in responses to comments 4a-c below.

Specific Comment 4a: Pentachlorophenol. *The USEPA 1999 reference cited in Table 3-3 (see notes a & b) is not listed in the reference section. Based on BAF values presented in Table 3-3, this reference appears to be the "SLERA Protocol for Hazardous Waste Combustion Facilities ..." (EPA 530-D-99-001A). No justification is provided for a default earthworm BAF of 1 for Pentachlorophenol (PCP). This is a concern especially since the USEPA 1999 reference recommends a BAF of 1,034. For pentachlorophenol, the estimate of bio-accumulation needs to use an earthworm BAF of 14.63 and a plant BAF of 5.93 (see USEPA 2005 Guidance for Developing Ecological Soil Screening Levels (Eco-SSL) report, Attachment 4.1).*

Response: The EcoSSL BAF for pentachlorophenol was used to estimate plant and earthworm tissue concentrations, as recommended in Specific Comment 4a. As noted in the revised results presented in Tables 3 and 4, the use of this BAF does not change the conclusions of the HHERA.

<u>Specific Comment 4b: Dioxin</u>. *The earthworm BAF (or BTF) as cited in Table 3-3 is incorrect. The mean BAF value of 0.44 is for insects not earthworms as reported by Meyn et al 1997. Meyn reported the soil to earthworm BAF has a lognormal distribution, but only reported a mean value of 4.3 and a regression equation was not provided. A lognormal regression equation was developed by Sample et al 1998 for a soil to earthworm BAF. The earthworm BAF needs to be derived from the Sample 1998 regression equation: ln(earthworm) = 3.533 + 1.182(ln[soil]). Using soil data (TCDD TEQ mammal) from Table 2-2, the low and high soil concentrations were entered into the above equation and the following earthworm concentration was obtained along with a soil to earthworm BAF.*

	Soil sample T22	***Soil Sample T1***
Soil	*0.00042 ug/kg*	*0.15 ug/kg*
Worm	*0.00349 ug/kg*	*3.63 ug/kg*
BAF	*8.31*	*24.2*

Response: We have reviewed the data used by Sample et al. (1998) and found that, compared to all the other data in the literature, they greatly overestimate the uptake of 2,3,7,8-TCDD by earthworms. Using dioxin BAFs other than those developed by Sample et al. (1998) is critical to develop realistic, yet conservative, estimates of potential risk. Alternatively, we used BAFs for plants and earthworms from USEPA (1999) which provide a unique BAF for each dioxin congener for both plants and earthworms. Once tissue concentrations are estimated using the appropriate BAFs, they are multiplied by the corresponding TEF and summed to obtain the TEQ concentration in tissue of the prey item (refer to Van den Berg et al. [2006] and USEPA [2008]). The BAF regression equation from Sample et al. (1998) as recommended in the comment is only for the 2,3,7,8-TCDD congener and does not account for total TEQ, which is required to model exposure to all dioxin congeners up through the food web to upper-trophic level birds and mammals (USEPA 2008). As noted in the attached Tables 3 and 4, the use of these revised BAFs does not change the conclusions of the HHERA.

<u>Specific Comment 4c: Polycyclic Aromatic Hydrocarbons (PAHs)</u>. *Because PAHs occur in the environment as mixtures, evaluating toxicity for individual PAHs does not address the additive effect and is expected to be under-protective. The Eco-SSL report for PAHs has developed toxicity and BAF values for low (2 & 3 rings) & high (4 rings or more) molecular weight PAH compounds. The individual LMW PAHs and HMW PAHs need to be summed and then the corresponding BAFs can be applied to estimate the corresponding earthworm and plant tissue concentrations. The current Eco-SSL report for PAHs has the following BAF values (B is the estimated PAH concentration in either earthworm or plant tissue):*

	Earthworms	***Plants***
LMW PAHs	*B = 3.04 x soil*	*B = 2.09 x soil*
HMW PAHs	*B = 2.6 x soil*	*lnB = (0.9469 x ln soil) - 1.7026*

Mammalian toxicity reference values (TRVs) for PAHs are available from the Eco-SSL report and will replace the values in Table 3-10 and 3-11. These NOAEL and LOAEL TRVs for PAHs are provided below and the LOAELs are the lowest bounded value from the categories of reproduction, growth and survival.

	Mammal NOAEL TRV	***Mammal LOAEL TRV***
LMW PAHs	*65.6 mg PAHs/kg bw/day*	*110 mg PAHs/kg bw/day*
HMW PAHs	*0.615 mg PAHs/kg bw/day*	*3.07 mg PAHs/kg bw/day*

Avian TRV data (Schafer et al. 1983) presented in this report needs to be deleted since it was rejected in the Eco-SSL PAH report. This data was rejected because it represents an acute study limited to either a single oral dose or exposure duration of three days or less. The Eco-SSL report did not derive Avian TRVs for either class of PAHs since data was limited to one species.

Concerns for Discussion:

1. Only evaluate risk to mammals since an avian TRV is not available (per Eco-SSL guidance).

2. Request an updated literature search for new avian TRV data (per Eco-SSL guidance, more than one species needed). Some suggested sources are: Patton & Dieter 1980, Comp. Biochem. Physiol. 65C: 33-36; Klasing et al. 2007, Dietary Exposure to Naphthalene in the Japanese Quail www.vetmed.ucdavis.edu/whc/owcnpdfs/eow07-proceedings-update08.pdf

3. WDNR can evaluate relative avian risk with LOAEL TRVs listed in the Eco-SSL report as follows: 33 mg/kg-d (LMW) and 20 mg/kg-d (HMW).

Response: The EcoSSL BAFs for low molecular weight (LMW) and high molecular weight (HMW) PAHs were incorporated into the food-web dose model to estimate plant and earthworm tissue concentrations, as recommended in Specific Comment 4c.

The EcoSSL TRVs for LMW and HMW PAHs were also used for mammals as recommended.

A literature search for alternative avian TRVs was conducted, as recommended in the "concerns for discussion". The revised avian TRVs are as follows:

- **LMW PAHs (Avian NOAEL TRV): 22.8 mg/kg-day (Patton and Dieter, 1980)**
- **LMW PAHs (Avian LOAEL TRV): 33 mg/kg-day (USEPA, 2007)**
- **HMW PAHs (Avian NOAEL TRV): 10 mg/kg-day (Trust et al, 1994)**
- **HMW PAHs (Avian LOAEL TRV): 20 mg/kg-day (USEPA, 2007)**

The attached Tables 3 and 4 present updated avian model results based on these revised avian TRVs. As shown in the attached Tables 3 and 4, the use of these BAFs, the mammalian EcoSSL TRVs, and the revised avian TRVs does not change the conclusions of the HHERA.

Specific Comment 5a. *For ecological risk assessment, the term "indirect effect" is incorrectly used and the term and explanation needs to be deleted and the discussion revised for this section. Food chain transport of a toxicant to an ecological receptor is a direct effect. When a toxicant results in a change of environment (loss of habitat and/ or food resource) the toxicant has an indirect effect on the ecological receptor. This is discussed in the "Ecological Risk Assessment Guidance for Superfund" (EPA 540-R-97-006, see Section 3.1).*

Response: Comment noted, but does not affect the conclusions of the HHERA.

Specific Comment 5b. *The following statement on page 54, 2nd paragraph), "…several of the multiple PAH tend not to bioaccumulate in higher trophic levels … because they are metabolized by vertebrates once ingested" is misleading because PAH exposure can adversely impact vertebrates. This narrative needs to discuss how vertebrates with direct exposure can be adversely impacted from PAH exposure.*

Response: Comment noted, but does not change the conclusions of the HHERA.

Specific Comment 5b. Concern for Discussion. *Goals to protect ecological uses (e.g., fish and wildlife) are established at the onset of the ecological risk assessment. Federal and State water quality standards (WQS) protect beneficial uses with the WQS chemical criteria used in an ecological risk assessment to protect aquatic life. "Fish tumors or other deformities" is one of 14 beneficial use impairments for the Great Lakes evaluated using biological criteria (often measured as external deformities, eroded fins, lesions or tumors and referred to as DELTs). Other Great Lakes sites have cleaned up PAH sediment contaminants to correct problems with fish DELTs. Need to determine if the Great Lakes Area of Concern and/ or Great Lakes Legacy Act are concerned with fish DELTs at this site.*

Response: Surface water screening comment is noted, but does not change the conclusions of the HHERA. All detected surface water concentrations are below the *WDNR's 2003 Consensus Based Sediment Quality Guidelines, the Great Lakes Water Quality Initiative, and USEPA's Region 5 Ecological Screening Levels (ESL) for surface water*.

Specific Comment 6a. *The USEPA, Ecological Soil Screening Level (Eco-SSL) Guidance 2003 (http://www.epa.gov/ecotox/ecossl/) needs to be cited as the primary guide in selecting toxicity reference values (TRVs) for chronic effects. Likewise, the description for selecting TRVs needs revised in the 2nd through 4th paragraphs. The use of allometric scaling (5th paragraph, page 56) is not appropriate for chronic toxicity and needs deleted and TRVs corrected. The principal author of the*

Sample et al. (1996) paper has advised in numerous forums not to use allometric scaling and some examples are:

- *1999 paper by Sample and Arenal (Bull Environ Contam Toxicol 62: 653-663) stated scaling is intended only for acute toxicity and they do not support scaling for chronic toxicity,*
- *Eco-SSL Guidance does not apply scaling for chronic toxicity,*
- *Sample advised against using scaling at the 2007 SETAC N.A. annual meeting (see "Recommend Don'ts" #2 as noted in "Summary of Recommendation for Wildlife TRV Development and Use"), and*
- *Allard et al. 2010 (Integr Environ Assess Manag 6: 28-37) also advised against using allometric dose-scaling to develop chronic wildlife TRVs.*

Specific Comment 6b. *For consistency with the USEPA, Ecological Soil Screening Level Guidance, both NOAEL and LOAEL TRVs need to represent chronic studies and LOAELs are the lowest bounded value from the categories of reproduction, growth and survival. Also, the NOAEL TRV needs to be the geometric mean of acceptable studies and lower than lowest bounded LOAEL.*

Response to Specific Comments 6a and 6b: TRVs from the EcoSSL documents were utilized in the food-web model revisions completed for this response and allometric scaling for differences in bodyweight were also removed. The results are presented in the attached Tables 3 and 4. As noted in the attached Tables 3 and 4, these changes do not affect the conclusions of the HHERA.

Concerns for Discussion: Table 2-1. *The highest avian and mammal TCDD-TEQ values (see sample R2 on 6/8/2005) listed were 0.069 ug/kg (69 pg/g) and 0.076 ug/kg (76 pg/g), respectively. In the 2003 WDNR Consensus Based Sediment Quality Guidelines report, Appendix C (see 6th bullet) gives an example of high dioxins/furans in sediment of 5,500 pg TCDD-EQ/g at Crawford Creek. WDNR needs to confirm correct data values are being presented.*

Response: No response required.

Comment A on Table 2-5a. *Since ecological risk assessments do not evaluate effects from cancer, carcinogenic equivalents (i.e., cancer potency relative to benzo(a)pyrene) and related toxic equivalency factors (TEF) need to be deleted. In Table 2-5, the column of TEF values and BaP-TE values needs to be deleted.*

Response: Comment noted, but does not change the conclusions of the HHERA.

Comment B on Table 2-5b. *Although Table 2-5 lists U data is ½ the reporting limit, these data were not used to calculate the Total PAH. Only the calculation of BaP-TE values used the "U" data, please explain.*

Response: The calculated total PAHs for the insect data were not used in the HHERA calculations. Note that a value equivalent to one-half the reporting limit was used as exposure point concentrations (EPCs) for the individual PAHs in the dose models.

<u>Concern for Discussion on Table 2-5.</u> *The original PAH data values need to be reviewed by WDNR and Total PAH checked. If U data is applied, Total PAH for FLY-1 and FLY-3 samples will be 1.657 and 1.598 mg/kg, respectively. U data was not used which resulted in lower Total PAH values for FLY-1 and FLY-3 of 1.1 and 0.56 mg/kg, respectively.*

<u>Comment C on Table 2-5.</u> *The low (2 & 3 Rings) and high (4 - 6 rings) molecular weight PAHs need to be presented in Table 2-5 for all samples. An example for samples FLY-1 and FLY-3 is shown below.*

	FLY-1	***FLY-3***
LMW - PAH	*0.89 mg/kg*	*0.45 mg/kg*
HMW - PAH	*0.77 mg/kg*	*1.15 mg/kg*

Response to Concern for Discussion on Table 2-5 and Comment C on Table 5: As noted above, a value equivalent to one-half the reporting limit was used as EPCs for the individual PAHs in the dose models. The HQs of the individual PAHs were summed to obtain a total PAH HQ to characterize potential risk from PAHs as a class. The food-web dose model assessment was updated as part of this response to include LMW and HMW PAHs (refer to attached Tables 3 and 4).

