October 19, 2012
Project No.: 6100-351-04-00-02

REMEDIATION WORK PLAN
TERRE HAUTE COKE & CARBON

Brownfields Site #4000043
1341 Hulman Street
Terre Haute, Indiana 47802

Prepared For:

Terre Haute Board of Sanitary Commissioners
17 Harding Avenue, Room 200
Terre Haute, Indiana 47807

Prepared by:

WEAVER
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EXECUTIVE SUMMARY

Weaver Boos Consultants, LLC (Weaver Boos) has prepared this Remediation Work Plan (RWP) on behalf of the Terre Haute Board of Sanitary Commissioners (the Board) for the Terre Haute Coke & Carbon (THCC) Brownfield Site (the Site) located at 1341 Hulman Street in Terre Haute, Indiana. The purpose of this RWP is to provide a plan for cleaning up and preparing a large portion of the Site for industrial/commercial redevelopment. A proposed paved trail along the west side of the Site is expected to provide a recreational component to the project. The specific objectives of the RWP include the following:

- Describe and summarize the data and information characterizing the current environmental condition of the Site.
- Assess potential risks associated with current conditions based on the soil and groundwater Screening Levels (SLs) listed in the Indiana Department of Environmental Management's (IDEM) Remediation Closure Guide (RCG).
- Identify remedial action objectives for specific environmental media (i.e., soil and groundwater).
- Identify and select an appropriate remedy for conditions and risks posed by the Site consistent with its proposed redevelopment.
- Provide a specific plan for implementing the remedy, including a monitoring plan and schedule.

The current Site Investigation and historical environmental assessments indicate that surface soil, and to a lesser extent, the groundwater, are affected by coal gasification and byproducts recovery residues leading to elevated concentrations of polycyclic aromatic hydrocarbons (PAHs), several volatile organic compounds (VOCs) (benzene in particular), several semi-volatile organic compounds (SVOCs), total arsenic, and total lead.

The remedial work plan is provided consistent with the level of resources available for this project. Insufficient funding is presently available to remediate the entire Site consisting of the North, Middle, and South Parcels, so the plan focuses on parts of the Site considered most marketable for redevelopment by the City of Terre Haute. The most marketable parts are the frontages along 13th and Hulman Streets offering visual exposure and ready access for future business use. Approximately 20 acres of land will be remediated under this plan by addressing the 13th Street frontage to a setback extending 325 ft east of the property boundary and the Hulman Street frontage to a setback extending 325 ft south of the property boundary. These areas are collectively designated as the "Remediation Site".

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Approximately 73,000 cubic yards (CY) of contaminated surface soil and debris will be remediated by excavation using conventional earth-moving equipment. The contaminated soil will be loaded onto trucks and transported to a secure off-site Subtitle D landfill for disposal. Remedial excavation will extend to variable depths (maximum of 10 ft below final grade), subject to verification grid sampling. Grid intersections failing to meet the required remedial objectives will be excavated deeper, and re-sampled to a maximum of 10 ft below final grade. Subsurface structures such as structural foundations, pipes, sumps, or other historical utilities will be demolished and removed wherever they are encountered within the Remediation Site footprint to depths of at least 10 ft below final grade. Approximately 52,000 CY of common borrow will be delivered, placed, and compacted to achieve the final grading plan. Approximately 3,230 CY of topsoil capable of sustaining healthy landscape plantings in the parkway between the 13th Street sidewalk and natural gas transmission main easement will be delivered and placed. Stormwater management facilities will be constructed to drain the Remediation Site's final surface grade. Approximately 4,500 square yards (SY) of bituminous concrete recreational trail will be laid atop the natural gas transmission main easement along the western boundary of the Site to prevent potential future recreational exposure in this area where excavation is considered impracticable. The approximately 20-acre Remediation Site will be restored by hydroseeding (with mulch and fertilizer) and placement of erosion control mat in specified area(s).

Approximately 6,500 CY of tar, tar-impacted soil, tar-impacted shallow aquifer soil, and tar and benzene-impacted shallow groundwater will be solidified and stabilized in place to remediate the former tar pit at the west end of the Middle Parcel. The volume of contaminated media extends to a depth of approximately 20 ft below existing grade, and therefore addresses shallow groundwater in this area. The solidified in-situ mass will be covered with a minimum of 2 ft of clean common borrow to mitigate potential future direct exposure. Placement of occupied structures will be prohibited over the former tar pit to mitigate potential benzene vapor intrusion exposure.

Active remediation of groundwater beneath other parts of the Remediation Site is not believed necessary and none is therefore proposed. Potential future exposure to groundwater beneath the Remediation Site will be prevented using the institutional control provided by the Environmental Restrictive Covenant proposed herein.

Weaver Boos believes that the majority of the work described herein can be best completed by local contractors using local labor and resources at a cost consistent with the level of funding understood to be available for the project. Detailed information regarding the estimated cost for the remedy is omitted from this document to protect the integrity of the public bidding process for the work. The duration of the work from notice to proceed through final completion is presently estimated at approximately eight (8) calendar months.

REMEDIATION WORK PLAN
TERRE HAUTE COKE & CARBON

TABLE OF CONTENTS

TABLE OF CONTENTS

REMEDIATION WORK PLAN
TERRE HAUTE COKE & CARBON

TABLE OF CONTENTS

TABLE OF CONTENTS

Figures

REMEDIATION WORK PLAN
TERRE HAUTE COKE & CARBON

TABLE OF CONTENTS

Tables

Appendices

1.0 INTRODUCTION

1.1 Project Background

Weaver Boos Consultants, LLC (Weaver Boos) prepared this Remediation Work Plan (RWP) on behalf of the Terre Haute Board of Sanitary Commissioners (the Board) for the former Terre Haute Coke & Carbon (THCC) Brownfield Site (the Site) located at 1341 Hulman Street in Terre Haute, Indiana as shown on **Figure 1**. Preparation of this RWP was authorized by the Board by accepting Weaver Boos Proposal No. WBCP-003-01-12 on June 27, 2012.

The purpose of this RWP is to provide a plan for cleaning up and preparing a large portion of the Site for industrial/commercial redevelopment. A paved trail along the west side of the Site provides a recreational component to the project. The specific objectives of the RWP include the following:

- Describe and summarize the data and information characterizing the current environmental condition of the Site.
- Assess potential risks associated with current conditions based on the soil and groundwater Screening Levels (SLs) listed in the Indiana Department of Environmental Management's (IDEM) Remediation Closure Guide (RCG).
- Identify remedial action objectives for specific environmental media (i.e., soil and groundwater).
- Identify and select an appropriate remedy for conditions and risks posed by the Site consistent with its proposed redevelopment.
- Provide a specific plan for implementing the remedy, including a monitoring plan and schedule.

Because the Brownfields Program does not provide specific guidance for developing a RWP, this plan is organized and presented in general accordance with the Remediation Work Plan outline listed in State Form 53413, "Remediation Work Plan Completeness Checklist" used for evaluating similar plans under the Voluntary Remediation Program (VRP). Weaver Boos notes that the Site Investigation undertaken during 2011 and 2012 were conducted and the results assessed consistent with the IDEM's former Risk Integrated System of Closure (RISC) used as a basis for the planning. References to the default closure levels (CLs) listed in the former RISC non-rule policy therefore survive in the elements of this RWP describing the Site Investigation. The SLs listed in the new RCG are generally similar to the default CLs listed in the former RISC non-rule policy, and so the findings described in the Site Investigation remain relevant as described herein. The remediation objectives and remediation plan listed herein are based entirely on the new RCG non-rule policy that came into effect on March 22, 2012 and therefore reflect the IDEM's most current risk-based corrective action non-rule policy.

This **Section 1.0** of the RWP introduces the Site and provides an overview of environmental impact to soil or groundwater based on review of historical data and information. **Section 2.0** provides background information and presents a baseline project assessment. **Section 3.0** describes the methods of investigation used during the 2011/2012 Site Investigation, thus providing a statement of work. **Section 4.0** presents the results of the Site Investigation. Conclusions supported by the Site Investigation are provided **Section 5.0**. **Section 6.0** provides the remediation plan, including an evaluation of remedial alternatives, the selected remedial technologies, the sampling plan, and project schedule. **Section 7.0** provides certain assumptions, qualifications, and limitations regarding site characterization and remedial design. References cited are listed in **Section 8.0**. Supporting data and information are summarized and presented on the figures and tables and appended in greater detail.

1.2 Project Identification

The former THCC Site is presently unoccupied, its historical facilities have been removed, and the Site has cleared of former above-grade structural and building improvements. The Site is located at 1341 and 1451 Hulman Street and 2030 South 13th Street as shown on the U.S. Geological Survey topographic provided as **Figure 1**. The Site includes three parcels of land, the North, Middle, and South Parcels as illustrated on **Figure 2**. The current owner is as follows:

City of Terre Haute, Department of Redevelopment
c/o: Patrick Martin, Chief Planner
17 Harding Avenue, Room 200,
Terre Haute, IN 47807
(812) 232-4028

1.3 Supporting Documents

Historical environmental assessments and the current Site Investigation indicates that surface soil, subsurface soil and groundwater are affected by coal gasification and byproducts recovery residues leading to elevated concentrations of polycyclic aromatic hydrocarbons (PAHs), several volatile organic compounds (VOCs), several semi-volatile organic compounds (SVOCs), and several metals. Historical environmental assessments of the Site include the following:

1. Trinity Environmental Group (TEG), March 2001, Phase II Environmental Site Assessment Report.

2. Trinity Environmental Group, April 2003, Phase II Environmental Site Assessment Report.

3. ATC Associates, Inc., May 2005, Additional Soil and Groundwater Sampling and Analysis.

4. Bruce Carter Associates, L.L.C., August 2008, Phase II ESA, Middle Parcel.

5. Bruce Carter Associates, L.L.C., October 2008, Phase II ESA Follow-up, Middle Parcel.

6. BCA Consultants, Inc., May 2010, Limited Supplemental Phase II Environmental Site Assessment.

7. Bruce Carter Associates, L.L.C., April 2011, Limited Supplemental Phase II ESA, THCC North Parcel.

The locations for historical samples described in the above listed reports are illustrated on **Figure 2**, along with the historical configuration of the THCC facility. In consultation with the IBP Project Manager for the Site Investigation, the data were organized into three media groups as follows:

- Surface soil (0 to 10 ft bgs),

- Subsurface soil (>10 ft bgs), and

- Groundwater.

The resulting comprehensive historical data summary tables are provided as **Appendix A**. The data structure used in Appendix A lists records (rows) for each sampling location with fields providing sample ID; date of collection; source of information; State Plane coordinates from mapping prepared by BCA dated March 31, 2011 and later survey work by Weaver Boos and Myers Engineering, Inc.; depth interval top and bottom; reported concentrations, and finally; fields for flags (0 or 1) indicating whether the chemical was detected above the laboratory reporting limit. The flags support evaluation of the tabular data using U.S. EPA's ProUCL software to compute upper confidence limits on mean for specific analytes. In further consultation with the IBP Project Manager, the concentrations for each target analyte are compared with IDEM's Risk Integrated System of Closure (RISC) closure levels (CLs) and non-default recreational closure levels (CLs) as follows:

1. Surface Soil – Compared with Residential Soil Direct Contact CLs, Recreational Surface Soil CLs, and Industrial/Commercial Soil Direct Contact CLs.

2. Subsurface Soil – Compared with Residential Migration to Groundwater and Industrial/Commercial Migration to Groundwater CLs.