<u>Comment D on Table 2-5</u>*. No data was provided for pentachlorophenol. Please explain.*

Response: Emergent insect tissue samples were not analyzed for pentachlorophenol which was consistent with the approach approved by WDNR. Pentachlorophenol is not typically a constituent of concern in tissue. Although it is recognized as a bioaccumulative substance, it is generally not observed at concentrations that would pose a risk in biological tissue. Also, pentachlorophenol concentrations in channel bottom sediment and floodplain material samples collected from the off-property portion of the Site are generally very low or non-detect.

5. Summary and Conclusions

This document provides responses to WDHS/USEPA comments on the 2009 HHERA for the off-property portion of the Former Koppers, Inc. Facility in Superior, Wisconsin. In light of recent updates to non-cancer toxicity values for 2,3,7,8-TCDD, the human health risk assessment performed for the off-property portion of the Site was also reviewed to see what effects USEPA's new dioxin toxicity value (i.e., oral RfD) would have on conclusions of the previous assessment. The conclusions of the responses are provided below:

- As requested in WDHS' comment on the human health portion of the HHERA, the Off-Property FCMS considers impacted floodplain materials that are present at depth, intersect the banks of Crawford Creek, and may cause surface water sheens in the creek. Additionally, institutional controls are also a component of the corrective actions evaluated in the FCMS.

- The new non-cancer RfD was incorporated into the human health exposure calculations. Comparison of the two sets of human health non-cancer risk results to the original 2009 HHERA results indicates there are no major changes in the potential non-cancer risk estimates for any scenario considered in the off-property areas. As a result, the new non-cancer RfD does not affect the conclusions of the human health risk assessment.

- Based on USEPA's comments on the ecological portion of the HHERA, the ecological food-web dose models were adjusted, as follows:
  - Shrew and woodcock ecological receptors were added to the dose models;
  - BAFs were updated based on USEPA's EcoSSLs (2007) for plants and earthworms and USEPA (1999) for individual dioxin congeners;
  - TRVs were updated to reflect those suggested in the comment letter; and
  - HMW and LMW PAH HQs were calculated.

- Revised ecological food-web model results for LOAEL-based HQs indicate that the shrew in Area 1 is the only receptor that slightly exceeds an HQ of 1. Given that this estimate conservatively assumes a diet comprised of 100% earthworms, the actual HQ is expected to be even lower. As a result, there is little to no potential ecological risk in the off-property portion of the Former Koppers Inc. Facility in Superior, Wisconsin. The comments on the ecological portion of the HHERA do not change the conclusions of the 2009 HHERA.

6. References

Allard, P., Fairbrother, A., Hope, B.K., Hull, R.N., Johnson, M.S., Kapustka, L., Mann, G., McDonald, B., and Sample, B.E., 2010. Integrated Environmental Assessment and Management 6(1): 28-37. January 2010.

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Table 1. Summary of Comparison of Potential Risks[a] - WDNR Assumptions - Off-Property Areas
KI Facility
Superior, WI

Current Potential Exposures		Cumulative Estimated Risks				Soil				Sediment				Surface Water[b]			
		Revised Estimates[a]		Original Estimates[c]		Revised Estimates[a]		Original Estimates[c]		Revised Estimates[a]		Original Estimates[c]		Revised Estimates[b]		Original Estimates[c]	
Exposure Area	Receptor	Noncancer (HI)	Cancer (PELCR)	Noncancer (HI)	Cancer (PELCR)	Noncancer (HI)	Cancer (PELCR)	Noncancer (HI)	Cancer (PELCR)	Noncancer (HI)	Cancer (PELCR)	Noncancer (HI)	Cancer (PELCR)	Noncancer (HI)	Cancer (PELCR)	Noncancer (HI)	Cancer (PELCR)
Area 1	Trapper as per WDNR Comments (adult)	1E-02	NR	3E-03	5E-06	8E-03	NR	6E-05	9E-07	5E-03	NR	2E-03	4E-06	NR	NR	2E-04	6E-07
	Recreational Visitor (7-18)	8E-02	NR	1E-02	1E-05	5E-02	NR	3E-04	2E-06	3E-02	NR	1E-02	8E-06	NR	NR	6E-04	2E-06
	Recreational Visitor (adult)	1E-02	NR	2E-03	4E-06	6E-03	NR	5E-05	7E-07	4E-03	NR	2E-03	3E-06	NR	NR	1E-04	5E-07
	Hunter (7-18)	8E-03	NR	1E-04	4E-07	8E-03	NR	5E-05	3E-07	2E-04	NR	9E-05	6E-08	NR	NR	4E-06	1E-08
	Hunter (adult)	3E-03	NR	6E-05	4E-07	3E-03	NR	2E-05	3E-07	9E-05	NR	4E-05	6E-08	NR	NR	3E-06	9E-09
Area 2	Trapper as per WDNR Comments (adult)	7E-03	NR	3E-03	5E-06	2E-03	NR	1E-05	1E-07	5E-03	NR	2E-03	4E-06	NR	NR	2E-04	8E-07
	Recreational Visitor (7-18)	4E-02	NR	1E-02	1E-05	1E-02	NR	6E-05	4E-07	2E-02	NR	1E-02	7E-06	NR	NR	8E-04	3E-06
	Recreational Visitor (adult)	5E-03	NR	2E-03	3E-06	2E-03	NR	9E-06	1E-07	3E-03	NR	2E-03	3E-06	NR	NR	2E-04	6E-07
	Hunter (7-18)	2E-03	NR	1E-04	2E-07	2E-03	NR	9E-06	6E-08	3E-04	NR	1E-04	8E-08	NR	NR	7E-06	3E-08
	Hunter (adult)	8E-04	NR	6E-05	1E-07	7E-04	NR	4E-06	5E-08	1E-04	NR	5E-05	7E-08	NR	NR	4E-06	2E-08
Area 3	Trapper as per WDNR Comments (adult)	7E-03	NR	2E-03	5E-06	2E-03	NR	1E-05	1E-07	5E-03	NR	2E-03	5E-06	NR	NR	2E-04	5E-07
	Recreational Visitor (7-18)	4E-02	NR	8E-03	1E-05	1E-02	NR	6E-05	4E-07	2E-02	NR	7E-03	9E-06	NR	NR	8E-04	2E-06
	Recreational Visitor (adult)	5E-03	NR	1E-03	4E-06	2E-03	NR	9E-06	1E-07	3E-03	NR	1E-03	3E-06	NR	NR	2E-04	4E-07
	Hunter (7-18)	2E-03	NR	9E-05	2E-07	2E-03	NR	9E-06	6E-08	2E-04	NR	7E-05	1E-07	NR	NR	6E-06	1E-08
	Hunter (adult)	8E-04	NR	4E-05	2E-07	7E-04	NR	4E-06	5E-08	1E-04	NR	3E-05	1E-07	NR	NR	4E-06	8E-09

Table 2. Summary of Comparison of Potential Risks - AMEC Assumptions - Off-Site Areas

Current Potential Exposures		Cumulative Risks				Soil				Sediment				Surface Water[b]			
		Revised Estimates[a]		Original Estimates[c]		Revised Estimates[a]		Original Estimates[c]		Revised Estimates[a]		Original Estimates[c]		Revised Estimates[b]		Original Estimates[c]	
Exposure Area	Receptor	Noncancer (HI)	Cancer (PELCR)	Noncancer (HI)	Cancer (PELCR)	Noncancer (HI)	Cancer (PELCR)	Noncancer (HI)	Cancer (PELCR)	Noncancer (HI)	Cancer (PELCR)	Noncancer (HI)	Cancer (PELCR)	Noncancer (HI)	Cancer (PELCR)	Noncancer (HI)	Cancer (PELCR)
Area 1	Recreational Visitor (15-16)	1E-03	NR	2E-04	1E-07	8E-04	NR	4E-06	2E-08	4E-04	NR	2E-04	4E-08	NR	NR	2E-05	6E-08
	Recreational Visitor (adult)	1E-03	NR	2E-04	2E-07	6E-04	NR	3E-06	5E-08	3E-04	NR	2E-04	1E-07	NR	NR	1E-05	5E-08
	Hunter (15-16)	4E-03	NR	6E-05	1E-07	4E-03	NR	2E-05	7E-08	1E-04	NR	4E-05	1E-08	NR	NR	3E-06	1E-08
	Hunter (adult)	3E-03	NR	5E-05	3E-07	3E-03	NR	1E-05	2E-07	8E-05	NR	3E-05	4E-08	NR	NR	3E-06	9E-09
Area 2	Recreational Visitor (15-16)	6E-04	NR	2E-04	1E-07	2E-04	NR	7E-07	3E-09	4E-04	NR	2E-04	4E-08	NR	NR	2E-05	8E-08
	Recreational Visitor (adult)	5E-04	NR	2E-04	2E-07	2E-04	NR	6E-07	9E-09	3E-04	NR	2E-04	1E-07	NR	NR	2E-05	6E-08
	Hunter (15-16)	1E-03	NR	5E-05	5E-08	9E-04	NR	3E-06	1E-08	1E-04	NR	4E-05	1E-08	NR	NR	6E-06	2E-08
	Hunter (adult)	8E-04	NR	4E-05	1E-07	7E-04	NR	3E-06	4E-08	8E-05	NR	3E-05	4E-08	NR	NR	4E-06	2E-08
Area 3	Recreational Visitor (15-16)	6E-04	NR	1E-04	1E-07	2E-04	NR	7E-07	3E-09	4E-04	NR	1E-04	6E-08	NR	NR	2E-05	5E-08
	Recreational Visitor (adult)	5E-04	NR	1E-04	2E-07	2E-04	NR	6E-07	9E-09	3E-04	NR	1E-04	2E-07	NR	NR	2E-05	4E-08
	Hunter (15-16)	1E-03	NR	4E-05	4E-08	9E-04	NR	3E-06	1E-08	1E-04	NR	3E-05	2E-08	NR	NR	5E-06	1E-08
	Hunter (adult)	8E-04	NR	3E-05	1E-07	7E-04	NR	3E-06	4E-08	8E-05	NR	2E-05	5E-08	NR	NR	4E-06	8E-09

Notes:
NR = Not Revised for this Response. The corrcted original values were not updated in response to Agency comments.
[a] Revised estimates of potential risk based on the 2014 non-cancer reference dose [RfD] for 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) in EPA's Integrated Risk Information System (IRIS).
[b] Dioxin was not evaluated in surface water. As such, revised estimates are not presented in this table. See footnote "c" for note regarding the original estimates
[c] Original estimates reflect calculation corrections made to the January 2009 Risk Estimates presented in the WDNR Submittal: *Human Health and Ecological Risk Assessment for the off-Property area.*
Red highlighted cells indicate exceedance of HI of 1 or exceedance of Potential ELCR of 1E-5. No exceedances are present

Table 3. NOAEL Hazard Quotient Summary

Area 1

	Mammal								Avian							
	Little Brown Bat		Meadow Vole		Mink		Shrew		American Robin		Belted Kingfisher		Tree Swallow		Woodcock	
Constituent	Previous	Revised	Previous	Revised	Previous	Revised	Previous	Revised	Previous	Revised	Previous	Revised	Previous	Revised	Previous	Revised
Total PAHs	0.20	0.61	0.20	0.85	**1.1**	**1.5**	-	**7.4**	0.52	**1.6**	**4.6**	0.28	**1.7**	0.14	-	0.35
LMW PAHs	-	0.003	-	0.005	-	0.04	-	0.04	-	0.4	-	0.16	-	0.03	-	0.08
HMW PAHs	-	0.60	-	0.85	-	**1.4**	-	**7.3**	-	**1.2**	-	0.12	-	0.12	-	0.28
Pentachlorphenol	0.000004	0.000004	0.01	0.15	0.000014	0.000004	-	0.36	0.01	**1.9**	0.000002	0.00002	0.000001	0.00001	-	0.29
TCDD TEQ	0.13	0.35	**1.2**	**2.0**	0.44	0.34	-	**17**	**2**	**1.7**	0.03	0.03	0.08	0.08	-	0.75