3. Groundwater – Compared with Residential and Industrial/Commercial Default CLs.

1.3.1 Historical Results Compared with RISC Closure Levels

1.3.1.1 Surface Soil

Considerable historical data were found for the surface soil medium (n ≈ 314). Benzene is the VOC most frequently detected in the previous historical investigations exceeding soil direct contact CLs, although it appears to be limited only to the Middle Parcel. Benzo(a)pyrene is the PAH most frequently exceeding soil direct contact CLs, although it is typically accompanied by other PAH compounds also exceeding their respective soil direct contact CLs. Arsenic and lead were the only metals that exceed soil direct contact CLs. Similar to benzene, surface soil lead concentrations exceeding soil direct contact CLs are mostly limited to the Middle Parcel. These four constituents of concern were identified in consultation with the IBP Project Manager as the most appropriate indicator constituents of concern (COCs) for assessing the extent of contamination and as primary drivers of risk under the proposed redevelopment.

1.3.1.2 Subsurface Soil

Historical data for the subsurface soil medium are relatively sparse (n ≈ 18). Few constituent COCs exhibit concentrations in soil exceeding the Industrial/Commercial Migration to Groundwater CLs. Benzene and benzo(a)pyrene are the only COCs exceeding the Industrial/Commercial Migration to Groundwater CLs in more than one sample and were therefore selected as the most appropriate indicators of extent.

1.3.1.3 Groundwater

Historical groundwater data are relatively plentiful (n ≈ 62). Benzene, naphthalene, and lead most frequently exceed their respective Residential or Industrial/Commercial Groundwater CLs. The historical groundwater data show benzene beneath only the Middle Parcel, in close association with the former tar pit located at the west end of the Middle Parcel, and naphthalene only in the area of the Benzol Plant formerly located on the North Parcel.

1.3.2 2011-2012 Site Investigation

The most recent phases of investigation were completed during 2011 and 2012 and culminated in the Phase II Site Investigation (Site Investigation) report completed by Weaver Boos on August 14, 2012. The 2011 and 2012 Site Investigation activities were funded by the U.S. Environmental Protection Agency (U.S. EPA) through its Section 128(a) Brownfields Grant program and implemented in accordance with the Quality Assurance Project Plan (QAPP) approved by the U.S. EPA in electronic correspondence dated March 27, 2012. The purpose, scope of work, and objectives for the Site Investigation are specified in two separate Sampling and Analysis Plans (SAP):

- *Historical Data Review and Sampling and Analysis Plan*, Revision 1, dated July 22, 2011 (approved by the U.S. EPA in electronic correspondence dated July 21, 2011), and
- *Sampling and Analysis Plan*, Revision 0, dated March 27, 2012 (approved by the U.S. EPA in electronic correspondence dated April 12, 2012).

The overall Site Investigation scope of work included the following general elements:

1. Review of existing historical data;
2. Surface soil sampling and analysis;
3. Groundwater sampling and analysis;
4. Determination of site-specific groundwater flow direction; and,
5. Integration of historical data with the current results to provide an overall assessment of environmental condition of the Site.

The methods of investigation for the current Site Investigation are described in detail **Section 3.0** and the results obtained are described in **Section 4.0**. The overall results for the Site Investigation are consistent with those reported in the historical environmental assessments. Surface soil remains widely impacted by arsenic, benzo(a)pyrene and related PAH compounds, and the eastern part of the Middle Parcel is characterized by elevated concentrations of lead. Impacts to groundwater are localized to specific areas of the Site for benzene and naphthalene. Elevated concentrations of total lead and total arsenic appear widespread beneath the Property. Dissolved concentrations of lead and arsenic were found compliant with RCG SLs for residential tap water in all of the current Site Investigation samples.

1.4 Remedial Action Objectives

1.4.1 Soil Media for Industrial/Commercial Redevelopment

RCG Commercial/Industrial Soil Direct Contact SLs will be the remedial action objectives through the upper two (2) ft of the post-remediation soil profile in areas proposed for industrial/commercial redevelopment. RCG Excavation Worker Soil Direct Contact SLs will be the remedial action objectives between depths of 2 ft and 10 ft of the post-remediation soil profile in areas proposed for industrial/commercial redevelopment. The remedial objectives are listed below for constituents of concern detected above Direct Contact SLs:

Table 1.4 – Soil Screening Levels

Constituent of Concern	Surface Soil (0 to 2 ft) Commercial/Industrial Soil Direct Contact Screening Level	Surface Soil (2 to 10 ft) Excavation Worker Soil Direct Contact Screening Level
Arsenic (mg/kg)	16	430
Lead (mg/kg)	1,300	970
Benzo(a)anthracene (ug/kg)	21,000	1,300,000
Benzo(a) pyrene (ug/kg)	2,100	130,000
Benzo(b)fluoranthene (ug/kg)	21,000	1,300,000
Benzo(k)fluoranthene (ug/kg)	210,000	1,300,000
Dibenz(a,h)anthracene (ug/kg)	2,100	1,300,000
Indeno(1,2,3-cd)pyrene (ug/kg)	21,000	1,300,000
2-Methylnaphthalene (ug/kg)	370,000	370,000
Naphthalene (ug/kg)	180,000	1,000,000

1.4.2 Soil Media for Recreational Trail Redevelopment

The remedial objective is exposure prevention using the trail as an engineered barrier. The recreational trail is proposed along the western boundary of the Site as a means to mitigate potential for direct contact exposure with surface soils above the natural gas main where excavation is considered impracticable.

1.4.3 Shallow Groundwater Beneath the Tar Pit

The remedial objective is exposure prevention by immobilizing the free product tar and benzene contained in the shallow groundwater. Free product tar and benzene-impacted shallow groundwater immediately beneath the former tar pit located at the west end of the Middle Parcel will be remediated by in-situ solidification/stabilization to form a homogeneous mass with an unconfined compressive strength of 25 (or more) pounds per square inch (psi).

1.4.4 Groundwater Beneath the Balance of The Property

The remedial objective is exposure prevention. An environmental restrictive covenant (ERC) is proposed as an institutional control prohibiting the future use of groundwater beneath the Property.

1.5 Summary of Remedial Work Plan

1.5.1 Extent of Remediation

This remedial work plan is provided consistent with the level of resources available for this project. Insufficient funding is presently available to remediate the entire Site, so the plan focuses on parts of the Site considered most marketable for redevelopment by the City of Terre Haute. The most marketable parts are the frontages along 13th and Hulman Streets offering visual exposure and ready access. Approximately 20 acres of land will be remediated under this plan by addressing the 13th Street frontage to a setback extending 325 ft east of the property boundary and the Hulman Street frontage to a setback extending 325 ft south of the property boundaries. The parkway between the 13th Street sidewalk and western property boundary will be remediated, as will the natural gas transmission main easement along the western boundary of the Site. These areas are collectively designated as the “Remediation Site” as illustrated on **Figure 18**.

1.5.2 Contractor’s Remediation Activities

The Contractor’s construction activities for implementing the selected remediation technologies are listed below. Qualified contractors inclined to propose suitable alternative technologies (e.g., thermal desorption to decontaminate and re-use the contaminated soil) are encouraged to do so and provide sufficient information to judge the expected cost and effectiveness.

1. A project-specific Health and Safety Plan (HASP) will be prepared to support the safe implementation of construction.

2. Necessary permits will be obtained. A Notice of Intent (NOI) will be required to inform the IDEM and local authority that construction will be performed in a manner consistent with the requirements established under 327 IAC Rule 5 "Storm Water Run-Off Associated with Construction Activity".

3. Pre-construction submittals will be prepared and submitted. These will include the following, among others:

    a. Performance and Payment Bonds, proof of insurance

    b. Project Performance Schedule

    c. HASP

    d. Rule 5 NOI

    e. Storm Water Pollution Prevention Plan

    f. Borrow Area Investigation for Suitable Soil, if other than the pre-approved source

    g. In-situ solidification/stabilization (ISS) treatability study and implementation plan

4. Investigate, sample, and analyze proposed borrow soil at a frequency of not less than one sample per 5,000 CY.

5. Mobilization.

6. Underground utility locating and protection.

7. Field location of all required work.

8. Demolish approximately 300 LF of fence.

9. Clear approximately 3 ac. of trees and brush.

10. In-situ solidification/stabilization of approximately 6,500 CY of tar, tar-impacted soil, tar-impacted shallow aquifer soil, and tar and benzene-impacted shallow groundwater. The solidified in-situ mass will be covered with a minimum of 2 ft of clean common borrow.

11. Sealing and abandonment of existing groundwater monitoring wells.

12. Excavation, loading, and transportation of approximately 73,000 CY of contaminated surface soil and debris for disposal at a secure Subtitle D facility. Remedial excavation will extend to variable subject to verification grid sampling. Grid intersections failing to

meet the required remedial objectives will be excavated deeper, and re-sampled to a maximum of 10 ft below final grade.

13. Demolition and removal of subsurface structures such as structural foundations, pipes, sumps, or other historical utilities wherever they are encountered within the Remediation Site footprint to depths of at least 10 ft below final grade. This activity does not apply to the parkway between 13th Street, nor to the natural gas transmission main easement along the western boundary of the property.

14. Sealing and abandonment of any historic water supply wells encountered within the Remediation Site footprint.

15. Post-excavation subgrade preparation for backfilling and final grading and drainage.

16. Deliver, place, and compact approximately 52,000 CY of common borrow to achieve final grading plan.

17. Deliver and place approximately 3,230 CY of topsoil capable of sustaining healthy landscape plantings in the parkway between the 13th Street sidewalk and natural gas transmission main easement.

18. Construct stormwater management facilities.

19. Construct approximately 4,500 SY of bituminous concrete recreational trail atop the natural gas transmission main easement along the western boundary of the Site.

20. The site will be restored, including hydroseeding with mulch and fertilizer over approximately 20 acres and erosion control mat in specified area(s).

21. Demobilization.

1.5.3 Owner's/Engineer's Remediation Activities

The owner's/engineer's remediation-related activities will include the following:

1. Sample and obtain approval for disposal of contaminated soil and debris from the secure off-site Subtitle D land disposal facility.

2. Review and evaluation of contractor submittals.

3. Continuous observation of the contractor's activities.

4. Grid sampling and analysis of the Remediation Site to verify attainment of remedial objectives.

5. Other quality assurance testing, such as compressive strength of the ISS mass and compaction of backfill.

6. Progress surveying for measurement and payment of construction soil volumes and areas.
7. As-built documentation and remediation completion report.

2.0 SITE BACKGROUND

2.1 Site History

Information provided by the IBP and City of Terre Haute indicates that the Site consists of three parcels, including the North, South, and Middle Parcels, totaling approximately 61.6 acres. The Site was utilized as a coke and manufactured gas production facility from 1926 to 1988. The structures have been razed since the cessation of operations, leaving the Site vacant. The Site is located as shown in **Figure 1**.

According to the TEG 2001 *Phase II Environmental Site Assessment Report*, the Property was originally operated as the Indiana Coke & Gas Company in 1926. The former facility manufactured 150,000 tons of high-carbon coke per year, which was used primarily for metallurgical purposes. Approximately 70 percent of the coke was shipped to gray iron foundries. The facility cased operation in 1988, and soon after, the owners razed most of the operating facilities and removed all storage vessels. The Property has remained unused since that time.

Weaver Boos is unaware of specific releases or remediation of historical releases that may have taken place at the former THCC facility. Our review of historical environmental reports indicates that surface soil, subsurface soil and groundwater are affected by coal gasification and byproducts recovery residues leading to elevated concentrations of PAHs, several VOCs, several SVOCs, arsenic, and lead. The IBP and City of Terre Haute Department of Redevelopment have stated that the future use of the overall property is intended to include redevelopment into an industrial park and recreational trail head.

2.2 Geographic Information

The Site is located at 1341 and 1451 Hulman Street and 2030 South 13th Street in Terre Haute, Vigo County, Harrison Township, Indiana (see **Figure 1**). The approximately 52.45-acre Site is located immediately to the southeast of the intersection of Hulman Street and South 13th Street and configured as illustrated on **Figure 2**. The Site is located in the west ½ of the northeast ¼ of federal Section 34, Township 12 North, Range 9 West.

The Site is located atop a nearly level terrace along the wide Wabash River valley at an elevation of approximately 492 ft NAVD88, approximately 1.4 miles east of the river. The normal bank elevation for the river at Terre Haute is about 445 ft. The regional slope of the Site and city is therefore westerly, towards the river. Consequently, the Site is located within the Wabash River watershed. Uplands dominate the landscape east of the city.