Area 2

	Mammal								Avian							
	Little Brown Bat		Meadow Vole		Mink		Shrew		American Robin		Belted Kingfisher		Tree Swallow		Woodcock	
Constituent	Previous	Revised	Previous	Revised	Previous	Revised	Previous	Revised	Previous	Revised	Previous	Revised	Previous	Revised	Previous	Revised
Total PAHs	0.10	0.33	0.03	0.13	**1.1**	**1.5**	-	**1.1**	0.09	0.29	**4.6**	0.28	1.0	0.08	-	0.06
LMW PAHs	-	0.002	-	0.003	-	0.04	-	0.01	-	0.12	-	0.16		0.02	-	0.02
HMW PAHs	-	0.33	-	0.13	-	**1.4**	-	**1.1**	-	0.18	-	0.12		0.06	-	0.04
Pentachlorphenol	0.000002	0.000002	0.004	0.10	0.000007	0.000002	-	0.24	0.005	**1.3**	0.000001	0.00001	0.0000003	0.000004	-	0.19
TCDD TEQ	0.20	0.54	0.21	0.37	0.44	0.34	-	**3.2**	0.28	0.30	0.03	0.03	0.12	0.12	-	0.13

Area 3

	Mammal								Avian							
	Little Brown Bat		Meadow Vole		Mink		Shrew		American Robin		Belted Kingfisher		Tree Swallow		Woodcock	
Constituent	Previous	Revised	Previous	Revised	Previous	Revised	Previous	Revised	Previous	Revised	Previous	Revised	Previous	Revised	Previous	Revised
Total PAHs	0.10	0.33	0.03	0.13	0.33	0.47	-	**1.1**	0.09	0.26	0.74	0.06	1.0	0.08	-	0.06
LMW PAHs	-	0.002	-	0.003	-	0.004	-	0.01	-	0.10	-	0.02		0.02	-	0.02
HMW PAHs	-	0.33	-	0.13	-	0.47	-	**1.1**	-	0.16	-	0.04		0.06	-	0.04
Pentachlorphenol	0.00001	0.00001	0.004	0.10	0.000008	0.000002	-	0.24	0.005	0.98	0.000001	0.00001	0.0000003	0.000004	-	0.19
TCDD TEQ	0.20	0.54	0.21	0.37	0.19	0.14	-	**3.2**	0.28	0.29	0.01	0.01	0.12	0.12	-	0.13

Notes:

Bold values indicate HQ>1

The areas are identified as follows:

Area 1: The portion of the tributary to Crawford Creek and the surrounding floodplain that is upstream/upgradient of the confluence with Crawford Creek.

Area 2: Crawford Creek and the surrounding floodplain from the confluence with the tributary to Crawford Creek downstream to the railroad embankment.

Area 3: Crawford Creek and the surrounding floodplain downstream of the railroad embankment to the confluence with the Nemadji River.

Table 4. LOAEL Hazard Quotient Summary

Area 1

Constituent	Mammal								Avian							
	Little Brown Bat		Meadow Vole		Mink		Shrew		American Robin		Belted Kingfisher		Tree Swallow		Woodcock	
	Previous	Revised	Previous	Revised	Previous	Revised	Previous	Revised	Previous	Revised	Previous	Revised	Previous	Revised	Previous	Revised
Total PAHs	0.03	0.12	0.02	0.17	0.23	0.31	-	**1.5**	0.05	0.88	0.46	0.17	0.17	0.08	-	0.19
LMW PAHs	-	0.002	-	0.00	-	0.02	-	0.03	-	0.28	-	0.11	-	0.02	-	0.05
HMW PAHs	-	0.12	-	0.17	-	0.29	-	**1.5**	-	0.60	-	0.06	-	0.06	-	0.14
Pentachlorphenol	0.000001	0.000003	0.0019	0.14	0.000002	0.000003	-	0.32	-	0.19	-	0.000002	-	0.000001	-	0.03
TCDD TEQ	0.01	0.04	0.12	0.20	0.04	0.03	-	**1.7**	0.15	0.17	0.003	0.003	0.01	0.01	-	0.08

Area 2

Constituent	Mammal								Avian							
	Little Brown Bat		Meadow Vole		Mink		Shrew		American Robin		Belted Kingfisher		Tree Swallow		Woodcock	
	Previous	Revised	Previous	Revised	Previous	Revised	Previous	Revised	Previous	Revised	Previous	Revised	Previous	Revised	Previous	Revised
Total PAHs	0.01	0.07	0.004	0.03	0.23	0.31	-	0.22	0.01	0.17	0.46	0.17	0.10	0.04	-	0.03
LMW PAHs	-	0.001	-	0.002	-	0.02	-	0.01	-	0.08	-	0.11	-	0.01	-	0.01
HMW PAHs	-	0.07	-	0.03	-	0.29	-	0.21	-	0.09	-	0.06	-	0.03	-	0.02
Pentachlorphenol	0.000001	0.000002	0.001	0.09	0.000001	0.000002	-	0.21	-	0.13	-	0.000001	-	0.0000004	-	0.02
TCDD TEQ	0.02	0.05	0.02	0.04	0.04	0.03	-	0.32	0.03	0.03	0.003	0.003	0.01	0.01	-	0.01

Area 3

Constituent	Mammal								Avian							
	Little Brown Bat		Meadow Vole		Mink		Shrew		American Robin		Belted Kingfisher		Tree Swallow		Woodcock	
	Previous	Revised	Previous	Revised	Previous	Revised	Previous	Revised	Previous	Revised	Previous	Revised	Previous	Revised	Previous	Revised
Total PAHs	0.01	0.07	0.004	0.03	0.04	0.1	-	0.22	0.01	0.15	0.07	0.03	0.10	0.04	-	0.03
LMW PAHs	-	0.001	-	0.002	-	0.002	-	0.01	-	0.07	-	0.01	-	0.01	-	0.01
HMW PAHs	-	0.07	-	0.03	-	0.09	-	0.21	-	0.08	-	0.02	-	0.03	-	0.02
Pentachlorphenol	0.000003	0.000008	0.001	0.09	0.000001	0.000002	-	0.21	-	0.1	-	0.000001	-	0.0000004	-	0.02
TCDD TEQ	0.02	0.05	0.02	0.04	0.02	0.01	-	0.32	0.03	0.03	0.001	0.001	0.01	0.01	-	0.01

Notes:

Bold values indicate HQ>1

The areas are identified as follows:

Area 1: The portion of the tributary to Crawford Creek and the surrounding floodplain that is upstream/upgradient of the confluence with Crawford Creek.

Area 2: Crawford Creek and the surrounding floodplain from the confluence with the tributary to Crawford Creek downstream to the railroad embankment.

Area 3: Crawford Creek and the surrounding floodplain downstream of the railroad embankment to the confluence with the Nemadji River.

Table 5
Exposure Parameters
Koppers Site, Superior, WI Off-Property Area

Parameter	Shrew		Woodcock	
	Value	Reference	Value	Reference
Body Weight (kg)	0.015	Sample and Suter (1994)	0.198	Sample and Suter (1994)
Total Dietary Intake (kg/d)	0.0014	Sample and Suter (1994) and converted to DW	0.024	Sample and Suter (1994) and converted to DW
Water ingestion rate (L/day)	0.0033	Sample and Suter (1994)	0.02	Sample and Suter (1994)
Soil Ingestion Rate (kg/day)	0.00117	Sample and Suter (1994)	0.0156	Sample and Suter (1994)
Earthworm Ingestion Rate (kg/d)	100%	Assumed	100%	Assumed
Soil Dry wt./wet wt. CF	0.60	Soils comprised of 60% solids.	0.60	Soils comprised of 60% solids.
Invert Dry wt./wet wt. CF	0.16	Assumes poisture content of 84% in earthworms (USEPA 2007)	0.16	Assumes poisture content of 84% in earthworms (USEPA 2007)
Home range (ha)	0.39	Sample and Suter (1994)	73.6	Sample and Suter (1994)
Area Use Factor: US and DS	1	Home range assumed to be smaller than exposure area.	1	Based on a home range and available habitat
SUF: US and DS	1	Potentially present year-round.	0.5	Assumed to be present 6 of 12 months.

ARCADIS

Appendix B

Corrective Action Alternative
Preliminary Cost Estimates

Appendix B - Table 1
Preliminary Cost Estimate - Alternative A1
Off-Property Focused Corrective Measures Study
Former Koppers Inc. Facility - Superior, Wisconsin

Area A - Tributary from Hammond Avenue to Crawford Creek Floodplain
Alternative A1: Channel and Bank Cover

This alternative includes the following components:

- Clear existing ground surface
- Smooth existing Tributary channel to eliminate vertical and undercut banks and large cobbles or boulders
- Install non-woven geotextile (NWGT) over the smoothed existing channel surface
- Place and compact 6" of general fill over the NWGT
- Install a layer of Reactive Core Mat (RCM)
- Place and compact a minimum of 6" of general fill over RCM, plus additional fill to establish restored channel.
- Install non-woven geotextile (NWGT)
- Install stone-filled gabion mattresses
- Install a demarcation layer of NWGT, 8" of general fill and 4" vegetated topsoil on each side of new channel to taper to existing ground

Item	Description	Estimated Quantity	Unit	Unit Price	Cost
Indirect Costs					
1.	Pre-Design Investigation	1	Lump Sum	$40,000	$40,000
2.	Administration and Engineering	1	Lump Sum	$340,000	$340,000
				Total Indirect Costs:	$380,000
Construction Costs					
3.	Mobilization/Demobilization	1	Lump Sum	$151,000	$151,000
4.	Survey Control	1	Lump Sum	$40,000	$40,000
5.	Construction Support	18	Weeks	$2,000	$36,000
6.	Health and Safety Monitoring	18	Weeks	$1,600	$28,800
7.	Site Preparation				
	- Clearing and Grubbing	4.2	Acre	$10,000	$42,000
	- Access Road/Staging Area Construction	2,300	Linear Feet	$20	$46,000
	- Erosion/Sedimentation Controls	4,600	Linear Feet	$15	$69,000
8.	Temporary Bypass Pumping System and Water Treatment				
	- Obtain/Setup/Install Pumps, Piping, etc.	1	Lump Sum	$15,000	$15,000
	- Weekly Operation	18	Weeks	$2,500	$45,000
	- Water management during excavation	1	Lump Sum	$50,000	$50,000
9.	General smoothing/reworking of Tributary channel	2,250	Linear Feet	$45	$101,250
	-Dewater/solidify excavated materials	500	Cubic Yards	$20	$10,000
10.	Tributary and Bank Restoration				
	-8-oz NWGT Demarcation Fabric	70,380	Square Feet	$0.45	$31,671
	-Reactive Core Mat (RCM)	57,920	Square Feet	$3.80	$220,096
	-General Fill	7,320	Cubic Yards	$30	$219,600
	-8-oz NWGT Separation Fabric (under gabions)	55,720	Square Feet	$0.45	$25,074
	-Gabion Mats				
	Type "I" - 12'x3'x1'	213	Each	$500	$106,500
	Type "Z" - 12'x6'x1'	426	Each	$575	$244,950
	-Stone Fill for Gabions (4" to 8"Ø rock)	1,421	Cubic Yards	$65	$92,365
	-Topsoil (4")	880	Cubic Yards	$60	$52,800
	-Temporary Erosion Control Mat (NAG SC150)	77,720	Square Feet	$1.50	$116,580
	-Restore upland/riparian vegetation	4.2	Acre	$6,000	$25,200
				Subtotal Construction Costs:	$1,768,886
				Contingency (25%):	$442,222
				Total Construction Costs:	$2,211,108
Material Disposal					
11.	Off-site T&D	850	Tons	$575	$488,750

Appendix B - Table 1
Preliminary Cost Estimate - Alternative A1
Off-Property Focused Corrective Measures Study
Former Koppers Inc. Facility - Superior, Wisconsin

Item	Description	Estimated Quantity	Unit	Unit Price	Cost
Operation and Maintenance (O&M) Costs					
12.	Annual Inspections (30 years)	1	Lump Sum	$5,000	$5,000
	Present Worth Factor (30 years @ 7%):				12.41
	Present Worth Cost:				$62,050
13.	Maintenance Activities (1 every five years for 30 years)	1	Lump Sum	$5,000	$5,000
	Sinking Fund Factor (5 years @ 7%):				0.174
	Present Worth Factor (30 years @ 7%):				12.41
	Present Worth Cost:				$10,797
	Total O&M Costs:				$72,847
	Total Estimated Cost for Alternative A1:				**$3,152,704**
	Total Estimated Cost for Alternative A1 (Rounded):				**$3,153,000**

General Comments:

- All costs include labor, materials, and installation unless otherwise noted.
- Costs do not include legal fees, permitting, obtaining access, negotiations, or agency oversight.
- Unit costs are estimated from RS Means Cost Data books, vendor quotes, professional judgment, and/or experience from other similar projects.
- Costs based on current site information and project understanding and may change following collection of additional data and/or receipt of WDNR input and actual project design.
- A 25% contingency allowance is included for construction costs to provide for unforeseen circumstances or variability in estimated quantities and/or unit prices.