2.3 Geologic Information

2.3.1 Surficial and Unconsolidated Geology

According to the publication Environmental Geology of Vigo County, Indiana – An Aid to Planning, Special Report 31, Hartke et al., 1983:

> The unconsolidated materials that form the land surface in Vigo County were derived primarily from the glaciers that covered the land as late as 15,000 years ago. The glacial till that forms the uplands was deposited directly by glacial ice, and the terrace and much of the subsurface floodplain material was deposited by meltwater flowing from the retreating glaciers. The surficial material in the modern floodplains was deposited by postglacial floodwater. Finally, a blanket of windblown material (loess) covers much of the area, especially the till upland east of the Wabash River.
>
> The terraces, which exist primarily on the east side of the Wabash Valley, reflect three stages of the valley development. They are composed of glacial outwash (layered sand and gravel) partly covered by a thin blanket of loess or alluvium (river-deposited silt, clay, and sand).

As illustrated in the Hartke et al. publication, the Site is positioned on the terrace consisting of Wisconsin-age gravel, sand and silt outwash deposits of glacial meltwater streams approximately 75 ft to 125 ft thick. An excerpt from the Regional Geologic Map No. 1 is reproduced in **Figure 3** and illustrates the Site directly underlain by valley-train deposits of gravel, sand and silt forming partial valley fill (Gray et al. (1979).

According to published mapping by the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS), the predominant surface soil unit on the Property is the Elston sandy loam which is described as a well drained loamy outwash over sandy and gravelly outwash. The Ade loamy fine sand, which is aeolian in nature, is identified in the north eastern portion of the Property. These surface soil units are consistent with the described composition of the glacial outwash terraces in the Hartke et al. publication.

2.3.2 Bedrock Geology

Bedrock beneath the Site is comprised of cyclothemic Pennsylvanian deposits of sandstone, siltstone, shale, coal and underclay. Relatively nonresistant siltstone and shale of Pennsylvanian age is the dominant rock type. This Pennsylvanian system has a total thickness of approximately 700 to 850 feet and is laterally extensive with a slight dip to the west-southwest into the Illinois Basin at about 30 feet per mile (Hartke et al., 1983). Bedrock immediately beneath the Site is mapped as the Carbondale Group (Gray, et al., 1979) as illustrated on **Figure 3**.

2.3.3 Hydrogeology

According to Hartke et al. (1983):

> Wells are developed in both the bedrock and unconsolidated systems, but most of the water is pumped from the shallow unconsolidated system. Wells in the bedrock are developed primarily in the thicker, more extensive sandstone bodies. In some places, however, shale and coal may produce satisfactory domestic supplies. The bedrock system is the primary source of water in much of the till-covered uplands in the northwestern, northeastern, and southeastern parts of Vigo County.
>
> Wells in the unconsolidated system are generally more productive and give better quality water than those in the bedrock system. The most productive aquifer in the county is a part of the unconsolidated aquifer system and is in the Wabash Valley. It is specifically referred to as the major unconsolidated aquifer and is composed of a thick and laterally extensive sequence of valley-train outwash sand and gravel. It is as much as 125 feet thick in an area underlying Terre Haute.

The Site and most of Terre Haute is situated within the outwash sand and gravel partly filling the Wabash Valley. The regional hydrogeology is illustrated on **Figure 4** (modified after Hartke et al., 1983) to show the generally northwesterly regional flow of groundwater towards the Wabash River.

2.4 Preliminary Evaluation of Potentially Susceptible Areas

2.4.1 Geologic

The valley-train terrace deposits of sand and gravel underlying the Site and most of Terre Haute are characterized by a sometimes high water table and permeable near surface soils providing little protection for groundwater (Hartke et al., 1983). Consequently, the hydrogeologic setting of the Site is considered potentially susceptible to impact by releases of hazardous or otherwise deleterious materials.

2.4.2 Wellhead Protection Areas

Potable water is supplied to the City of Terre Haute and surrounding areas by Indiana American Water and a handful of other smaller water utilities. Indiana American Water produces the Terre Haute municipal supply from five wells located adjacent to the Wabash River. Average daily demand is 10 MGD, with a peak of 14 MGD, and the system has a capacity of 17 MGD according to online information published by the Terre Haute Economic Development Corp. However; the Site is not located within a regulated wellhead protection area (WHPA) according to the Indiana American Water map entitled *Terre Haute Operations Wellhead Protection Area*.

In 2011 Weaver Boos conducted a preliminary search of the Indiana Department of Natural Resources online water well database which indicates that water wells are located near the Site, although not regulated under the WHPA. Online listings of water wells potentially located within a 1-mile radius of the Site are reproduced in **Appendix B**, beginning with a map of their locations according to reference number compiled by Weaver Boos during 2012.

Southwest, south, or southeast of the Site, in Sections 2, 3, and 4, Township 11N, Range 9W, records were found for 49, 92, and 39 wells, respectively. None of these appears susceptible to releases from the Site; however, because they are located hydraulically upgradient. Northeast, north, and northwest of the Site, in Sections 26, 27, and 28, Township 12N, Range 9W, records were found for 13, 14, and 18 wells, respectively. Well located in either Section 27 or 28 are potentially downgradient from the Site, and may therefore be susceptible to impacts originating at the Site. Directly west and downgradient of the Site in Section 33, records for 49 wells were found. In Section 34, which is occupied by the Site, record listings for 52 water wells were found, including listings for eight wells owned by Indiana Gas & Chemical, a presumed predecessor to THCC. The other wells listed in Section 34 are generally located upgradient or side-gradient to the Site (e.g., southwest, south, or east) and not generally susceptible to impacts originating at the Site. East (and hydraulically upgradient) of the Site in Section 35, records for 53 wells were found.

A large majority of the nearby water wells extend to depths of approximately 50 ft to 100 ft below ground surface and produce water from the unconsolidated sand and gravel. Few of the wells extend to bedrock. In Section 34, only well Reference No. 200335, located south of the Site, reached bedrock, which was shale at a depth of 90 ft below ground surface. In Section 27 adjoining the Site to the north, only well Reference No. 200354 is reported to have reached shale bedrock at a depth of 127 ft below ground surface. The depth to bedrock beneath the Site implied by these well records is therefore between 90 ft and 127 ft below ground surface.

Based on our review of nearby water well record listings and mapping of their locations during 2012, Weaver Boos identified nine (9) specific water wells appearing to be located within approximately 1.0 mile directly downgradient from the Site. These wells are shown in **Appendix B** using the annotated well location map in order to identify candidate wells for sampling and analysis as is later discussed in **Section 3.2.2.5**.

2.4.3 Social

The Site is located within an area used for residential, commercial, industrial, and institutional purposes likely to include socially sensitive areas. Specifically, the Sarah Scott Middle School is located approximately ¼ mile directly west of the Site. The St. Margaret Mary's School is located approximately ½ mile west-southwest of the Site. The Booker T. Washington High School is located between ¼ and ½ mile north-northwest of the Site.

2.4.4 Ecological

With regard for ecologically susceptible areas, the north and south parcels of the Site have been recently graded and mowed and offer little in the way of quality wildlife habitat. The middle parcel appears to be recently reforested by a variety of young softwood trees and thus offers some arboreal habitat of low quality. Lands adjoining the Site are generally fully developed for residential, commercial, industrial, or institutional land uses and are therefore unexpected to offer quality ecological habitat. No specific ecologically susceptible areas were identified based on this preliminary review.

2.5 Preliminary Evaluation of Constituents of Concern

Review of the historical sampling data for the Site indicates that soil, and to a lesser extent the groundwater, have been affected by coal gasification and byproducts recovery residues generally including PAHs, several specific VOCs, several specific SVOCs, arsenic, or lead at concentrations greater than relevant RISC CLs. Significant concentrations of benzene, other aromatic VOCs, and lead are generally limited to the Middle Parcel. Based on review of the historical data tabulated as shown in **Appendix A**, COCs exceeding relevant CLs in one or more samples include the following:

Surface Soil COCs

PAHs	VOCs	SVOCs	Metals
Benzo(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Benzo(k)fluoranthene Dibenz(a,h)anthracene Indeno(1,2,3-cd)pyrene 2-Methylnapthalene Naphthalene Phenanthrene	Benzene Cumene Isopropylbenzene n-Propylbenzene 1,2,4-Trimethylbenzene 1,3,5-Trymethylbenzene Toluene Ethylbenzene Xylene	Carbazole Dibenzofuran	Arsenic Lead

Subsurface Soil COCs

PAHs	VOCs	SVOCs	Metals
Acenaphthene Acenaphthylene Benzo(a)anthracene Benzo(a)pyrene Dibenz(a,h)anthracene 2-Methylnapthalene Naphthalene Phenanthrene	Benzene 1,2,4-Trimethylbenzene 1,3,5-Trimethylbenzene	None	None

Groundwater COCs

PAHs	VOCs	SVOCs	Metals
Acenaphthylene Benzo(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Dibenz(a,h)anthracene Fluorene Indeno(1,2,3-cd)pyrene 2-Methylnapthalene Naphthalene Phenanthrene	Benzene 1,2,4-Trimethylbenzene 1,3,5-Trimethylbenzene Toluene	None	Arsenic Lead

2.6 Preliminary Evaluation of Contaminant Transport Mechanisms

Subsurface soils beneath the Site are dominated by permeable gravel, sand and silt outwash material. This material is well drained; consequently no surface water features have been identified on or near the Property except for a storm water basin constructed at its southeast corner some time between 2005 and 2006. The storm water basin is unlikely to be affected by subsurface migration originating elsewhere on the Property owing to its location along the upgradient boundary of the Property. The most likely form of contaminant transport is vertical migration of contaminants into the groundwater, followed by potential lateral groundwater migration in the downgradient direction. However; the groundwater sampling data do not imply widespread or generalized impact to groundwater quality beneath the Site. Rather, the indicated impacts to groundwater quality appear to be localized.

Beneath the North Parcel, transport to groundwater appears to be localized in the area of the historic Benzol Plant, suggesting downward transport only in a preferred area. Such an area might be associated with historic underground utility or similar features once serving the former Benzol Plant. Beneath the Middle Parcel, migration to groundwater is also localized to an area where tar seeps have been observed at the surface of the ground near the west end of the Middle Parcel as illustrated on **Figure 2**. Direct burial of tar or other residue such as gas condensate seems to be implied at this location.

The Site is currently unused, so physical tracking of soil by people, animals, or machinery is regarded only a minor potential concern. The Site is mostly well vegetated at this time, and so wind transport of particulate is also regarded as a minor present concern. Physical tracking and wind transport may become more relevant during redevelopment or construction for future uses at the Site. Dust emissions, stormwater runoff, sedimentation, or off-site tracking are expected to be controllable under state air management and stormwater pollution prevention rules applicable to similar construction projects when remediation is undertaken.

2.7 Preliminary Evaluation of Potential Human Exposure Pathways

Environmental conditions at the Property, current land use, and its proposed future redevelopment suggest that the following human exposure routes may be relevant for the indicated media and potentially exposed populations:

1. Direct contact with surface soil by construction workers, industrial workers, and recreational users;

2. Direct contact with subsurface soil by construction workers excavating below 10 ft;

3. Ingestion of groundwater by users of nearby water wells affected by contaminants migrating from the Site (if any such wells are present);

4. Ingestion of groundwater by future users of water wells that might be drilled at the Site; and,

5. Vapor intrusion to indoor air, which is only relevant for parts of the Middle Parcel where benzene was detected in soil or shallow groundwater.