Notes and Assumptions:

- Administration and engineering cost includes design of remedial approach, onsite construction observation, and project documentation. Assumed to be approximately 15% of the construction costs.
- Mobilization/demobilization includes costs for mobilization and demobilization of labor, equipment, and materials necessary to implement this alternative (assumed to be approximately 10% of the cost of Items 7-10). Cost estimate assumes one construction season would be required to complete the project.
- Survey control includes construction layout and grade control, and as-built survey.
- Construction support cost includes an office trailer, phone/fax line, electrical supply, portable restroom facilities, etc. for the duration of the construction project.
- Health and safety monitoring includes air monitoring required for worker health and safety.
- Off-site disposal costs assume materials are hazardous waste; transportation by rail; and 1.7 tons per in-situ cubic yard of excavated material.
- Estimated construction durations assume no weather or flooding-related delays. Adverse weather and flooding conditions could significantly impact the schedule for construction activities, resulting in potentially longer durations than estimated.

Appendix B - Table 2
Preliminary Cost Estimate - Alternative A2
Off-Property Focused Corrective Measures Study
Former Koppers Inc. Facility - Superior, Wisconsin

Area A - Tributary from Hammond Avenue to Crawford Creek Floodplain
Alternative A2: Channel and Bank Cover, with DNAPL Collection Provisions

This alternative includes the following components:
- Clear existing ground surface
- Smooth the existing Tributary channel to eliminate vertical and undercut banks and large cobbles or boulders
- Install non-woven geotextile (NWGT) over the smoothed existing channel surface
- Install a gravel collection trench upgradient of the railroad crossing
- Place and compact 6" of general fill over the NWGT
- Install a layer of Reactive Core Mat (RCM) over the general fill
- Place and compact a minimum of 6" of general fill over the RCM, plus additional fill to establish the Baseline and Secondary flow channels
- Install non-woven geotextile (NWGT) and soil-choked stone-filled gabion mattresses as the Baseline Flow Channel
- Install wedge dam or rock weir velocity control structures
- Install erosion control mat and riparian vegetation within Secondary Flow Channel

Item	Description	Estimated Quantity	Unit	Unit Price	Cost
Indirect Costs					
1.	Pre-Design Investigation	1	Lump Sum	$40,000	$40,000
2.	Administration and Engineering	1	Lump Sum	$300,000	$300,000
				Total Indirect Costs:	$340,000
Construction Costs					
3.	Mobilization/Demobilization	1	Lump Sum	$155,000	$155,000
4.	Survey Control	1	Lump Sum	$40,000	$40,000
5.	Construction Support	19	Weeks	$2,000	$38,000
6.	Health and Safety Monitoring	19	Weeks	$1,600	$30,400
7.	Site Preparation				
	- Clearing and Grubbing	4.2	Acre	$10,000	$42,000
	- Access Road/Staging Area Construction	2,300	Linear Feet	$20	$46,000
	- Erosion/Sedimentation Controls	4,600	Linear Feet	$15	$69,000
8.	Temporary Bypass Pumping System and Water Treatment				
	- Obtain/Setup/Install Pumps, Piping, etc.	1	Lump Sum	$15,000	$15,000
	- Weekly Operation	19	Weeks	$2,500	$47,500
	- Water management during excavation	1	Lump Sum	$50,000	$50,000
9.	General smoothing/reworking of Tributary channel	2,250	Linear Feet	$45	$101,250
	-Dewater/solidify excavated materials	500	Cubic Yards	$20	$10,000
10.	Tributary and Bank Restoration				
	-8-oz NWGT Separation Fabric	103,800	Square Feet	$0.45	$46,710
	-General Fill for RCM cushion	1,137	Cubic Yards	$30	$34,097
	-Reactive Core Mat (RCM)	73,290	Square Feet	$3.80	$278,502
	-Excavation for DNAPL collection trench	6	Cubic Yards	$60	$356
	-Dewater/solidify excavated material	6	Cubic Yards	$20	$119
	-Gravel for DNAPL collection trench	6	Cubic Yards	$100	$593
	-HDPE pipe for DNAPL collection trench	15	Linear Feet	$20	$300
	-General Fill	6,118	Cubic Yards	$30	$183,528
	-8-oz NWGT Separation Fabric (under gabions)	36,000	Square Feet	$0.45	$16,200
	-Gabion Mats				
	Type "I" - 12'x3'x1'	375	Each	$500	$187,500
	Type "Z" - 12'x6'x1'	188	Each	$575	$107,813
	-Stone Fill for Gabions (4" to 8"Ø rock; 80%)	800	Cubic Yards	$65	$52,000
	-General Fill for Gabions (20%)	200	Cubic Yards	$30	$6,000
	-Install wedge dam or rock weir grade control structures	9	each	$5,000	$45,000
	-Topsoil (4")	921	Cubic Yards	$60	$55,278
	-Temporary Erosion Control Mat (NAG SC150)	89,550	Square Feet	$1.50	$134,325
	-Restore upland/riparian vegetation	4.2	Acre	$6,000	$25,200
				Subtotal Construction Costs:	$1,554,269
				Contingency (25%):	$388,567
				Total Construction Costs:	$1,942,836
Material Disposal					
11.	Off-Site T&D	850	Tons	$575	$488,750

Appendix B - Table 2
Preliminary Cost Estimate - Alternative A2
Off-Property Focused Corrective Measures Study
Former Koppers Inc. Facility - Superior, Wisconsin

Item	Description	Estimated Quantity	Unit	Unit Price	Cost
Operation and Maintenance (O&M) Costs					
12.	Annual Inspections (30 years)	1	Lump Sum	$5,000	$5,000
	Present Worth Factor (30 years @ 7%):				12.41
	Present Worth Cost:				$62,050
13.	Maintenance Activities (1 every five years for 30 years)	1	Lump Sum	$5,000	$5,000
	Sinking Fund Factor (5 years @ 7%):				0.174
	Present Worth Factor (30 years @ 7%):				12.41
	Present Worth Cost:				$10,796.70
	Total O&M Costs:				$72,847
	Total Estimated Cost for Alternative A2:				**$2,844,433**
	Total Estimated Cost for Alternative A2 (Rounded):				**$2,844,000**

General Comments:

- All costs include labor, materials, and installation unless otherwise noted.
- Costs do not include legal fees, permitting, obtaining access, negotiations, or agency oversight.
- Unit costs are estimated from RS Means Cost Data books, vendor quotes, professional judgment, and/or experience from other similar projects.
- Costs based on current site information and project understanding and may change following collection of additional data and/or receipt of WDNR input and actual project design.
- A 25% contingency allowance is included for construction costs to provide for unforeseen circumstances or variability in estimated quantities and/or unit prices.

Notes and Assumptions:

- Administration and engineering cost includes design of remedial approach, onsite construction observation, and project documentation. Assumed to be approximately 15% of the construction costs.
- Mobilization/demobilization includes costs for mobilization and demobilization of labor, equipment, and materials necessary to implement this alternative (assumed to be approximately 10% of the cost of Items 7-10). Cost estimate assumes one construction season would be required to complete the project.
- Survey control includes construction layout and grade control, and as-built survey.
- Construction support cost includes an office trailer, phone/fax line, electrical supply, portable restroom facilities, etc. for the duration of the construction project.
- Health and safety monitoring includes air monitoring required for worker health and safety.
- Off-site disposal costs assume materials are hazardous waste; transportation by rail; and 1.7 tons per in-situ cubic yard of excavated material.
- Estimated construction durations assume no weather or flooding-related delays. Adverse weather and flooding conditions could significantly impact the schedule for construction activities, resulting in potentially longer durations than estimated.

Appendix B - Table 3
Preliminary Cost Estimate - Alternative A3
Off-Property Focused Corrective Measures Study
Former Koppers Inc. Facility - Superior, Wisconsin

Area A - Tributary from Hammond Avenue to Crawford Creek Floodplain
Alternative A3: Extended Channel and Bank Excavation/Backfill

This alternative includes the following components:
- -Clear existing ground surface
- -Excavate Tributary channel and bank materials to the limits shown on Figure 6, which are based on existing soil boring and test pit data. Excavation limits extend up to 55 feet from the edge of the channel and up to 24 feet bgs.
- -Fill excavation with general fill
- -Install non-woven NWGT and stone-filled gabion mattresses in Tributary
- -Install 4" vegetated topsoil on each side of excavated channel
- -Consolidate excavated materials in on-property CAMU containment cell, or dispose of off-Site

Item	Description	Estimated Quantity	Unit	Unit Price	Cost
Indirect Costs					
1.	Pre-Design Investigation	1	Lump Sum	$20,000	$20,000
2.	Administration and Engineering	1	Lump Sum	$2,980,000	$2,980,000
				Total Indirect Costs:	$3,000,000
Construction Costs					
3.	Mobilization/Demobilization (2 construction seasons)	2	Lump Sum	$1,306,000	$2,612,000
4.	Survey Control	1	Lump Sum	$40,000	$40,000
5.	Construction Support	40	Weeks	$2,000	$80,000
6.	Health and Safety Monitoring	40	Weeks	$1,600	$64,000
7.	Site Preparation				
	- Clearing and Grubbing	6.5	Acre	$10,000	$65,000
	- Access Road/Staging Area Construction	5,200	Linear Feet	$20	$104,000
	- Erosion/Sedimentation Controls	5,200	Linear Feet	$15	$78,000
8.	Temporary Bypass Pumping System and Water Treatment				
	- Obtain/Setup/Install Pumps, Piping, etc.	1	Lump Sum	$15,000	$15,000
	- Weekly Operation	40	Weeks	$2,500	$100,000
	- Water management during excavation	1	Lump Sum	$1,500,000	$1,500,000
9.	Tributary Channel/Bank Excavation				
	-Excavate Tributary channel and bank materials	60,710	Cubic Yards	$90	$5,463,900
	-Dewater/solidify excavated materials	60,710	Cubic Yards	$20	$1,214,200
	-Overexcavation for side-slope stability	18,750	Cubic Yards	$90	$1,687,500
10.	Tributary and Bank Restoration				
	-General Fill	57,716	Cubic Yards	$30	$1,731,480
	-Re-place/compact overexcavated material	18,750	Cubic Yards	$15	$281,250
	-8-oz NWGT Separation Fabric (under gabions)	56,460	Square Feet	$0.45	$25,407
	-Gabion Mats				
	Type "I" - 12'x3'x1'	213	Each	$500	$106,500
	Type "Z" - 12'x6'x1'	426	Each	$575	$244,950
	-Stone Fill for Gabions (4" to 8"Ø rock)	1,421	Cubic Yards	$65	$92,365
	-Topsoil (4")	1,573	Cubic Yards	$60	$94,380
	-Temporary Erosion Control Mat (NAG SC150)	148,005	Square Feet	$1.50	$222,008
	-Restore upland/riparian vegetation	6.5	Acre	$6,000	$39,000
				Subtotal Construction Costs:	$15,860,940
				Contingency (25%):	$3,965,235
				Total Construction Costs:	$19,826,174
Material Disposal					
11.	Option 1: Off-Site T&D	103,207	Tons	$575	$59,344,025
12.	Option 2: On-Site CAMU Disposal				
	Transport excavated material to CAMU	60,710	Cubic Yards	$13	$789,230
	CAMU Construction, Operation, and Maintenance	1	Lump Sum	$5,200,000	$5,200,000

Appendix B - Table 3
Preliminary Cost Estimate - Alternative A3
Off-Property Focused Corrective Measures Study
Former Koppers Inc. Facility - Superior, Wisconsin

Item	Description	Estimated Quantity	Unit	Unit Price	Cost
Operation and Maintenance (O&M) Costs					
13.	Annual Inspections (30 years)	1	Lump Sum	$5,000	$5,000
	Present Worth Factor (30 years @ 7%):				12.41
	Present Worth Cost:				$62,050
14.	Maintenance Activities (1 every five years for 30 years)	1	Lump Sum	$5,000	$5,000
	Sinking Fund Factor (5 years @ 7%):				0.174
	Present Worth Factor (30 years @ 7%):				12.41
	Present Worth Cost:				$10,796.70
	Total O&M Costs:				$72,847
	Total Estimated Cost for Alternative A3, Off-Site Disposal:				**$82,243,046**
	Total Estimated Cost for Alternative A3, Off-Site Disposal (Rounded):				**$82,243,000**
	Total Estimated Cost for Alternative A3, CAMU:				**$28,888,251**
	Total Estimated Cost for Alternative A3, CAMU (Rounded):				**$28,888,000**

General Comments:

- All costs include labor, materials, and installation unless otherwise noted.
- Costs do not include legal fees, permitting, obtaining access, negotiations, or agency oversight.
- Unit costs are estimated from RS Means Cost Data books, vendor quotes, professional judgment, and/or experience from other similar projects.
- Costs based on current site information and project understanding and may change following collection of additional data and/or receipt of WDNR input and actual project design.
- A 25% contingency allowance is included for construction costs to provide for unforeseen circumstances or variability in estimated quantities and/or unit prices.