2.8 Identification of Historical Data Gaps

Surface soil defined herein as extending from 0 to 10 ft below ground (<10 ft bgs) is well characterized by the historic sampling data. Gaps in the historic characterization of this medium are generally limited only by the scope of historic sampling. Review of the historic sample data indicates that the primary data gaps for surface soil are as follows:

- Limited to a scarcity of arsenic and lead data for the North Parcel,
- Absence of historic arsenic or lead data for surface soil at the South Parcel, and
- The historically noted presence of benzene, benzo(a)pyrene, arsenic and lead in concentrations exceeding various RISC CLs. Prior to 2012, the Middle Parcel was characterized only by historical data that predate the establishment of U.S. EPA approved Quality Assurance Project Plan procedures.

Surface soil sampling during this two-year Site Investigation is intended to address these data gaps and provide generally more complete data for the North, Middle and South Parcels.

Subsurface soil is defined for this project as extending from 10 ft below ground surface to the surface of the shallow water table at about 12 ft to 17 ft below ground surface and therefore represents only a thin layer of soil. Given the limited vertical extent of the subsurface soil medium and its isolation from the surface, the scarcity of historic sampling data from this vertical zone is not regarded as a significant data gap. However, the historic subsurface sample database indicates that benzene is present above the Residential Migration to Groundwater CL beneath the former Tar Storage Tanks on the North Parcel. Benzo(a)pyrene was also detected above its Residential and Industrial/Commercial Migration to Groundwater CL beneath the former Tar Storage Tanks. Benzene was also prominently detected beneath a small area at the west end of the Middle Parcel where tar seeps have been observed during historic fieldwork at the Site.

Groundwater beneath the Site is not well characterized by the historic sampling data owing to a scarcity of data beneath the North and South Parcels. Historic groundwater sample results indicate that benzene affects a localized area beneath the west end of the Middle Parcel. Additionally, the Middle Parcel is thus far characterized by historical data that predate the establishment of U.S. EPA approved Quality Assurance Project Plan procedures. Groundwater sampling during this Site Investigation is intended to address these data gaps.

3.0 METHODS OF INVESTIGATION

3.1 Sampling and Analysis Plan

The approved SAPs (see **Section** Error! Reference source not found.) specify the purpose, objectives, scope of work, and methodologies for the Site Investigation activities described in this report. Field sampling and analytical protocol for the Site Investigation were conducted as specified in the approved 2011 QAPP and updated 2012 QAPP, respectively. Pursuant to IBP's request, the following activities were conducted in accordance with the SAPs:

<u>2011 Site Investigation Activities</u>

1. Previous environmental reports were obtained from the IDEM's Virtual File Cabinet. The historical data found in the subject reports was manually tabulated. The data and information were reviewed to develop an understanding of the physical setting, history, and environmental condition of the Property.

2. Two (2) surface soil samples were collected from each of 20 locations (SS11-1 through SS11-20) at intervals of 0 to 1 ft and 1 to 2 ft below ground surface (bgs) to complete the assessment of surficial materials across the North and South Parcels. Forty (40) surface soil samples were collected from these locations.

3. Twenty-one (21) soil probes (TW11-1 through TW11-20 and TW11-8I) were advanced to investigate the former Benzol Plant, the Area of Concern (AOC) on the South Parcel and "hot spots" identified on the isopleths maps. Weaver Boos collected 20 soil samples from the soil probes; sample selection was based on visual evidence of contamination and/or photoionization detector (PID) readings.

4. Temporary groundwater monitoring wells were emplaced in the 21 soil probes (TW11-1 through TW11-20 and TW11-8I) to facilitate the collection of groundwater samples from the North and South Parcels.

5. Nine (9) permanent groundwater monitoring wells were installed utilizing rotary drilling methods in the area of the Benzol Plant. The monitoring wells are designated PW11-1 through PW11-6; a suffix "S" indicates a shallow well, a suffix "I" indicates an intermediate well, and a suffix "D" indicates a deep well. Groundwater samples were collected from the nine (9) installed monitoring wells.

6. Eleven (11) test pits (TP11-1 through TP11-11) were excavated on the North and South Parcels to assess subsurface conditions. Fourteen soil samples were collected from the test pits; sample selection was based on visual evidence of contamination and/or PID readings.

7. The new monitoring wells were surveyed to establish their coordinate location and elevation. Weaver Boos obtained a full round of groundwater level measurements for calculation of groundwater elevations at all of the on-Site groundwater monitoring wells for groundwater flow direction determination.

8. A groundwater sample was collected from a historical permanent groundwater monitoring well (MW-6).

2012 Site Investigation Activities

1. Five (5) soil probes (TW12-24 through TW12-28) were advanced in the Middle Parcel to characterize surface soil and subsurface soil concentrations under current QAPP protocols. Surface soil samples were collected from intervals of 0 to 1 ft bgs in each soil probe. Two (2) additional soil samples were collected from each of the five (5) soil probes advanced in the Middle Parcel. The depth intervals of the samples collected varied based on field observations (i.e., visual evidence of contamination and/or photoionization detector (PID) readings); however, the sample interval selection was biased toward the collection of one additional surface soil sample (<10 ft bgs) and one subsurface soil sample (>10 ft bgs) per probe. A total of 10 surface soil samples and five (5) subsurface soil samples from the Middle Parcel.

2. Three (3) soil probes (TW12-21I through TW12-23I) were advanced to the west of the North Parcel in the City right-of-way along South 13th Street in an attempt to further characterize a groundwater plume of naphthalene inferred to emanate from the former Benzol Plant during 2011. Surface soil samples were collected from intervals of 0 to 1 ft bgs in each soil probe to define surficial soil concentrations in the area. Two (2) additional soil samples were collected from each of the three (3) soil probes. The depth intervals of the samples collected varied based on field observations (i.e., visual evidence of contamination and/or photoionization detector (PID) readings); however, the sample interval selection was biased toward the collection of one additional surface soil sample (<10 ft bgs) and one subsurface soil sample (>10 ft bgs) per probe. Weaver Boos collected a total of six (6) surface soil samples and three (3) subsurface soil samples from the probes.

3. Temporary groundwater monitoring wells were emplaced in the five (5) soil probes (TW12-24 through TW12-28) in the Middle Parcel and the three (3) soil probes (TW12-21I through TW12-23I) in the City right-of-way along S. 13th Street.

4. Results of the 2011 Site Investigation imply the presence of a naphthalene plume in the groundwater emanating from the former Benzol Plant at an intermediate depth of approximately 30 to 35 ft bgs. The plume appears to be absent at shallower depths and possibly at deeper depths as well, but appears to extend northwesterly from the former Benzol Plant to the western Site boundary. The monitoring well network installed during 2011 was augmented by the installation of 15 new groundwater monitoring wells (permanent and temporary) to characterize the extent and concentration of the inferred

naphthalene plume. As illustrated on Figure 5, the 12 new permanent monitoring wells are designated PW12-4 through PW12-10, whereas the three (3) new temporary monitoring wells are designated TW12-21I through TW12-23I; a suffix “S” indicates a shallow well, a suffix “I” indicates an intermediate well, and a suffix “D” indicates a deep well. Groundwater samples were collected from the 21 permanent monitoring wells and three (3) temporary wells.

5. The new monitoring wells (permanent and temporary) were surveyed to establish their coordinate location and elevation. Weaver Boos obtained a full round of groundwater level measurements for calculation of groundwater elevations at all of the on-Site groundwater monitoring wells for groundwater flow direction determination.

6. Weaver Boos identified nearby water wells with considerable assistance from the Terre Haute City Engineer and sampled the two wells that were found to assess for potential migration in the downgradient area to the west.

3.2 Fieldwork

3.2.1 Soil Sampling

In consultation with the IBP Project Manager, soil samples selected for laboratory analysis during the Site Investigation were chosen based on visual evidence of contamination and/or PID readings. Where no evidence of contamination or PID readings was observed or measured, the sample interval from eight (8) to 10 feet was submitted for analysis as requested by the IBP Project Manager.

3.2.1.1 Direct Push Sampling - 2011

On July 25-29, 2011, Midway Services, Inc., under the supervision of a Weaver Boos geologist, advanced 21 soil probes, designated TW11-1 through TW11-20 and TW11-8I, on the Site using direct-push drilling technology (i.e. GeoProbe®). Twenty soil probe locations were indicated in the SAP dated July 22, 2011; however, based on field observations by Weaver Boos and IBP, one additional soil probe, TW11-8I, was added adjacent to TW11-8. The location of the 21 soil probes are illustrated on in **Figure 5**. During drilling, soil samples were continuously collected at 4-foot intervals by hydraulically driving a hollow sampling tool into the underlying unconsolidated material. Weaver Boos performed on-site observation during drilling; the soil samples were logged, based on visual observation, and information such as soil type, color, grain size, and moisture was recorded.

Twenty (20) soil samples were collected for laboratory analysis of VOCs, SVOCs, free cyanide and RCRA 8 Metals. One soil sample was collected from the interval of eight (8) to 10 feet bgs in each soil probe TW11-1 through TW11-20.

During drilling, the observed uppermost saturated zone occurred in the sand and gravel at depths ranging from 12 feet bgs in the northern portion of the Property to 17 feet bgs in areas of the South Parcel. Temporary groundwater monitoring wells were installed in each of the soil probes. The temporary wells were constructed of 1-inch inner-diameter, flush-threaded, schedule 40 polyvinyl chloride (PVC), terminated with 5 feet of 0.010-inch slotted screen set into the saturated zone.

Direct-push drilling technology was also utilized during the week of July 25, 2011, under the supervision of a Weaver Boos geologist, to advance six (6) soil probes to facilitate the installation of permanent monitoring wells. The soil probes were advanced to obtain hydrogeologic information to determine the depths at which the permanent wells were to be emplaced. Nine (9), 2-inch diameter, permanent groundwater monitoring wells, PW11-1S, PW11-2S, PW11-3S, PW11-3I, PW11-3D, PW11-4S, PW11-4I, PW11-5S, and PW11-6S, were subsequently installed utilizing 4.25-inch hollow stem augers. A suffix of “S” indicates a shallow well, a suffix “I” indicates an intermediate well, and a suffix “D” indicates a deep well. All of the shallow wells are screened from 10 to 20 feet bgs to intersect the surface of the water table with the exception of PW11-6S, which is screened from 15 to 25 feet bgs. Due to the predominance of sand and gravel, hydraulically distinct aquifer layers do not appear to be present at the Site. Consequently, 10 feet of vertical separation was employed between the screened intervals of the shallow, intermediate, and deep wells as stated in the SAP. The two intermediate wells, PW11-3I and PW11-4I, are screened from 30 to 35 feet bgs and the one deep well, PW11-3D, is screened from 45 to 50 feet bgs. Locations of the permanent groundwater monitoring wells are illustrated on **Figure 5**. Detailed lithologic descriptions with integrated well completion diagrams are included on the soil probe logs provided in **Appendix C**.

Direct-push drilling technology was further utilized during the week of July 25, 2011, under the supervision of a Weaver Boos geologist, to advance 20 shallow surface soil probes, designated SS11-1 through SS11-20, to complete the surface soil assessment at the Site. Several of the shallow soil probe locations were co-located with the aforementioned deeper soil probes that facilitated temporary well emplacement. Locations of the shallow soil probes were indicated in the SAP dated July 22, 2011 and are illustrated on **Figure 5**.

Forty (40) shallow soil samples were collected for laboratory analysis of SVOCs, free cyanide and RCRA 8 Metals. Two (2) surface soil samples were collected from each of the 20 locations at intervals of 0 to 1 ft and 1 to 2 ft bgs.

3.2.1.2 Direct Push Sampling - 2012

On April 10-11, 2012, Enviro-Dynamics, LLC, under the supervision of a Weaver Boos geologist, advanced eight (8) soil probes, designated TW12-21I through TW12-23I and TW12-24 through TW12-28, using direct-push drilling technology (i.e. GeoProbe®). The location of the eight (8) soil probes are illustrated on **Figure 5**. During drilling, soil samples were continuously collected at 4-foot intervals by hydraulically driving a hollow sampling tool into the underlying unconsolidated material. Weaver Boos performed on-site observation during drilling; the soil samples were logged, based on visual observation, and information such as soil type, color, grain size, and moisture was recorded.