Notes and Assumptions:

- Administration and engineering cost includes design of remedial approach, onsite construction observation, and project documentation. Assumed to be approximately 15% of the construction costs.
- Mobilization/demobilization includes costs for mobilization and demobilization of labor, equipment, and materials necessary to implement this alternative (assumed to be approximately 10% of the cost of Items 7-10). Cost estimate assumes two construction seasons would be required to complete the project.
- Survey control includes construction layout and grade control, and as-built survey.
- Construction support cost includes an office trailer, phone/fax line, electrical supply, portable restroom facilities, etc. for the duration of the construction project.
- Health and safety monitoring includes air monitoring required for worker health and safety.
- Off-site disposal costs assume materials are hazardous waste; transportation by rail; and 1.7 tons per in-situ cubic yard of excavated material.
- CAMU construction, operation, and maintenance costs estimated from costs of other similar projects.
- Estimated construction durations assume no weather or flooding-related delays. Adverse weather and flooding conditions could significantly impact the schedule for construction activities, resulting in potentially longer durations than estimated.

Appendix B - Table 4
Preliminary Cost Estimate - Alternative B1
Off-Property Focused Corrective Measures Study
Former Koppers Inc. Facility - Superior, Wisconsin

Area B - Tributary within Crawford Creek Floodplain
Alternative B1: Partial Channel Excavation/Backfill, 1' Floodplain Cover

This alternative includes the following components:

- -Clear existing ground surface
- -Excavate sediment from bottom/banks of Tributary channel as necessary for new channel (4' wide base, 1' depth, 3H:1V sideslopes)
- -Install a layer of Reactive Core Mat (RCM) within the Tributary channel
- -Install 1/2" square, 19 gauge galvanized wire mesh over the RCM
- -Install and compact 12-inches clayey general fill in Tributary channel
- -Install a demarcation layer of NWGT, 8" of general fill and 4" vegetated topsoil over prepared impacted floodplain area

Item	Description	Estimated Quantity	Unit	Unit Price	Cost
Indirect Costs					
1.	Pre-Design Investigation	1	Lump Sum	$25,000	$25,000
2.	Administration and Engineering	1	Lump Sum	$130,000	$130,000
				Total Indirect Costs:	$155,000
Construction Costs					
3.	Mobilization/Demobilization	1	Lump Sum	$56,000	$56,000
4.	Survey Control	1	Lump Sum	$20,000	$20,000
5.	Construction Support	6	Weeks	$2,000	$12,000
6.	Health and Safety Monitoring	6	Weeks	$1,600	$9,600
7.	Site Preparation				
	- Clearing and Grubbing	4.4	Acre	$8,000	$35,200
	- Access Road/Staging Area Construction	630	Linear Feet	$20	$12,600
	- Erosion/Sedimentation Controls	1,260	Linear Feet	$15	$18,900
8.	Temporary Bypass Pumping System and Water Treatment				
	- Obtain/Setup/Install Pumps, Piping, etc.	1	Lump Sum	$15,000	$15,000
	- Weekly Operation	6	Weeks	$2,500	$15,000
	- Water management during excavation	1	Lump Sum	$50,000	$50,000
9.	Tributary Channel Excavation				
	-Excavate Tributary channel	139	Cubic Yards	$60	$8,333
	-Dewater/solidify excavated materials	139	Cubic Yards	$20	$2,778
10.	Tributary Restoration				
	-Reactive Core Mat (RCM)	9,000	Square Feet	$3.80	$34,200
	-1/2" square, 19 gauge galvanized wire mesh	9,000	Square Feet	$0.63	$5,625
	-General Fill	347	Cubic Yards	$30	$10,417
11.	Floodplain Cover				
	-8-oz NWGT Separation Fabric	169,110	Square Feet	$0.45	$76,100
	-General Fill (8")	4,176	Cubic Yards	$30	$125,267
	-Topsoil (4")	2,088	Cubic Yards	$60	$125,267
	-Seed and Mulch w/ Native Wetland Mix	4.4	Acre	$6,000	$26,400
				Subtotal Construction Costs:	$658,686
				Contingency (25%):	$164,671
				Total Construction Costs:	$823,357
Material Disposal					
12.	Off-Site T&D	236	Tons	$575	$135,764

Appendix B - Table 4
Preliminary Cost Estimate - Alternative B1
Off-Property Focused Corrective Measures Study
Former Koppers Inc. Facility - Superior, Wisconsin

Item	Description	Estimated Quantity	Unit	Unit Price	Cost
Operation and Maintenance (O&M) Costs					
13.	Restored Wetlands Inspection and Maintenance (5 years)	1	Lump Sum	$10,000	$10,000
	Present Worth Factor (5 years @ 7%):				4.1
	Present Worth Cost:				$41,000
14.	Annual Inspections (30 years)	1	Lump Sum	$3,000	$3,000
	Present Worth Factor (30 years @ 7%):				12.41
	Present Worth Cost:				$37,230
15.	Maintenance Activities (1 every five years for 30 years)	1	Lump Sum	$4,000	$4,000
	Sinking Fund Factor (5 years @ 7%):				0.174
	Present Worth Factor (30 years @ 7%):				12.41
	Present Worth Cost:				$8,637
	Total O&M Costs:				$86,867
	Total Estimated Cost for Alternative B1:				**$1,200,988**
	Total Estimated Cost for Alternative B1 (Rounded):				**$1,201,000**

General Comments:

- All costs include labor, materials, and installation unless otherwise noted.
- Costs do not include legal fees, permitting, obtaining access, negotiations, or agency oversight.
- Unit costs are estimated from RS Means Cost Data books, vendor quotes, professional judgment, and/or experience from other similar projects.
- Costs based on current site information and project understanding and may change following collection of additional data and/or receipt of WDNR input and actual project design.
- A 25% contingency allowance is included for construction costs to provide for unforeseen circumstances or variability in estimated quantities and/or unit prices.

Notes and Assumptions:

- Administration and engineering cost includes design of remedial approach, onsite construction observation, and project documentation. Assumed to be approximately 15% of the construction costs.
- Mobilization/demobilization includes costs for mobilization and demobilization of labor, equipment, and materials necessary to implement this alternative (assumed to be approximately 10% of the cost of Items 7-11). Cost estimate assumes one construction season would be required to complete the project.
- Survey control includes construction layout and grade control, and as-built survey.
- Construction support cost includes an office trailer, phone/fax line, electrical supply, portable restroom facilities, etc. for the duration of the construction project.
- Health and safety monitoring includes air monitoring required for worker health and safety.
- Off-site disposal costs assume materials are hazardous waste; transportation by rail; and 1.7 tons per in-situ cubic yard of excavated material.
- Estimated construction durations assume no weather or flooding-related delays. Adverse weather and flooding conditions could significantly impact the schedule for construction activities, resulting in potentially longer durations than estimated.

Appendix B - Table 5
Preliminary Cost Estimate - Alternative B2
Off-Property Focused Corrective Measures Study
Former Koppers Inc. Facility - Superior, Wisconsin

Area B - Tributary within Crawford Creek Floodplain
Alternative B2: Partial Channel Excavation/Backfill, 1' Floodplain Excavation/Backfill

This alternative includes the following components:
- -Clear existing ground surface
- -Excavate sediment from bottom/banks of Tributary channel as necessary for new channel (4' wide base, 1' depth, 3H:1V sideslopes)
- -Install a layer of Reactive Core Mat (RCM) within the Tributary channel
- -Install 1/2" square, 19 gauge galvanized wire mesh over the RCM
- -Install and compact 12-inches clayey general fill in Tributary channel
- -Excavate 1' of existing floodplain materials from impacted floodplain area
- -Backfill floodplain excavation with a demarcation layer of NWGT, 8" of general fill and 4" vegetated topsoil
- -Consolidate excavated materials in on-property CAMU containment cell, or dispose of off-Site

Item	Description	Estimated Quantity	Unit	Unit Price	Cost
Indirect Costs					
1.	Pre-Design Investigation	1	Lump Sum	$25,000	$25,000
2.	Administration and Engineering	1	Lump Sum	$210,000	$210,000
				Total Indirect Costs:	$235,000
Construction Costs					
3.	Mobilization/Demobilization	1	Lump Sum	$94,000	$94,000
4.	Survey Control	1	Lump Sum	$20,000	$20,000
5.	Construction Support	8	Weeks	$2,000	$16,000
6.	Health and Safety Monitoring	8	Weeks	$1,600	$12,800
7.	Site Preparation				
	- Clearing and Grubbing	4.4	Acre	$8,000	$35,200
	- Access Road/Staging Area Construction	630	Linear Feet	$20	$12,600
	- Erosion/Sedimentation Controls	1,260	Linear Feet	$15	$18,900
8.	Temporary Bypass Pumping System and Water Treatment				
	- Obtain/Setup/Install Pumps, Piping, etc.	1	Lump Sum	$15,000	$15,000
	- Weekly Operation	8	Weeks	$2,500	$20,000
	- Water management during excavation	1	Lump Sum	$100,000	$100,000
9.	Tributary Channel Excavation				
	-Excavate Tributary channel	347	Cubic Yards	$60	$20,833
	-Dewater/solidify excavated materials	347	Cubic Yards	$20	$6,944
10.	Tributary Restoration/Backfill				
	-Reactive Core Mat (RCM)	9,000	Square Feet	$3.80	$34,200
	-1/2" square, 19 gauge galvanized wire mesh	9,000	Square Feet	$0.63	$5,625
	-General Fill	278	Cubic Yards	$30	$8,333
11.	Floodplain Excavation				
	-Excavate Floodplain	5,219	Cubic Yards	$40	$208,778
	-Dewater/solidify excavated materials	5,219	Cubic Yards	$20	$104,389
12.	Floodplain Restoration/Backfill				
	-8-oz NWGT Separation Fabric	169,110	Square Feet	$0.45	$76,100
	-General Fill (8")	4,176	Cubic Yards	$30	$125,267
	-Topsoil (4")	2,088	Cubic Yards	$60	$125,267
	-Seed and Mulch w/ Native Wetland Mix	4.4	Acre	$6,000	$26,400
				Subtotal Construction Costs:	$1,086,636
				Contingency (25%):	$271,659
				Total Construction Costs:	$1,358,295
Material Disposal					
13.	Option 1: Off-Site T&D	9,463	Tons	$575	$5,441,417
14.	Option 2: On-Site CAMU Disposal				
	Transport excavated material to CAMU	5,567	Cubic Yards	$13	$72,367
	CAMU Construction, Operation, and Maintenance	1	Lump Sum	$1,400,000	$1,400,000