The soil probes facilitated the collection of surface and subsurface soil samples. A total of Eight (8) surface soil samples were collected; five (5) from the soil probes advanced in the Middle Parcel and three (3) from the soil probes advanced in the City right-of-way adjacent to the North Parcel. The surface and subsurface soil samples were collected for laboratory analysis of SVOCs, arsenic and lead. The subsurface samples were also analyzed for VOC.

During drilling in 2012, the uppermost saturated zone occurred in the sand and gravel at depths ranging from 16 to 19 feet bgs, which is generally about 2 ft deeper than during 2011. Temporary groundwater monitoring wells were installed in each of the soil probes. The temporary wells were constructed of 1-inch inner-diameter, flush-threaded, schedule 40 PVC, terminated with 10 feet of 0.010-inch slotted screen set into the saturated zone. The three (3) soil probes located in the City right-of-way adjacent to the North Parcel were advanced to 36 feet bgs to facilitate the emplacement of intermediate zone temporary wells associated with the naphthalene plume inferred during the 2011 Site Investigation activities.

Direct-push drilling technology was also utilized during the week of April 9, 2012, under the supervision of a Weaver Boos geologist, to advance seven (7) soil probes to facilitate the installation of permanent monitoring wells. Twelve (12), 2-inch diameter, permanent groundwater monitoring wells, PW12-4D, PW12-5I, PW12-6S, PW12-6I, PW12-6D, PW12-7S, PW12-7I, PW12-8I, PW12-9S, PW12-9I, PW12-9D, and PW12-10I, were subsequently installed utilizing 4.25-inch hollow stem augers. A suffix of "S" indicates a shallow well, a suffix "I" indicates an intermediate well, and a suffix "D" indicates a deep well. All of the shallow wells are screened from 10 to 20 feet bgs to intersect the surface of the water table. As stated in the SAP, the intermediate wells are screened from 30 to 35 feet bgs and the deep wells are screened from 45 to 50 feet bgs. Locations of the permanent groundwater monitoring wells are illustrated on **Figure 5**. Detailed lithologic descriptions with integrated well completion diagrams are included on the soil probe logs provided in **Appendix C**.

3.2.1.3 Test Pit Sampling - 2011

On July 27, 2011, S & G Excavating, Inc., under the supervision of a Weaver Boos geologist, excavated 11 test pits on the Site, designated TP11-1 through TP11-11. Ten (10) test pit locations are indicated in the SAP; however, based on field observations by IBP and the City of Terre Haute, one additional test pit (TP11-11) was excavated. The locations of the 11 test pits are shown on **Figure 5**. The test pits were excavated utilizing a Caterpillar 320L track excavator equipped with a 1.25-cubic yard capacity bucket. Weaver Boos performed on-site observation during excavation activities; the subsurface material was screened with a PID and logged based on visual observation. Observations during the excavation of the test pits are presented in the test pit logs provided in **Appendix C**.

Fourteen (14) soil samples from the test pits were collected for laboratory analysis of VOCs, SVOCs, free cyanide and RCRA 8 Metals. Visual evidence of contamination and/or elevated PID readings was encountered in test pits TP11-3, TP11-6 and TP11-10; consequently, two (2) soil samples were collected from each of these test pits. One (1) soil sample was collected from each of the remaining eight test pits from the interval of 8 to 10 ft bgs.

The soil types encountered during excavation of the test pits were generally the same as those encountered during the soil probes. However, what appeared to be demolition debris (e.g. bricks and masonry blocks) was found in test pit TP11-4 to the terminus at eight (8) feet bgs and test pit TP11-9 exhibited approximately 11 feet of fill material and debris and other non-native materials that included wood, brick, and plastic bottles.

3.2.2 Groundwater Sampling

3.2.2.1 Temporary Groundwater Monitoring Wells – 2011

Groundwater samples were collected from all 21 of the temporary groundwater monitoring wells between August 3-5, 2011 for laboratory analysis of VOCs, SVOCs, free cyanide, RCRA 8 Metals, and ammonia, which was added at the request of IBP. Sampling of the temporary wells was conducted using a fully enclosed (i.e., no exposure of sample to gas or air) pneumatic bladder pump and dedicated bladders and tubing for each well, with the exception of TW11-2 and TW11-8. Groundwater samples for quantitative analysis were dispensed into their respective containers via gentle side filling directly from the discharge side of the pump tubing. Upon filling the vials for VOC analysis and the polyethylene bottles for free cyanide, RCRA 8 Metals, and ammonia utilizing the bladder pump, disposable bailers were used to fill the remaining vessels in the bottle sets for SVOC analysis. The discrete groundwater samples, in addition to necessary quality control/quality assurance (QA/QC) samples, were sealed, labeled, placed on ice, documented with a chain-of-custody form and shipped to the laboratory via overnight courier. Groundwater sampling field forms are available for review in the August 14, 2012 Phase II Site Investigation report prepared by Weaver Boos.

Upon completion of the groundwater sampling, Midway Services, Inc. abandoned the temporary monitoring wells on August 8, 2011 by removing the PVC screen and casing and backfilling the open holes with bentonite to ground surface.

3.2.2.2 Temporary Groundwater Monitoring Wells – 2012

Groundwater samples were collected from all 8 of the temporary groundwater monitoring wells between April 17-19, 2012 for laboratory analysis of VOCs, SVOCs, PAHs, total and dissolved lead, and total and dissolved arsenic. Although dissolved arsenic was not listed on the chain of custody forms that accompanied the groundwater samples, the omission was promptly realized and the laboratory was instructed to perform the requisite analysis. Sampling of the temporary wells was conducted using a fully enclosed (i.e., no exposure of sample to gas or air) pneumatic bladder pump and dedicated bladders and tubing for each well. Groundwater samples for quantitative analysis were dispensed into their respective containers via gentle side filling directly from the discharge side of the pump tubing. Upon filling the vials for VOC analysis utilizing the bladder pump, a peristaltic pump fitted with dedicated tubing was used to fill the remaining vessels in the bottle sets. Dissolved lead and arsenic samples were field filtered using 0.45 micron, single-use groundwater filters. The discrete groundwater samples, in addition to necessary quality control/quality assurance (QA/QC) samples, were sealed, labeled, placed on ice, and documented with a chain-of-custody form. The samples were ultimately relinquished to the laboratory courier for transport. Groundwater sampling field forms are available for review in the August 14, 2012 Phase II Site Investigation report prepared by Weaver Boos.

Upon completion of the groundwater sampling, Weaver Boos abandoned the temporary monitoring wells on April 19, 2012. The PVC casings were unable to be removed from the ground, consequently the abandonment was performed by plugging the well casing with bentonite, severing the casing slightly below existing grade and finally covering with natural soil to match the surrounding grade.

3.2.2.3 Permanent Groundwater Monitoring Wells – 2011

Groundwater samples were collected from all nine of the permanent groundwater monitoring wells, and the preexisting monitoring well MW-6, between August 3-5, 2011 for laboratory analysis of VOCs, SVOCs, free cyanide, RCRA 8 Metals, and ammonia, which was added at the request of IBP. Sampling of the permanent wells was conducted using a fully enclosed (i.e., no exposure of sample to gas or air) pneumatic bladder pump and dedicated bladders and tubing for each well. Groundwater samples for quantitative analysis were dispensed into their respective containers via gentle side filling directly from the discharge side of the pump tubing. Upon filling the vials for VOC analysis and the polyethylene bottles for free cyanide, RCRA 8 Metals, and ammonia utilizing the bladder pump, disposable bailers were used to fill the remaining vessels in the bottle sets for SVOC analysis. The discrete groundwater samples, in addition to necessary quality control/quality assurance (QA/QC) samples, were sealed, labeled, placed on ice, documented with a chain-of-custody form and shipped to the laboratory via overnight courier. Groundwater sampling field forms are provided in available for review in the August 14, 2012 Phase II Site Investigation report prepared by Weaver Boos.

3.2.2.4 Permanent Groundwater Monitoring Wells – 2012

Groundwater samples were collected from all 21 of the permanent groundwater monitoring wells between April 17-19, 2012 for laboratory analysis of VOCs, SVOCs, PAHs, total and dissolved lead, and total and dissolved arsenic. Sampling of the temporary wells was conducted using a fully enclosed (i.e., no exposure of sample to gas or air) pneumatic bladder pump and dedicated bladders and tubing for each well. Groundwater samples for quantitative analysis were dispensed into their respective containers via gentle side filling directly from the discharge side of the pump tubing. Upon filling the vials for VOC analysis utilizing the bladder pump, a peristaltic pump fitted with dedicated tubing was used to fill the remaining vessels in the bottle sets. Dissolved lead and arsenic samples were field filtered using 0.45 micron, single-use groundwater filters. The discrete groundwater samples, in addition to necessary quality control/quality assurance (QA/QC) samples, were sealed, labeled, placed on ice, and documented with a chain-of-custody form. The samples were ultimately relinquished to the laboratory courier for transport. Although dissolved arsenic was not listed on the chain of custody forms that accompanied the groundwater samples, the omission was promptly realized and the laboratory was instructed to perform the requisite analysis. Dissolved lead and dissolved arsenic analyses were not performed for monitoring well PW11-4S due to the lack of appropriate sample submission to the laboratory. However, a duplicate sample (Dup-3) was collected at monitoring well PW11-4S therefore dissolved lead and dissolved arsenic analytical data is available. Groundwater sampling field forms are provided in available for review in the August 14, 2012 Phase II Site Investigation report prepared by Weaver Boos.

3.2.2.5 Identification of Nearby Water Wells

Weaver Boos compiled well records according to federal section numbers during 2011 as presented in **Appendix B**. The locations of wells within approximately 1.0 mile of the Property were then plotted from IDNR database coordinate information using GIS mapping techniques during 2012. Weaver Boos assessed the map with consideration for the groundwater flow direction and identified nine (9) candidate wells located inside a 60 degree arc to the west of the Property. Weaver Boos provided this information to the Terre Haute City Engineer who then attempted to establish contact and permission to sample the wells during 2012. No successful arrangement was established with any of the listed well owners (most of the information contained in the well records is older than 20 years). In the absence of successful prior arrangements, Weaver Boos visited the area accompanied by the City Engineer and the two of them canvassed the downgradient target area door to door on May 9, 2012 and found well owners at the two following addresses who provided permission for us to sample:

Well 1 – 630 Putnam Street

Well 2 – 1444 South Center Street

Weaver Boos sampled the two water wells and submitted them for laboratory analyses of VOCs, SVOCs, total and dissolved arsenic, and total and dissolved lead. The groundwater samples were obtained via an indoor faucet or outside spigot that was allowed to run open for approximately 10 minutes to allow for water to be purged from the pressure tank. After a period of ten minutes, the flow was reduced a trickle and the samples were collected following the procedures outlined in the Weaver Boos Field SOP 08-003 (Rev. 1) *Groundwater Sampling* for collecting groundwater samples for specific analyses. Sampling information for the two residential water wells is included in **Appendix B**.

3.2.3 Survey Control

Prior to drilling, the Site Investigation sample locations were laid out and staked by a Weaver Boos land surveyor using a sub-centimeter global positioning system (GPS) unit with integrated VRS correction. Subsequent to their installation, the temporary groundwater monitoring wells and permanent groundwater monitoring wells were surveyed to obtain horizontal position, top of casing elevations, and ground elevations. Horizontal survey control was North American Datum of 1983 (NAD83), Indiana State Plane West Zone 1302. The 2011 monitoring well survey was performed by Myers Engineering, Inc., whereas the 2012 survey was completed by Weaver Boos. The survey was conducted in accordance with the IDEM Office of Land Quality Spatial Data Collection Standards, Version 1.0 dated July 29, 2008. The survey results are provided in **Appendix D**.

3.2.4 Analytical Work

The investigational samples and required quality control/quality assurance (QA/QC) samples collected as part of this site investigation were submitted under chain of custody to Pace Analytical Services, Inc. in Indianapolis. During the 2011 investigation, surface soil samples collected at depth ranging from zero (0) to two (2) ft bgs were analyzed for, SVOCs utilizing EPA Method 8270, free cyanide via EPA Method 9014, and RCRA 8 Metals in accordance with EPA Method 6010/7471. Soil samples collected at depths deeper than two (2) ft bgs were analyzed for the same parameters with the addition of VOCs in accordance with EPA Method 5035/8260. Groundwater samples were analyzed for the same parameters (including VOCs) and EPA Methods with the addition of ammonia (as nitrogen) via EPA Method 350.1.

The requested laboratory analyses were modified during the 2012 investigation to include only VOCs, SVOCs, arsenic, and lead. Groundwater samples collected during 2012 were analyzed for both total and dissolved arsenic and lead.

The resulting analytical reports from 2011 and 2012, together with Level IV Data Packages for each laboratory report are included in portable document format (.pdf) on the compact disc available for review in the August 14, 2012 Phase II Site Investigation report prepared by Weaver Boos.

4.0 INVESTIGATION RESULTS

4.1 Subsurface Geology Investigation Results

Subsurface geologic conditions encountered during the Site Investigation are consistent with the professional literature and prior assessments of the Site. The soil types encountered during drilling included fill material (varying mixtures of cinders, coal ash, coke, sand, gravel, and fines) at depths less than approximately 4 ft bgs, which was underlain by loam (sand and clay mixture) at depths less than approximately 8 ft bgs. These materials were in turn underlain by sand and gravel exhibiting variable grain/clast sizes from approximately 8 ft bgs to the maximum observed depth of 50 ft bgs.

The loamy soil near the surface appears to represent the Elston sandy loam mapped by the USDA/NRCS. The sand and gravel encountered at depths greater than 8 ft bgs is consistent with the glacial outwash deposits mapped by Gray et al. (1979) and further described by Hartke et al. (1983).

4.2 Hydrogeology Investigation Results

Also consistent with the professional literature, the Site was found to be underlain by glacial outwash deposits of predominantly sand and gravel with no hydraulically distinct aquifer layers between approximately eight (8) feet bgs to the maximum observed depth of 50 feet bgs. During the 2011 Site Investigation field work, the vadose zone was observed to extend to approximately 12 ft bgs beneath the North Parcel and to approximately 17 ft bgs beneath the South Parcel where groundwater was first encountered. Groundwater levels were approximately 2 ft deeper during the 2012 field activities, likely owing to an extended period of dry weather.

Groundwater encountered in unconsolidated outwash aquifer beneath the Site appears to be hydraulically unconfined at its surface and thus forms a typical water table condition. Water levels measured in the monitoring wells on August 3, 2011 are listed on **Table 1-1** and those measured on April 17, 2012 are listed on **Table 1-2**. These tables reduce the measurements to groundwater elevations (NAVD88) using the survey control data. The potentiometric surface for the Site water table developed from the groundwater elevations in 2011 and 2012 is provided on **Figures 6A** and **6B**, respectively. The maps show a consistent, relatively uniform west-northwesterly groundwater flow towards the Wabash River.

Near the middle of the Site in 2011, a gradient of 1.6 ft / 760 ft (0.0021 ft/ft) was indicated between temporary monitoring wells TW11-9 and TW11-8. The unconfined outwash aquifer is characterized by a field permeability (or hydraulic conductivity) of 1,200 gpd/ft^2 according to Cable et al. (1971), or 160 ft/day in more convenient units. Assuming an effective porosity of 0.3 which is typical for sand and gravel aquifers, the horizontal groundwater flow velocity beneath the Site is estimated using Darcy's law as approximately (160 ft/day)(0.0021 ft/ft)/0.3 = 1 ft/day. A somewhat gentler gradient was obtained in the same general area of the Site during 2012, when a gradient of 0.80 ft / 615 ft (0.0013 ft/ft) was indicated between well PW11-1S and PW12-9S, suggesting a slightly lesser groundwater flow velocity of approximately (160 ft/day)(0.0013 ft/ft)/0.3 = 0.7 ft/day

Modest vertical gradients are indicated by the water level measurements taken in the nested wells installed during the Site Investigation. Near the former Benzol Plant in well cluster PW11-3, the 2011 groundwater elevation in the shallow well was 473.56 ft, the intermediate well was 473.42 ft, and the deep well was 473.46 ft. With vertical screen center separation of approximately 32.5 ft between PW11-3S and PW11-3D, the downward vertical gradient is estimated as (473.56 ft – 473.46 ft)/32.5 ft = 0.0031 ft/ft. The 2011 elevations exhibit a downward vertical gradient at well cluster PW11-4S and PW11-4I is estimated as (473.44 ft – 473.36 ft)/17.25 ft = 0.0046 ft/ft. An upward vertical gradient is indicated at well cluster TW8 and TW8I during 2011, estimated as (472.78 ft – 472.90 ft)/18.0 ft = -0.0067 ft/ft.

Vertical gradients were calculated using the 2012 water level data. Similar results were obtained, such as the PW11-3 cluster estimated as (471.67 ft - 471.55 ft)/32.5 ft = 0.0037 ft/ft. Of note is well cluster 4; the shallow (PW11-4S) and intermediate (PW11-4I) wells were installed in 2011 whereas the deep well (PW12-4D) was installed during the 2012 field activities. The vertical gradients were calculated and appear to show a convergence toward the intermediate zone. A downward vertical gradient between the shallow and intermediate wells is estimated as (471.53 ft – 471.46 ft)/17.5 ft = 0.004 ft/ft, however an upward vertical gradient is estimated between the intermediate and deep as (471.46 ft – 471.67 ft)/15 ft = -0.014 ft/ft. The overall vertical gradient at well cluster 4 (between PW11-4S and PW12-4D) appears to be upward as estimated by (471.53 ft – 471.67 ft)/32.5 ft = -0.0043 ft/ft.

The small magnitude of the vertical gradients and frequent upward direction generally indicates a low potential for downward vertical migration or "plume diving" beneath the Site. Upward vertical flow gradients are reasonably expected given the Site's near proximity to the Wabash River and the presence of upland recharge areas to the east.

4.3 Laboratory Analytical Results

4.3.1 Surface Soil Analytical Results – North Parcel

Surface soil concentrations measured during the Site Investigation are summarized on **Table 2**, which includes data from the North, South, and Middle Parcels. Specific sample locations are illustrated on **Figure 5**. Discussion of the surface soil analytical results focuses on the frequency of measurements at levels above relevant closure levels in this section. The location, distribution, and extent of relevant concentrations are discussed in **Section 4.3.5**.

On the North Parcel, concentrations of benzo(a)pyrene were measured in 6 out of the 45 samples of surface soil analyzed for PAHs at levels above the Industrial/Commercial Soil Direct Contact CL (1,500 ug/kg). The frequency of concentrations above either the Recreational Surface Soil CL (510 ug/kg) or the Residential Soil Direct Contact CL (500 ug/kg) is 10 out of the 45 samples analyzed. Several other PAHs, including benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, phenanthrene, or naphthalene also exceeded their respective Soil Direct Contact or Recreational Surface Soil CLs in generally the same individual samples, although less frequently than benzo(a)pyrene.

Concentrations of total arsenic were measured in 4 out of 45 surface soil samples collected from the North Parcel at levels above the Industrial/Commercial Soil Direct Contact CL (20 mg/kg). The frequency of total arsenic measurements above the Recreational Surface Soil CL (13 mg/kg) is also 4 out of 45 surface soil samples collected. The majority of the surface soil samples (38 out of 45) indicate total arsenic concentrations above the Residential Soil Direct Contact CL (3.9 mg/kg) calculated based on the U.S. EPA Soil Screening Guidance for vegetable uptake. Weaver Boos notes that Indiana soils are frequently characterized by background concentrations greater than the Residential Soil Direct Contact CL for arsenic. The IDEM (2004) has acknowledged a background concentration for arsenic as high has 13 mg/kg.

4.3.2 Groundwater Analytical Results – North Parcel

Groundwater Concentrations are summarized on **Table 4**, which includes data for monitoring wells located on the North, South, and Middle Parcels. Groundwater sample locations are illustrated on **Figure 5**.

In the 45 groundwater samples collected from monitoring wells (temporary and permanent) installed on or adjacent to the North Parcel, VOCs were not detected above their respective Industrial/Commercial Groundwater CLs. During 2011 and 2012 sampling, 1,2,4-trimethylbenzene and 1,3,5-trimethylbenzene were detected in permanent monitoring well

PW11-4I located downgradient from the former Benzol Plant at concentrations above their respective Residential Groundwater CLs (both equal to 16 ug/l). Results from the 2011 sampling indicate polycyclic aromatic hydrocarbons (quantitated as SVOCs) including benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, phenanthrene, naphthalene, and 2-methylnaphthalene as also being present in groundwater at PW11-4I at concentrations above their respective Industrial/Commercial Groundwater CLs, as was dibenzofuran. Concentrations of these PAHs were exhibited in 2012 sampling results for PW11-4I, however at lesser concentrations. Additional PAHs were detected in this well during 2011 and 2012 at concentrations above Residential Groundwater CLs including acenaphthene, acenaphthalylene, and fluorene.

Only a few PAHs or SVOCs were detected in groundwater samples from other monitoring wells drilled on the North Parcel; these included naphthalene, dibenzofuran, and bis(2-ethylhexyl)phthalate above their respective Residential Groundwater CLs.

Total arsenic was detected in groundwater samples at concentrations above the Industrial/Commercial Groundwater CL (10 ug/l) in several monitoring wells during 2011 or 2012, including PW11-1S, PW11-2S, PW11-3S, PW11-4S, PW11-4I, PW11-5S, PW12-6S, PW12-7S, PW12-9S, PW12-10I, TW11-4, TW11-5, TW11-6, TW11-9, TW12-21I, and TW12-23I. Dissolved arsenic analyses were also performed during 2012. Only PW11-4S exhibited a dissolved arsenic concentration above the laboratory reporting limit which consequently also exceeded the Industrial/Commercial Groundwater CL (note that this concentration is inferred from the duplicate sample “Dup-3”; as indicated previously no primary filtered sample was collected for PW11-4S). Groundwater samples collected during 2011 and 2012 indicated total lead concentrations exceeding the Industrial/Commercial Groundwater CL (42 ug/l) in several monitoring wells, including PW11-1S, PW11-2S, PW11-3S, PW11-3I, PW11-4I, PW11-5S, PW12-7S, PW12-9S, PW12-10I, TW11-4, TW11-5, TW11-6, and TW12-23I, and also at concentrations above the Residential Groundwater CL (15 ug/l) in monitoring wells PW12-6S, TW11-8, TW11-9, and TW12-21I. Dissolved lead analysis was also performed during 2012; no concentrations were detected above the laboratory reporting limit in groundwater samples from the North Parcel. Total barium or total cadmium were detected in several groundwater samples collected from temporary monitoring wells during 2011 at concentrations greater than the Residential Groundwater CLs of 2,000 ug/l and 5 ug/l, respectively.

4.3.3 Surface Soil Analytical Results – South Parcel

Surface soil concentrations measured during the Site Investigation are summarized on **Table 2**, which includes data from both the North Parcel and the South Parcel. On the South Parcel, concentrations of benzo(a)pyrene were measured in 6 out of the 29 samples of surface soil analyzed for PAHs at levels above the Industrial/Commercial Soil Direct Contact CL (1,500 ug/kg). The frequency of concentrations above either the Recreational Surface Soil CL (510 ug/kg) or the Residential Soil Direct Contact CL (500 ug/kg) is 9 out of the 29 samples analyzed. Several other PAHs, including benzo(a)anthracene, benzo(b)fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, or naphthalene also exceeded their respective Soil Direct Contact or Recreational Surface Soil CLs in generally the same individual samples, although less frequently than benzo(a)pyrene.