Appendix B - Table 5
Preliminary Cost Estimate - Alternative B2
Off-Property Focused Corrective Measures Study
Former Koppers Inc. Facility - Superior, Wisconsin

Item	Description	Estimated Quantity	Unit	Unit Price	Cost
Operation and Maintenance (O&M) Costs					
15.	Restored Wetlands Inspection and Maintenance (5 years)	1	Lump Sum	$10,000	$10,000
	Present Worth Factor (5 years @ 7%):				4.1
	Present Worth Cost:				$41,000
16.	Annual Inspections (30 years)	1	Lump Sum	$3,000	$3,000
	Present Worth Factor (30 years @ 7%):				12.41
	Present Worth Cost:				$37,230
17.	Maintenance Activities (1 every five years for 30 years)	1	Lump Sum	$4,000	$4,000
	Sinking Fund Factor (5 years @ 7%):				0.174
	Present Worth Factor (30 years @ 7%):				12.41
	Present Worth Cost:				$8,637
	Total O&M Costs:				$86,867
	Total Estimated Cost for Alternative B2, Off-Site Disposal:				**$7,121,579**
	Total Estimated Cost for Alternative B2, Off-Site Disposal (Rounded):				**$7,122,000**
	Total Estimated Cost for Alternative B2, CAMU:				**$3,152,529**
	Total Estimated Cost for Alternative B2, CAMU (Rounded):				**$3,153,000**

General Comments:

- All costs include labor, materials, and installation unless otherwise noted.
- Costs do not include legal fees, permitting, obtaining access, negotiations, or agency oversight.
- Unit costs are estimated from RS Means Cost Data books, vendor quotes, professional judgment, and/or experience from other similar projects.
- Costs based on current site information and project understanding and may change following collection of additional data and/or receipt of WDNR input and actual project design.
- A 25% contingency allowance is included for construction costs to provide for unforeseen circumstances or variability in estimated quantities and/or unit prices.

Notes and Assumptions:

- Administration and engineering cost includes design of remedial approach, onsite construction observation, and project documentation. Assumed to be approximately 15% of the construction costs.
- Mobilization/demobilization includes costs for mobilization and demobilization of labor, equipment, and materials necessary to implement this alternative (assumed to be approximately 10% of the cost of Items 7-12). Cost estimate assumes one construction season would be required to complete the project.
- Survey control includes construction layout and grade control, and as-built survey.
- Construction support cost includes an office trailer, phone/fax line, electrical supply, portable restroom facilities, etc. for the duration of the construction project.
- Health and safety monitoring includes air monitoring required for worker health and safety.
- Off-site disposal costs assume materials are hazardous waste; transportation by rail; and 1.7 tons per in-situ cubic yard of excavated material.
- CAMU construction, operation, and maintenance costs estimated from costs of other similar projects.
- Estimated construction durations assume no weather or flooding-related delays. Adverse weather and flooding conditions could significantly impact the schedule for construction activities, resulting in potentially longer durations than estimated.

Appendix B - Table 6
Preliminary Cost Estimate - Alternative B3
Off-Property Focused Corrective Measures Study
Former Koppers Inc. Facility - Superior, Wisconsin

Area B - Tributary within Crawford Creek Floodplain
Alternative B3: Extended Channel and Floodplain Excavation/Backfill

This alternative includes the following components:

- -Clear existing ground surface
- -Excavate Tributary channel and bank materials to the limits shown on Figure 9, which are based on existing soil boring and test pit data. Excavation limits extend up to 250 feet from the edge of the channel and up to 15 feet bgs.
- -Fill excavation with general fill
- -Install and compact 12-inches clayey general fill in Tributary channel
- -Install 4" vegetated topsoil on each side of excavated channel
- -Consolidate excavated materials in on-property CAMU containment cell, or dispose of off-Site

Item	Description	Estimated Quantity	Unit	Unit Price	Cost
Indirect Costs					
1.	Pre-Design Investigation	1	Lump Sum	$15,000	$15,000
2.	Administration and Engineering	1	Lump Sum	$2,240,000	$2,240,000
				Total Indirect Costs:	$2,255,000
Construction Costs					
3.	Mobilization/Demobilization (2 construction seasons)	2	Lump Sum	$977,000	$1,954,000
4.	Survey Control	1	Lump Sum	$20,000	$20,000
5.	Construction Support	53	Weeks	$2,000	$106,000
6.	Health and Safety Monitoring	53	Weeks	$1,600	$84,800
7.	Site Preparation				
	- Clearing and Grubbing	4.9	Acre	$8,000	$39,200
	- Access Road/Staging Area Construction	600	Linear Feet	$20	$12,000
	- Erosion/Sedimentation Controls	1,200	Linear Feet	$15	$18,000
8.	Temporary Bypass Pumping System and Water Treatment				
	- Obtain/Setup/Install Pumps, Piping, etc.	1	Lump Sum	$15,000	$15,000
	- Weekly Operation	53	Weeks	$2,500	$132,500
	- Water management during excavation	1	Lump Sum	$1,000,000	$1,000,000
9.	Tributary Channel and Floodplain Excavation				
	-Excavate Tributary and Floodplain Materials	55,716	Cubic Yards	$90	$5,014,440
	-Dewater/solidify excavated materials	55,716	Cubic Yards	$20	$1,114,320
	-Overexcavation for side-slope stability	6,833	Cubic Yards	$90	$615,000
10.	Tributary Restoration/Backfill				
	-General Fill	2,233	Cubic Yards	$30	$67,000
11.	Floodplain Restoration/Backfill				
	-General Fill	51,877	Cubic Yards	$30	$1,556,315
	-Re-place/compact overexcavated material	6,833	Cubic Yards	$15	$102,500
	-Topsoil (4")	1,606	Cubic Yards	$60	$55,350
	-Seed and Mulch w/ Native Wetland Mix	4.9	Acre	$6,000	$29,400
				Subtotal Construction Costs:	$11,935,825
				Contingency (25%):	$2,983,956
				Total Construction Costs:	$14,919,781
Material Disposal					
12.	Option 1: Off-Site T&D	94,717	Tons	$575	$54,462,390
13.	Option 2: On-Site CAMU Disposal				
	Transport excavated material to CAMU	55,716	Cubic Yards	$13	$724,308
	CAMU Construction, Operation, and Maintenance	1	Lump Sum	$4,800,000	$4,800,000

Appendix B - Table 6
Preliminary Cost Estimate - Alternative B3
Off-Property Focused Corrective Measures Study
Former Koppers Inc. Facility - Superior, Wisconsin

Item	Description	Estimated Quantity	Unit	Unit Price	Cost
Operation and Maintenance (O&M) Costs					
14.	Restored Wetlands Inspection and Maintenance (5 years)	1	Lump Sum	$10,000	$10,000
	Present Worth Factor (5 years @ 7%):				4.1
	Present Worth Cost:				$41,000
15.	Annual Inspections (30 years)	1	Lump Sum	$3,000	$3,000
	Present Worth Factor (30 years @ 7%):				12.41
	Present Worth Cost:				$37,230
16.	Maintenance Activities (1 every five years for 30 years)	1	Lump Sum	$4,000	$4,000
	Sinking Fund Factor (5 years @ 7%):				0.174
	Present Worth Factor (30 years @ 7%):				12.41
	Present Worth Cost:				$8,637.36
Total O&M Costs:					$86,867
Total Estimated Cost for Alternative B3, Off-Site Disposal:					**$71,724,039**
Total Estimated Cost for Alternative B3, Off-Site Disposal (Rounded):					**$71,724,000**
Total Estimated Cost for Alternative B3, CAMU:					**$22,785,957**
Total Estimated Cost for Alternative B3, CAMU (Rounded):					**$22,786,000**

General Comments:

- All costs include labor, materials, and installation unless otherwise noted.
- Costs do not include legal fees, permitting, obtaining access, negotiations, or agency oversight.
- Unit costs are estimated from RS Means Cost Data books, vendor quotes, professional judgment, and/or experience from other similar projects.
- Costs based on current site information and project understanding and may change following collection of additional data and/or receipt of WDNR input and actual project design.
- A 25% contingency allowance is included for construction costs to provide for unforeseen circumstances or variability in estimated quantities and/or unit prices.

Notes and Assumptions:

- Administration and engineering cost includes design of remedial approach, onsite construction observation, and project documentation. Assumed to be approximately 15% of the construction costs.
- Mobilization/demobilization includes costs for mobilization and demobilization of labor, equipment, and materials necessary to implement this alternative (assumed to be approximately 10% of the cost of Items 7-11). Cost estimate assumes two construction seasons would be required to complete the project.
- Survey control includes construction layout and grade control, and as-built survey.
- Construction support cost includes an office trailer, phone/fax line, electrical supply, portable restroom facilities, etc. for the duration of the construction project.
- Health and safety monitoring includes air monitoring required for worker health and safety.
- Off-site disposal costs assume materials are hazardous waste; transportation by rail; and 1.7 tons per in-situ cubic yard of excavated material.
- CAMU construction, operation, and maintenance costs estimated from costs of other similar projects.
- Estimated construction durations assume no weather or flooding-related delays. Adverse weather and flooding conditions could significantly impact the schedule for construction activities, resulting in potentially longer durations than estimated.

Appendix B - Table 7
Preliminary Cost Estimate - Alternative C1
Off-Property Focused Corrective Measures Study
Former Koppers Inc. Facility - Superior, Wisconsin

Area C - Crawford Creek from Tributary to Railroad Embankment
Alternative C1: Channel Relocation with Armored Channel

This alternative includes the following components:
- Clear existing ground surface
- Construct a new creek channel along western/northwestern edge of Crawford Creek floodplain:
  - Install a layer of Reactive Core Mat (RCM), 12" general fill, non-woven geotextile (NWGT) and 12" gravel/stone armoring in the new channel 100' up and downgradient of where new channel connects with the existing channel
  - Install NWGT and 12" gravel/stone armoring in the remaining stretches of the new channel
- Install NWGT and backfill existing channel with soils excavated from the new channel construction.
- Where the new alignment connects to the existing:
  - Excavate channel bottom/banks as necessary
  - Install a layer of Reactive Core Mat (RCM)
  - Install 12" general fill
  - Install NWGT and 12" gravel/stone armoring
- Install 4" vegetated topsoil over backfilled existing channel.

Item	Description	Estimated Quantity	Unit	Unit Price	Cost
Indirect Costs					
1.	Pre-Design Investigation	1	Lump Sum	$85,000	$85,000
2.	Administration and Engineering	1	Lump Sum	$440,000	$440,000
				Total Indirect Costs:	$525,000
Construction Costs					
3.	Mobilization/Demobilization	1	Lump Sum	$201,000	$201,000
4.	Survey Control	1	Lump Sum	$50,000	$50,000
5.	Construction Support	18	Weeks	$2,000	$36,000
6.	Health and Safety Monitoring	18	Weeks	$1,600	$28,800
7.	Site Preparation				
	- Clearing and Grubbing	17	Acre	$8,000	$136,000
	- Access Road/Staging Area Construction	3,500	Linear Feet	$20	$70,000
	- Erosion/Sedimentation Controls	7,000	Linear Feet	$15	$105,000
8.	Temporary Bypass Pumping System and Water Treatment				
	- Obtain/Setup/Install Pumps, Piping, etc.	1	Lump Sum	$15,000	$15,000
	- Weekly Operation	18	Weeks	$2,500	$45,000
	- Water management during excavation	1	Lump Sum	$50,000	$50,000
9.	Excavate new channel alignment (includes additional excavation for 100' up/downgradient of where new channel connects with existing)	8,178	Cubic Yards	$18	$147,200
10.	Construct new channel alignment				
	-8-oz NWGT Demarcation Fabric	103,130	Square Feet	$0.45	$46,409
	-RCM (install 100' up/downgradient of where new channel connects with existing)	8,000	Square Feet	$3.80	$30,400
	-General Fill (install over RCM, 100' up/downgradient of where new channel connects with existing)	296	Cubic Yards	$30	$8,889
	-Gravel/Stone	3,150	Cubic Yards	$100	$315,000
11.	In-Place Channel Excavation/Restoration				
	-Excavate channel bottom/banks	500	Cubic Yards	$60	$30,000
	-Dewater/solidify excavated material	500	Cubic Yards	$20	$10,000
	-Reactive Core Mat (RCM)	6,075	Square Feet	$3.80	$23,085
	-General Fill	225	Cubic Yards	$30	
	-8-oz NWGT Separation Fabric	1,800	Square Feet	$0.45	$810
	-Gravel/Stone	5,625	Cubic Yards	$100	$562,500
	-Topsoil (4"), above flowline	1,199	Cubic Yards	$60	$71,955
	-Temporary Erosion Control Mat (NAG SC150)	3,600	Square Feet	$1.50	$5,400
12.	Fill existing channel				
	-8-oz NWGT Demarcation Fabric	156,520	Square Feet	$0.45	$70,434
	-Backfill with stockpiled cut from new channel alignment	6,074	Cubic Yards	$24	$145,778
	-Topsoil (4")	326	Cubic Yards	$60	$19,556
13.	General Restoration				
	Seed and Mulch w/ Native Wetland Mix	17	Acre	$6,000	$102,000
				Subtotal Construction Costs:	$2,326,215
				Contingency (25%):	$581,554
				Total Construction Costs:	$2,907,768
Material Disposal					
14.	Off-Site T&D	850	Tons	$575	$488,750

Appendix B - Table 7
Preliminary Cost Estimate - Alternative C1
Off-Property Focused Corrective Measures Study
Former Koppers Inc. Facility - Superior, Wisconsin

Item	Description	Estimated Quantity	Unit	Unit Price	Cost
Operation and Maintenance (O&M) Costs					
15.	Restored Wetlands Inspection and Maintenance (5 years)	1	Lump Sum	$15,000	$15,000
	Present Worth Factor (5 years @ 7%):				4.1
	Present Worth Cost:				$61,500
16.	Annual Inspections (30 years)	1	Lump Sum	$5,000	$5,000
	Present Worth Factor (30 years @ 7%):				12.41
	Present Worth Cost:				$62,050
17.	Maintenance Activities (1 every five years for 30 years)	1	Lump Sum	$5,000	$5,000
	Sinking Fund Factor (5 years @ 7%):				0.174
	Present Worth Factor (30 years @ 7%):				12.41
	Present Worth Cost:				$10,797
	Total O&M Costs:				$134,347
	Total Estimated Cost for Alternative C1:				**$4,055,865**
	Total Estimated Cost for Alternative C1 (Rounded):				**$4,056,000**

General Comments:

- All costs include labor, materials, and installation unless otherwise noted.
- Costs do not include legal fees, permitting, obtaining access, negotiations, or agency oversight.
- Unit costs are estimated from RS Means Cost Data books, vendor quotes, professional judgment, and/or experience from other similar projects.
- Costs based on current site information and project understanding and may change following collection of additional data and/or receipt of WDNR input and actual project design.
- A 25% contingency allowance is included for construction costs to provide for unforeseen circumstances or variability in estimated quantities and/or unit prices.

Notes and Assumptions:

- The pre-design investigation (PDI) would be conducted to determine the exact location of the new Crawford Creek channel and the hydraulic forces that the new channel must be designed to withstand.
- Administration and engineering cost includes design of remedial approach, onsite construction observation, and project documentation. Assumed to be approximately 15% of the construction costs.
- Mobilization/demobilization includes costs for mobilization and demobilization of labor, equipment, and materials necessary to implement this alternative (assumed to be approximately 10% of the cost of Items 7-13). Cost estimate assumes one construction
- Survey control includes construction layout and grade control, and as-built survey.
- Construction support cost includes an office trailer, phone/fax line, electrical supply, portable restroom facilities, etc. for the duration of the construction project.
- Health and safety monitoring includes air monitoring required for worker health and safety.
- Off-site disposal costs assume materials are hazardous waste; transportation by rail; and 1.7 tons per in-situ cubic yard of excavated material.
- Estimated construction durations assume no weather or flooding-related delays. Adverse weather and flooding conditions could significantly impact the schedule for construction activities, resulting in potentially longer durations than estimated.

Appendix B - Table 8
Preliminary Cost Estimate - Alternative C2
Off-Property Focused Corrective Measures Study
Former Koppers Inc. Facility - Superior, Wisconsin

Area C - Crawford Creek from Tributary to Railroad Embankment
Alternative C2: Channel Relocation with Clay-Lined Channel

This alternative includes the following components:
- -Clear existing ground surface
- -Construct a new creek channel along western/northwestern edge of Crawford Creek floodplain:
  - -Install a layer of Reactive Core Mat (RCM), 12" general fill, non-woven geotextile (NWGT) and 12" gravel/stone armoring in the new channel 100' up and downgradient of where new channel connects with the existing channel
  - -Compact clayey subgrade, as necessary in the remaining stretches of the new channel
- -Where the new alignment connects to the existing:
  - -Excavate channel bottom/banks as necessary
  - -Install a layer of Reactive Core Mat (RCM)
  - -Install 1/2" square, 19 gauge galvanized wire mesh and non-woven geotextile (NWGT) over the RCM
  - -Install and compact 12-inches clayey general fill
- -Install NWGT and backfill existing channel with soils excavated from the new channel construction
- -Install 4" vegetated topsoil over backfilled existing channel
- -Install erosion control features within the new/restored creek channel to provide velocity control, stability and habitat

Item	Description	Estimated Quantity	Unit	Unit Price	Cost
Indirect Costs					
1.	Pre-Design Investigation	1	Lump Sum	$85,000	$85,000
2.	Administration and Engineering	1	Lump Sum	$330,000	$330,000
				Total Indirect Costs:	$415,000
Construction Costs					
3.	Mobilization/Demobilization	1	Lump Sum	$145,000	$145,000
4.	Survey Control	1	Lump Sum	$50,000	$50,000
5.	Construction Support	18	Weeks	$2,000	$36,000
6.	Health and Safety Monitoring	18	Weeks	$1,600	$28,800
7.	Site Preparation				
	- Clearing and Grubbing	17	Acre	$8,000	$136,000
	- Access Road/Staging Area Construction	3,500	Linear Feet	$20	$70,000
	- Erosion/Sedimentation Controls	7,000	Linear Feet	$15	$105,000
8.	Temporary Bypass Pumping System and Water Treatment				
	- Obtain/Setup/Install Pumps, Piping, etc.	1	Lump Sum	$15,000	$15,000
	- Weekly Operation	18	Weeks	$2,500	$45,000
	- Water management during excavation	1	Lump Sum	$50,000	$50,000
9.	Excavate new channel alignment (includes additional excavation for 100' up/downgradient of where new channel connects with existing)	3,678	Cubic Yards	$18	$66,200
10.	Construct new channel alignment				
	-RCM (install 100' up/downgradient of where new channel connects with existing)	8,000	Square Feet	$3.80	$30,400
	-1/2" square, 19 gauge galvanized wire mesh (install over RCM, 100' up/downgradient of where new channel connects with existing)	8,000	Square Feet	$0.63	$5,000
	-General Fill (install over RCM and wire mesh, 100' up/downgradient of where new channel connects with existing)	296	Cubic Yards	$30	$8,889
	-Topsoil (4"), above flowline	432	Cubic Yards	$60	$25,896
	-Temporary Erosion Control Mat (NAG SC150)	34,960	Square Feet	$1.50	$52,440
11.	In-Place Channel Excavation/Restoration				
	-Excavate channel bottom/banks	2,730	Cubic Yards	$60	$163,800
	-Dewater/solidify excavated material	2,730	Cubic Yards	$20	$54,600
	-Reactive Core Mat (RCM)	36,855	Square Feet	$3.80	$140,049
	-1/2" square, 19 gauge galvanized wire mesh	36,855	Square Feet	$0.63	$23,034
	-8-oz NWGT Separation Fabric	10,920	Square Feet	$0.45	$4,914
	-General Fill	1,264	Cubic Yards	$30	$37,917
	-Topsoil (4"), above flowline	270	Cubic Yards	$60	$16,178
	-Temporary Erosion Control Mat (NAG SC150)	21,840	Square Feet	$1.50	$32,760
	-Install erosion control features	10	each	$5,000	$50,000

Appendix B - Table 8
Preliminary Cost Estimate - Alternative C2
Off-Property Focused Corrective Measures Study
Former Koppers Inc. Facility - Superior, Wisconsin

Item	Description	Estimated Quantity	Unit	Unit Price	Cost
12.	Fill existing channel				
	-8-oz NWGT Demarcation Fabric	56,695	Square Feet	$0.45	$25,513
	-Backfill with stockpiled cut from new channel alignment	3,678	Cubic Yards	$24	$88,267
	-General Fill (to within 4" of final grade)	1,869	Cubic Yards	$30	$56,076
	-Topsoil (4")	700	Cubic Yards	$60	$41,996
13.	General Restoration				
	Seed and Mulch w/ Native Wetland Mix	17	Acre	$6,000	$102,000
				Subtotal Construction Costs:	$1,706,729
				Contingency (25%):	$426,682
				Total Construction Costs:	$2,133,411
Material Disposal					
14.	Option 1: Off-Site T&D	4,641	Tons	$575	$2,668,575
15.	Option 2: On-Site CAMU Disposal				
	Transport excavated material to CAMU	2,730	Cubic Yards	$13	$35,490
	CAMU Construction, Operation, and Maintenance	1	Lump Sum	$1,200,000	$1,200,000
Operation and Maintenance (O&M) Costs					
16.	Restored Wetlands Inspection and Maintenance (5 years)	1	Lump Sum	$15,000	$15,000
				Present Worth Factor (5 years @ 7%):	4.1
				Present Worth Cost:	$61,500
17.	Annual Inspections (30 years)	1	Lump Sum	$5,000	$5,000
				Present Worth Factor (30 years @ 7%):	12.41
				Present Worth Cost:	$62,050
18.	Maintenance Activities (1 every five years for 30 years)	1	Lump Sum	$5,000	$5,000
				Sinking Fund Factor (5 years @ 7%):	0.174
				Present Worth Factor (30 years @ 7%):	12.41
				Present Worth Cost:	$10,797
				Total O&M Costs:	$134,347
				Total Estimated Cost for Alternative C2, Off-Site Disposal:	**$5,351,333**
				Total Estimated Cost for Alternative C2, Off-Site Disposal (Rounded):	**$5,351,000**
				Total Estimated Cost for Alternative C2, CAMU:	**$3,918,248**
				Total Estimated Cost for Alternative C2, CAMU (Rounded):	**$3,918,000**

General Comments:

- All costs include labor, materials, and installation unless otherwise noted.
- Costs do not include legal fees, permitting, obtaining access, negotiations, or agency oversight.
- Unit costs are estimated from RS Means Cost Data books, vendor quotes, professional judgment, and/or experience from other similar projects.
- Costs based on current site information and project understanding and may change following collection of additional data and/or receipt of WDNR input and actual project design.
- A 25% contingency allowance is included for construction costs to provide for unforeseen circumstances or variability in estimated quantities and/or unit prices.

Notes and Assumptions:

- The pre-design investigation (PDI) would be conducted to determine the exact location of the new Crawford Creek channel and the hydraulic forces that the new channel must be designed to withstand.
- Administration and engineering cost includes design of remedial approach, onsite construction observation, and project documentation. Assumed to be approximately 15% of the construction costs.
- Mobilization/demobilization includes costs for mobilization and demobilization of labor, equipment, and materials necessary to implement this alternative (assumed to be approximately 10% of the cost of Items 7-13). Cost estimate assumes one construction season would be required to complete the project.
- Survey control includes construction layout and grade control, and as-built survey.
- Construction support cost includes an office trailer, phone/fax line, electrical supply, portable restroom facilities, etc. for the duration of the construction project.
- Health and safety monitoring includes air monitoring required for worker health and safety.
- Off-site disposal costs assume materials are hazardous waste; transportation by rail; and 1.7 tons per in-situ cubic yard of excavated material.
- CAMU construction, operation, and maintenance costs estimated from costs of other similar projects.
- Estimated construction durations assume no weather or flooding-related delays. Adverse weather and flooding conditions could significantly impact the schedule for construction activities, resulting in potentially longer durations than estimated.