Concentrations of total arsenic were measured in 2 out of 29 surface soil samples collected from the South Parcel at levels above the Industrial/Commercial Soil Direct Contact CL (20 mg/kg). The frequency of total arsenic measurements above the Recreational Surface Soil CL (13 mg/kg) is also 2 out of 29 surface soil samples collected. The majority of the surface soil samples (26 out of 29) indicate total arsenic concentrations above the Residential Soil Direct Contact CL (3.9 mg/kg).

4.3.4 Groundwater Analytical Results – South Parcel

No organic compounds (VOCs, PAHs, or SVOCs) were detected in groundwater samples collected from any of the monitoring wells drilled on the South Parcel at concentrations above Residential Groundwater CLs.

Total arsenic was detected in the groundwater samples collected from monitoring wells PW11-6S and TW11-18 at concentrations above the Industrial/Commercial Groundwater CL (10 ug/l). Total cadmium was detected in groundwater samples collected from monitoring wells TW11-14, TW11-15, TW11-16, TW11-18, and TW11-20 above the Residential Groundwater CL (5 ug/l). Total chromium was detected at a concentration above the Residential Groundwater CL (100 ug/l) in monitoring well TW11-18. Total lead was detected in groundwater samples collected from monitoring wells PW11-6S, TW11-16 and TW11-18 at concentrations above the Residential Groundwater CL (15 ug/l).

4.3.5 Surface Soil Analytical Results – Middle Parcel

Surface soil concentrations measured during the Site Investigation are summarized on **Table 2**, which includes data from the North, South, and Middle Parcels. On the Middle Parcel, concentrations of benzo(a)pyrene were measured in 4 out of the 10 samples of surface soil analyzed for PAHs at levels above the Industrial/Commercial Soil Direct Contact CL (1,500 ug/kg). The frequency of concentrations above either the Recreational Surface Soil CL (510 ug/kg) or the Residential Soil Direct Contact CL (500 ug/kg) is 5 out of the 10 samples analyzed. Several other PAHs, including benzo(a)anthracene, benzo(b)fluoranthene, dibenz(a,h)anthracene, or indeno(1,2,3-cd)pyrene also exceeded their respective Soil Direct Contact or Recreational Surface Soil CLs in generally the same individual samples, although less frequently than benzo(a)pyrene.

Concentrations of total arsenic were measured in 1 out of 10 surface soil samples collected from the Middle Parcel at levels above the Industrial/Commercial Soil Direct Contact CL (20 mg/kg). The frequency of total arsenic measurements above the Recreational Surface Soil CL (13 mg/kg) is 3 out of 10 surface soil samples collected. Additionally, 8 of the 10 surface soil samples from the Middle Parcel indicate total arsenic concentrations above the Residential Soil Direct Contact CL (3.9 mg/kg). One lead concentration was measured above the Industrial/Commercial Soil Direct Contact CL (1,300 mg/kg) in the surface soil samples collected from the Middle Parcel. No other samples from the Middle Parcel exhibited concentrations exceeding the lead CLs.

4.3.6 Subsurface Soil Analytical Results – Middle Parcel

Subsurface soil concentrations measured during the Site Investigation are summarized on **Table 2**, which includes data from the North and Middle Parcels. Beneath the Middle Parcel, concentrations of PAHs were less than laboratory reporting limits in all of the five subsurface soil samples. Concentrations of total arsenic were measured in 1 out of 5 subsurface soil samples collected from the Middle Parcel at levels above the Recreational Soil Direct Contact CL (13 mg/kg). The frequency of total arsenic measurements above the Residential Soil Direct Contact CL (3.9 mg/kg) is 3 out of 5 subsurface soil samples collected.

4.3.7 Groundwater Analytical Results – Middle Parcel

No organic compounds (VOCs, PAHs, or SVOCs) were detected in groundwater samples collected from any of the temporary monitoring wells drilled on the South Parcel during 2012 at concentrations above Residential Groundwater CLs.

Total arsenic was detected in all 5 groundwater samples collected from the Middle Parcel at concentrations above the Industrial/Commercial Groundwater CL (10 ug/l). However, dissolved arsenic analysis measured in the same five samples yielded results consistently less than the laboratory reporting limit. Total and dissolved lead indicated a similar trend; concentrations in all five groundwater samples exceed the Industrial/Commercial Groundwater CL (42 ug/l), whereas the dissolved lead analysis yielded results below the laboratory reporting limit.

4.3.8 Nearby Water Well Analytical Results

No organic compounds (VOCs, PAHs, or SVOCs), arsenic (total or dissolved), or lead (total or dissolved) were detected at concentrations above Residential Groundwater CLs in the groundwater samples collected from any of the nearby water wells located at 630 Putnam or 1444 South Center Street.

4.4 Mapping Concentration and Extent

The preceding discussion of analytical results focuses only on samples collected by Weaver Boos during the Site Investigation. The current analytical results are integrated with the historical results collected between 2001 and early 2012 to provide an overall assessment of the Site with consideration for the all of the currently available data for the North, South, and Middle Parcels.

The horizontal extent of COCs detected in the three media were mapped to the Property using the March 31, 2011 AutoCAD drawing by Bruce Carter Associates, L.L.C. as a base plan. The data were inputted to SURFER 6.0 software using reduced versions of the historical data tables (Appendix A) and current Site Investigation data presented in **Tables 2**, **3**, and **4**. For the surface soil medium, many of the data points provided up to three distinct measurements at various depths 0 and 10 ft bgs. With consideration for the calculation of potential exposure concentrations (PECs) consistent with RISC Technical Guide, vertical average concentrations were calculated for each sample point with multiple depth intervals and the average value was used for mapping purposes. Maximum detected concentrations were considered for the assessment of concentration and extent in the subsurface soil and groundwater media if several vertical intervals were sampled.

The data were interpolated using the SURFER Kriging routine with default settings and contoured with high smoothing. Automated interpolation provided unsatisfactory results for the subsurface soil and organic COCs in the groundwater media, so these results were contoured by visual inspection and illustrated using the AutoCAD software. Concentration measurements for the indicator COCs were posted to the maps to illustrate where data are present or absent and to illustrate the greatest concentration detected at each location. Contour intervals were selected to match the CLs for Residential, Recreational, and Industrial/Commercial Soil Direct Contact exposure for the surface soil medium. Contour intervals for were selected to match the CLs for

Migration to Residential and Industrial/Commercial groundwater. Contour intervals were select to match Residential and Industrial/Commercial Groundwater CLs for the groundwater medium.

4.4.1 Surface Soil

Vertical average surface soil benzene concentrations are mapped as shown on **Figure 7**. As shown on this map, average benzene concentrations in surface soil above the Soil Direct Contact CLs are only present on the east and west portions of the Middle Parcel.

Vertical average surface soil benzo(a)pyrene concentrations are mapped as shown on **Figure 8**. As shown on this map, average benzo(a)pyrene concentrations above the Soil Direct Contact CLs are present over much of the Site, including the North, Middle, and South Parcels. Because benzo(a)pyrene is treated as an indicator for PAHs in general, average concentrations of other PAH exceeding Soil Direct Contact CLs are implied over similar (yet less extensive) areas of the Site.

Vertical average arsenic concentrations in surface soil are mapped as shown on **Figure 9**. As shown on this map, average arsenic concentrations above Soil Direct Contact CLs are present in surface soil on about ½ of the North and Middle Parcels and on a small fraction of the South Parcel.

Vertical average lead concentrations in surface soil are mapped as shown on **Figure 10**. As shown on this map, average lead concentrations above the Residential Soil Direct Contact CL and Interim Recreational CL are limited to a relatively small area on the eastern portion of the Middle Parcel.

4.4.2 Subsurface Soil

The highest measured benzene and benzo(a)pyrene concentrations in subsurface soil are mapped together as shown on **Figure 11**. Benzene was detected above the Residential Migration to Groundwater CL beneath the former Tar Storage Tanks on the North Parcel. Benzo(a)pyrene was also detected above its Residential and Industrial/Commercial Migration to Groundwater CL beneath the former Tar Storage Tanks. Benzene was also prominently detected beneath a small area at the west end of the Middle Parcel where tar seeps were observed during historic and most recent fieldwork at the Site.

4.4.3 Groundwater

The highest measured benzene and naphthalene concentrations in groundwater are mapped together as shown on **Figures 1 A** for 2011 and historical groundwater sampling data. Benzene was prominently detected in groundwater beneath a small area at the west end of the Middle Parcel. The benzene appears to be localized to only a small area, and little if any downgradient migration is indicated by groundwater samples collected from temporary groundwater monitoring wells TW11-12 or TW11-13.

Naphthalene was prominently detected just northwest of the former Benzol Plant on the North Parcel in 2011 Site Investigation and historical groundwater sampling data as illustrated on **Figure 12A**. The 2011 Site Investigation groundwater data, including the site specific water table potentiometric map (**Figure 6A**) and the naphthalene concentration measured in temporary monitoring well TW11-8I suggested continuity with intermediate level groundwater results obtained nearer to the former Benzol Plant. This continuity implied the presence of a groundwater naphthalene plume extending towards the west-northwest at least to the western boundary of the North Parcel at the intermediate depth interval. The near absence of detectable groundwater impact in the shallow monitoring wells screened across the water table suggested in 2011 that groundwater migration beneath the Site was probably only detectable using monitoring wells at intermediate (or deeper) screen intervals. Similar results were obtained during 2012, except that little or no continuity of naphthalene concentrations are indicated by the expanded permanent groundwater monitoring well network as illustrated on **Figure 12B**. The inferred extent or plume of naphthalene thought to emanate from the former Benzol Plant based on the 2011 data is replaced by two separate areas of naphthalene impact separated by non-detectable results in permanent monitoring wells PW12-5I, PW12-6I, and PW12-7I. Additionally, no naphthalene was detected in temporary monitoring wells TW12-21I, TW12-22I, or TW12-23I, indicating no off-site migration beneath South 13th Street.

The highest measured total arsenic and total lead concentrations measured in groundwater are mapped together as shown on **Figure 13** that illustrates the 2011 and historical groundwater data. Arsenic and lead concentrations above Residential or Industrial/Commercial CLs are present beneath the central portion of the North Parcel, but absent along the downgradient boundaries of the parcel along its north and west sides. No off-site migration of arsenic or lead in groundwater is therefore suggested from the North Parcel. Elevated concentrations of lead and arsenic were only detected in one monitoring well located on the South Parcel (TW11-18), suggesting some potential for off-site migration. Turbidity of the temporary monitoring well sample might also explain this measurement.

Total arsenic concentrations measured in the monitoring wells sampled during 2012 are posted to show their locations as illustrated on **Figure 14**. The concentrations are not contoured given the limited extent of the dataset. Review of the total arsenic concentrations posted on **Figure 14** indicates that total arsenic concentrations measured during 2012 are frequently elevated above Residential or Industrial/Commercial CLs. Conversely, the dissolved arsenic concentrations posted to the Site map as illustrated on **Figure 15** indicate uniformly non-detectable concentrations (less than 10 ug/l). Based on these results, total arsenic concentrations appear to be influenced by conditions at the site while the dissolved concentrations are not. This trend indicates that arsenic is not soluble, and hence immobile in the groundwater beneath the Site.

Total lead concentrations measured in the monitoring wells sampled during 2012 are posted to show their locations as illustrated on **Figure 16**. The concentrations are not contoured given the limited extent of the dataset. Review of the total lead concentrations posted on **Figure 16** indicates that total lead concentrations measured during 2012 are frequently elevated above Residential or Industrial/Commercial CLs. Conversely, the dissolved lead concentrations posted to the Site map as illustrated on **Figure 17** indicate uniformly non-detectable concentrations (less than 5 ug/l). Based on these results, total lead concentrations appear to be influenced by conditions at the site while the dissolved concentrations are not. This trend indicates that lead is not soluble, and hence immobile in the groundwater beneath the Site.