Appendix B - Table 9
Preliminary Cost Estimate - Alternative C3
Off-Property Focused Corrective Measures Study
Former Koppers Inc. Facility - Superior, Wisconsin

Area C - Crawford Creek from Tributary to Railroad Embankment
Alternative C3: Partial Channel Excavation/Backfill

This alternative includes the following components:

- -Clear existing ground surface
- -Excavate sediment from bottom/banks of Crawford Creek channel as necessary for new channel (5' wide base, 3' depth, 3H:1V sideslopes)
- -Install a layer of Reactive Core Mat (RCM) within the Crawford Creek channel
- -Install 1/2" square, 19 gauge galvanized wire mesh over the RCM
- -Install and compact 12-inches clayey general fill in the Crawford Creek channel
- -Install erosion control features within the restored creek channel to provide velocity control, stability and habitat
- -Consolidate excavated materials in on-property CAMU containment cell, or dispose of off-Site

Item	Description	Estimated Quantity	Unit	Unit Price	Cost
Indirect Costs					
1.	Pre-Design Investigation	1	Lump Sum	$50,000	$50,000
2.	Administration and Engineering	1	Lump Sum	$270,000	$270,000
				Total Indirect Costs:	$320,000
Construction Costs					
3.	Mobilization/Demobilization	1	Lump Sum	$121,000	$121,000
4.	Survey Control	1	Lump Sum	$50,000	$50,000
5.	Construction Support	12	Weeks	$2,000	$24,000
6.	Health and Safety Monitoring	12	Weeks	$1,600	$19,200
7.	Site Preparation				
	- Clearing and Grubbing	9.4	Acre	$8,000	$75,200
	- Access Road/Staging Area Construction	2,440	Linear Feet	$20	$48,800
	- Erosion/Sedimentation Controls	4,880	Linear Feet	$15	$73,200
8.	Temporary Bypass Pumping System and Water Treatment				
	- Obtain/Setup/Install Pumps, Piping, etc.	1	Lump Sum	$15,000	$15,000
	- Weekly Operation	12	Weeks	$2,500	$30,000
	- Water management during excavation	1	Lump Sum	$200,000	$200,000
9.	Crawford Creek Channel Excavation				
	-Excavate Channel	3,156	Cubic Yards	$60	$189,389
	-Dewater/solidify excavated material	3,156	Cubic Yards	$20	$63,130
10.	Channel Restoration				
	-Reactive Core Mat (RCM)	64,284	Square Feet	$3.80	$244,279
	-1/2" square, 19 gauge galvanized wire mesh	64,284	Square Feet	$0.63	$40,178
	-General Fill	2,164	Cubic Yards	$30	$64,933
	-Install erosion control features	10	each	$5,000	$50,000
11.	Floodplain Restoration				
	-8-oz NWGT Separation Fabric	38,960	Square Feet	$0.45	$17,532
	-General Fill	451	Cubic Yards	$30	$13,528
	-Topsoil (4")	481	Cubic Yards	$60	$28,859
	-Seed and Mulch w/ Native Wetland Mix	9.4	Acre	$6,000	$56,400
				Subtotal Construction Costs:	$1,424,628
				Contingency (25%):	$356,157
				Total Construction Costs:	$1,780,784
Material Disposal					
12.	Option 1: Off-Site T&D	5,366	Tons	$575	$3,085,461
13.	Option 2: On-Site CAMU Disposal				
	Transport excavated material to CAMU	3,156	Cubic Yards	$13	$41,034
	CAMU Construction, Operation, and Maintenance	1	Lump Sum	$1,300,000	$1,300,000

Appendix B - Table 9
Preliminary Cost Estimate - Alternative C3
Off-Property Focused Corrective Measures Study
Former Koppers Inc. Facility - Superior, Wisconsin

Item	Description	Estimated Quantity	Unit	Unit Price	Cost
Operation and Maintenance (O&M) Costs					
14.	Restored Wetlands Inspection and Maintenance (5 years)	1	Lump Sum	$15,000	$15,000
				Present Worth Factor (5 years @ 7%):	4.1
				Present Worth Cost:	$61,500
15.	Annual Inspections (30 years)	1	Lump Sum	$5,000	$5,000
				Present Worth Factor (30 years @ 7%):	12.41
				Present Worth Cost:	$62,050
16.	Maintenance Activities (1 every five years for 30 years)	1	Lump Sum	$5,000	$5,000
				Sinking Fund Factor (5 years @ 7%):	0.174
				Present Worth Factor (30 years @ 7%):	12.41
				Present Worth Cost:	$10,797
				Total O&M Costs:	$134,347
				Total Estimated Cost for Alternative C3, Off-Site Disposal:	**$5,320,592**
				Total Estimated Cost for Alternative C3, Off-Site Disposal (Rounded):	**$5,321,000**
				Total Estimated Cost for Alternative C3, CAMU:	**$3,576,165**
				Total Estimated Cost for Alternative C3, CAMU (Rounded):	**$3,576,000**

General Comments:

- All costs include labor, materials, and installation unless otherwise noted.
- Costs do not include legal fees, permitting, obtaining access, negotiations, or agency oversight.
- Unit costs are estimated from RS Means Cost Data books, vendor quotes, professional judgment, and/or experience from other similar projects.
- Costs based on current site information and project understanding and may change following collection of additional data and/or receipt of WDNR input and actual project design.
- A 25% contingency allowance is included for construction costs to provide for unforeseen circumstances or variability in estimated quantities and/or unit prices.

Notes and Assumptions:

- Administration and engineering cost includes design of remedial approach, onsite construction observation, and project documentation. Assumed to be approximately 15% of the construction costs.
- Mobilization/demobilization includes costs for mobilization and demobilization of labor, equipment, and materials necessary to implement this alternative (assumed to be approximately 10% of the cost of Items 7-11). Cost estimate assumes one construction season would be required to complete the project.
- Survey control includes construction layout and grade control, and as-built survey.
- Construction support cost includes an office trailer, phone/fax line, electrical supply, portable restroom facilities, etc. for the duration of the construction project.
- Health and safety monitoring includes air monitoring required for worker health and safety.
- Off-site disposal costs assume materials are hazardous waste; transportation by rail; and 1.7 tons per in-situ cubic yard of excavated material.
- CAMU construction, operation, and maintenance costs estimated from costs of other similar projects.
- Estimated construction durations assume no weather or flooding-related delays. Adverse weather and flooding conditions could significantly impact the schedule for construction activities, resulting in potentially longer durations than estimated.

Appendix B - Table 10
Preliminary Cost Estimate - Alternative C4
Off-Property Focused Corrective Measures Study
Former Koppers Inc. Facility - Superior, Wisconsin

Area C - Crawford Creek from Tributary to Railroad Embankment
Alternative C4: Extended Channel and Floodplain Excavation/Backfill

This alternative includes the following components:

-Clear existing ground surface
-Excavate Crawford Creek channel and bank materials to the limits shown on Figure 13, which are based on existing soil boring and test pit data. Excavation limits extend up to 300 feet from the edge of the channel and up to 30 feet bgs.

-Fill excavation with general fill
-Install and compact 12-inches clayey general fill in the Crawford Creek channel
-Install 4" vegetated topsoil in floodplain areas
-Consolidate excavated materials in on-property CAMU containment cell, or dispose of off-Site

Item	Description	Estimated Quantity	Unit	Unit Price	Cost
Indirect Costs					
1.	Pre-Design Investigation	1	Lump Sum	$25,000	$25,000
2.	Administration and Engineering	1	Lump Sum	$4,300,000	$4,300,000
				Total Indirect Costs:	$4,325,000
Construction Costs					
3.	Mobilization/Demobilization (2 construction seasons)	3	Lump Sum	$1,736,000	$5,208,000
4.	Survey Control	1	Lump Sum	$50,000	$50,000
5.	Construction Support	72	Weeks	$2,000	$144,000
6.	Health and Safety Monitoring	72	Weeks	$1,600	$115,200
7.	Site Preparation				
	- Clearing and Grubbing	10.2	Acre	$8,000	$81,600
	- Access Road/Staging Area Construction	3,500	Linear Feet	$20	$70,000
	- Erosion/Sedimentation Controls	7,000	Linear Feet	$15	$105,000
8.	Temporary Bypass Pumping System and Water Treatment				
	- Obtain/Setup/Install Pumps, Piping, etc.	1	Lump Sum	$15,000	$15,000
	- Weekly Operation	72	Weeks	$2,500	$180,000
	- Water management during excavation	1	Lump Sum	$2,000,000	$2,000,000
9.	Crawford Creek Channel and Bank/Floodplain Excavation				
	-Excavate channel and bank/floodplain materials	95,194	Cubic Yards	$90	$8,567,470
	-Dewater/solidify excavated material	95,194	Cubic Yards	$20	$1,903,882
	-Overexcavation for side-slope stability	14,583	Cubic Yards	$90	$1,312,500
10.	Crawford Creek Channel Restoration				
	-General Fill	22,142	Cubic Yards	$30	$664,267
11.	Floodplain Restoration				
	-General Fill	70,949	Cubic Yards	$30	$2,128,478
	-Re-place/compact overexcavated material	14,583	Cubic Yards	$15	$218,750
	-Topsoil (4")	2,103	Cubic Yards	$60	$55,350
	-Seed and Mulch w/ Native Wetland Mix	10.2	Acre	$6,000	$61,200
				Subtotal Construction Costs:	$22,880,697
				Contingency (25%):	$5,720,174
				Total Construction Costs:	$28,600,871
Material Disposal					
12.	Option 1: Off-Site T&D	161,830	Tons	$575	$93,052,244
13.	Option 2: On-Site CAMU Disposal				
	Transport excavated material to CAMU	95,194	Cubic Yards	$13	$1,237,523
	CAMU Construction, Operation, and Maintenance	1	Lump Sum	$7,600,000	$7,600,000

Appendix B - Table 10
Preliminary Cost Estimate - Alternative C4
Off-Property Focused Corrective Measures Study
Former Koppers Inc. Facility - Superior, Wisconsin

Item	Description	Estimated Quantity	Unit	Unit Price	Cost
Operation and Maintenance (O&M) Costs					
14.	Restored Wetlands Inspection & Maintenance (5 years)	1	Lump Sum	$15,000	$15,000
	Present Worth Factor (5 years @ 7%):				4.1
	Present Worth Cost:				$61,500
15.	Annual Inspections (30 years)	1	Lump Sum	$5,000	$5,000
	Present Worth Factor (30 years @ 7%):				12.41
	Present Worth Cost:				$62,050
16.	Maintenance Activities (1 every five years for 30 years)	1	Lump Sum	$5,000	$5,000
	Sinking Fund Factor (5 years @ 7%):				0.174
	Present Worth Factor (30 years @ 7%):				12.41
	Present Worth Cost:				$10,797
	Total O&M Costs:				$134,347
	Total Estimated Cost for Alternative C4, Off-Site Disposal:				**$126,112,461**
	Total Estimated Cost for Alternative C4, Off-Site Disposal (Rounded):				**$126,112,000**
	Total Estimated Cost for Alternative C4, CAMU:				**$41,897,741**
	Total Estimated Cost for Alternative C4, CAMU (Rounded):				**$41,898,000**

General Comments:

- All costs include labor, materials, and installation unless otherwise noted.
- Costs do not include legal fees, permitting, obtaining access, negotiations, or agency oversight.
- Unit costs are estimated from RS Means Cost Data books, vendor quotes, professional judgment, and/or experience from other similar projects.
- Costs based on current site information and project understanding and may change following collection of additional data and/or receipt of WDNR input and actual project design.
- A 25% contingency allowance is included for construction costs to provide for unforeseen circumstances or variability in estimated quantities and/or unit prices.

Notes and Assumptions:

- Administration and engineering cost includes design of remedial approach, onsite construction observation, and project documentation. Assumed to be approximately 15% of the construction costs.
- Mobilization/demobilization includes costs for mobilization and demobilization of labor, equipment, and materials necessary to implement this alternative (assumed to be approximately 10% of the cost of Items 7-11). Cost estimate assumes three construction seasons would be required to complete the project.
- Survey control includes construction layout and grade control, and as-built survey.
- Construction support cost includes an office trailer, phone/fax line, electrical supply, portable restroom facilities, etc. for the duration of the construction project.
- Health and safety monitoring includes air monitoring required for worker health and safety.
- Off-site disposal costs assume materials are hazardous waste; transportation by rail; and 1.7 tons per in-situ cubic yard of excavated material.
- CAMU construction, operation, and maintenance costs estimated from costs of other similar projects.
- Estimated construction durations assume no weather or flooding-related delays. Adverse weather and flooding conditions could significantly impact the schedule for construction activities, resulting in potentially longer durations than estimated.