4.5 Parcel-Specific Potential Exposure Concentrations

Potential exposure concentrations (PECs) were computed at the request of the IBP Project Manager for surface soil at the North Parcel, South Parcel, and Middle Parcel. Constituents of concern were first identified for surface soil based on review of both the historic and current data bases (**Appendix A** and **Table 2**, respectively). Analytes detected above relevant CLs in one or more samples were found to include benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, 2-methylnaphthalene, naphthalene, phenanthrene, arsenic and lead. The historic and current data were combined into a single database and sorted by parcel. The relevant surface soil results for the North Parcel are listed on **Table 5**, those for the South Parcel are listed on **Table 6**, and relevant surface soil results for the Middle Parcel are listed on **Table 7**. The separate listings for each parcel were subsequently imported to ProUCL Version 4.1 software and evaluated to determine their 95% upper confidence limits for the mean concentration of each COC. The ProUCL inputs and outputs are provided in **Appendix E**. The resulting 95% UCL concentrations were then transferred to **Tables 5**, **6**, and **7**, where they are compared with relevant soil screening levels (SLs) published by the IDEM in its new RCG.

For the North Parcel the 95% UCL concentration for benzo(a)pyrene was found to be greater than the Industrial/Commercial Soil Direct Contact SL (2,100 ug/kg), as were several of the other PAH compounds. The 95% UCL concentration for arsenic at the North Parcel is 18.3 mg/kg, which exceeds the Industrial/Commercial Soil Direct Contact SL (16 mg/kg). These results are summarized on **Table 5**.

For the South Parcel the 95% UCL concentration for benzo(a)pyrene was found to be greater than the Industrial/Commercial Soil Direct Contact SL, as was naphthalene. The 95% UCL concentration for arsenic at the South Parcel is 10.75 mg/kg, which meets the Industrial/Commercial Soil Direct Contact SL (16 mg/kg). These results are summarized on **Table 6**.

For the Middle Parcel the 95% UCL concentration for benzo(a)pyrene was found to be greater than the Construction Worker Soil Direct Contact SL (130,000 mg/kg), as was dibenz(a,h)anthracene. The 95% UCL concentration for arsenic (14.98 mg/kg) meets the Industrial/Commercial Soil Direct Contact SL. Additionally, the 95% UCL concentration for lead (527.3 mg/kg) exceeds the Recreational Surface Soil SL (400 mg/kg). These results are summarized on **Table 7**.

4.6 Field and Analytical QA/QC

4.6.1 Field and Analytical QA/QC - 2011

Field QA/QC soil samples collected during the 2011 investigation included five field duplicates, five matrix spike/matrix spike duplicates (MS/MSD), and the transportation and analysis of four trip blanks. The field duplicate samples, identified as "Dup-1" through "Dup-5", were collected concurrently with the primary soil samples TW11-5 (8-10), TP11-4 (6-8), SS11-18 (1-2), SS11-14 (1-2), and TW11-20 (8-10), respectively. The MS/MSD samples were collected concurrently with the primary samples at TW11-17 (8-10), TW11-18 (8-10), TP11-7 (8-10), SS11-13 (1-2), and SS11-17 (1-2), identified with the suffixes "(MS)" and "(MSD)". As prescribed by the laboratory, the trip blanks were prepared in the field by labeling unopened sampling vials as "Trip Blank". The unopened vials accompanied the sampling containers and samples beginning with their delivery to Weaver Boos and ending with their return to the laboratory.

Field QA/QC groundwater samples collected during the 2011 investigation included two field duplicates, two matrix spike/matrix spike duplicates (MS/MSD), two equipment blanks, and the transportation and analysis of one trip blank. The field duplicate samples, identified as "Dup-1" and "Dup-2", were collected concurrently with the primary groundwater samples at temporary monitoring well TW11-17 and permanent monitoring well PW11-1S, respectively. The MS/MSD samples were collected concurrently with the primary samples at temporary monitoring well TW11-15 and permanent monitoring well PW11-2S, identified with the suffixes "(MS)" and "(MSD)". After utilizing proper decontamination procedures, the equipment blank "EB-1" was collected by pumping an aliquot of laboratory-provided, deionized water through the bladder pump followed by dispensing and containerization of the samples; whereas, the equipment blank "EB-2" was collected by filling a new disposable bailer with laboratory-provided, deionized water and dispensing into the appropriate sampling containers. The trip blank was prepared by the laboratory and accompanied the sampling containers and samples beginning with their delivery to Weaver Boos and ending with their return to the laboratory.

Weaver Boos requested that the analytical work be conducted in accordance with Level IV protocol.

4.6.2 Field and Analytical QA/QC - 2012

Field QA/QC soil samples collected during the 2012 investigation included two field duplicates, two matrix spike/matrix spike duplicates (MS/MSD), two equipment blanks, and the transportation and analysis of two trip blanks. The field duplicate samples, identified as "Dup-1" and "Dup-2", were collected concurrently with the primary soil samples TW12-26 (14-16) and TW12-27 (0-1), respectively. The MS/MSD samples were collected concurrently with the primary samples at TW12-28 (8-10) and TW12-23I (6-8), identified with the suffixes "(MS)" and "(MSD)". The equipment blanks, identified as "EB-1" and "EB-2" were collected by dispensing aliquots of laboratory-provided, deionized water through separate, unused acetate sleeves which are utilized for soil sample collection in association with the Geoprobe; the water was then containerized in the appropriate sampling containers. The trip blanks were prepared by the laboratory and accompanied the sampling containers and samples beginning with their delivery to Weaver Boos and ending with their return to the laboratory.

Field QA/QC groundwater samples collected during the 2012 investigation included three field duplicates, two matrix spike/matrix spike duplicates (MS/MSD), three equipment blanks, and the transportation and analysis of one trip blank. The field duplicate samples, identified as "Dup-1" through "Dup-3", were collected concurrently with the primary groundwater samples at temporary monitoring well TW12-25 and permanent monitoring wells PW12-7S and PW11-4S, respectively. The MS/MSD samples were collected concurrently with the primary samples at temporary monitoring well TW12-22I and permanent monitoring well PW12-8I, identified with the suffixes "(MS)" and "(MSD)". After utilizing proper decontamination procedures, the equipment blanks “EB-1” and “EB-3” were collected by pumping an aliquot of laboratory-provided, deionized water through the bladder pump followed by dispensing and containerization of the samples; whereas, the equipment blank “EB-2” was collected by pumping an aliquot of laboratory-provided, deionized water through unused polyethylene tubing via the peristaltic pump and dispensing into the appropriate sampling containers. The trip blank was prepared by the laboratory and accompanied the sampling containers and samples beginning with their delivery to Weaver Boos and ending with their return to the laboratory.

Weaver Boos requested that the analytical work be conducted in accordance with Level IV protocol.

4.7 Data Quality Assessment

Data quality is discussed in terms of sample delivery and analytical work, field QA/QC results, and finally, in terms of the data quality objectives (DQOs) stated in the approved SAP.

4.7.1 Sample Delivery and Analytical Work

4.7.1.1 Sample Delivery and Analytical Work - 2011

The soil samples were collected on July 26-29, 2011 and shipped to the laboratory via overnight courier daily on July 26th, 27th, and 28th. On July 29th, Weaver Boos transferred the remaining samples to the laboratory courier for direct transport to the laboratory. The laboratory indicates that the samples were received in good condition on July 27-29. Duplicate sample “Dup-5” was inadvertently omitted from the chain of custody form; however, the samples were transported with the shipment relinquished by Weaver Boos on July 28th. The omission was promptly realized and the requisite analysis was performed.

The laboratory reported its analytical results with qualifications; in general, they are limited to elevated reporting limits for phenol based on the initial sample volume or weight not being used for extraction. Additional details are provided in the analytical reports.

The groundwater samples were collected on August 3-5, 2011 and personally transferred to the laboratory courier on August 5th for direct transport to the laboratory. The laboratory indicates that the samples were received in good condition on August 5th. The laboratory noted that a large number of sample vials were received with headspace present. This was due to the moderate to strong effervescence when the sample aliquot of groundwater was introduced to the hydrochloric acid preservative contained in the sample vials. From this observation Weaver Boos infers that VOC results for samples affected by headspace are likely to be biased low.

Additionally, the laboratory noted that the pH for several nitric acid, sulfuric acid, and sodium hydroxide preserved samples were not within their required range. The laboratory indicates that nitric acid preserved samples were further acidified before extraction, and not believed to be biased. The results for the sulfuric acid preserved aliquots for ammonia and sodium hydroxide preserved aliquots for cyanide are inferred to be biased low. The pre-preserved sampling containers provided by the laboratory were not altered in the field to cause a change in preservative quantity (e.g. overfilled or spilled) and so the cause of the pH discrepancy is unknown. Unusual buffering capacity of the groundwater provides one possible explanation.

4.7.1.2 Sample Delivery and Analytical Work - 2012

The soil samples were collected on April 10-11, 2012 and personally transferred to the laboratory courier on April 12th for direct transport to the laboratory. The laboratory indicates that the samples were received in good condition on April 12th. The laboratory reported its analytical results with limited qualifications; in general, they are restricted to dilution notation. Additional details are provided in the analytical reports.

The groundwater samples were collected on April 17-19, 2012 and personally transferred to the laboratory courier on April 19th for direct transport to the laboratory. The laboratory indicates that the samples were received in good condition on April 19th. Although dissolved arsenic was not listed on the chain of custody forms that accompanied the groundwater samples, the omission was promptly realized and the laboratory was instructed to perform the requisite analysis. The laboratory noted that a field filtered sample from monitoring well PW11-4S was not received by the lab although it is included on the chain of custody. Subsequently, dissolved lead and dissolved arsenic analyses were not performed for monitoring well PW11-4S due to the lack of appropriate sample submission to the laboratory. However, a duplicate sample (Dup-3) was collected at monitoring well PW11-4S therefore dissolved lead and dissolved arsenic analytical data is available.

As noted previously, the laboratory noted that a large number of sample vials were received with headspace present during the 2011 groundwater sampling event. This was due to the moderate to strong effervescence when the sample aliquot of groundwater was introduced to the hydrochloric acid preservative contained in the sample vials. As a consequence, the vials utilized for VOC sample containerization during the 2012 event were unpreserved and resulted in reduced effervescence during sample collection. Additionally, as in 2011, the laboratory noted that the pH for several nitric acid preserved samples were not within their required range. The laboratory indicates that nitric acid preserved samples were further acidified before extraction, and not believed to be biased. The pre-preserved sampling containers provided by the laboratory were not altered in the field to cause a change in preservative quantity (e.g. overfilled or spilled) and so the cause of the pH discrepancy is unknown. Unusual buffering capacity of the groundwater provides one possible explanation.

4.7.2 Field QA/QC Results

Qualitative review of **Table 2** shows that similar results were obtained for soil samples that were collected in duplicate. The Quality Assurance Project Plan precision objectives for soil and groundwater duplicate samples are 50% and 35%, respectively. Individual relative percent difference (RPD) calculations were calculated for each detected chemical in the primary and respective field duplicate soil samples. The mean RPD for the soil duplicate samples and groundwater duplicate samples is 75% and 33.43%, respectively. The soil sampling program therefore indicates greater than desired variation among the soil sample duplicate results, suggesting that the concentrations might be considered estimated values. High precision is often difficult to achieve with soil samples owing to the heterogeneous nature of the matrix. The groundwater sampling program is indicated to meet the precision objective.

Results for the equipment blanks and trip blanks, during 2011 and 2012, identified no constituents above the laboratory reporting limits other than bis(2-ethylhexyl)phthalate at 9.5 ug/l in EB-1 during the 2011 activities. This result is not regarded as significant because this chemical was detected in only one investigational groundwater sample during 2011, permanent monitoring well PW11-4S at a concentration of 48.8 ug/l. No cross contamination during sampling or sample transportation is therefore inferred.

4.8 Data Quality Objectives

As mentioned previously, this Site Investigation Site Investigation was completed in two parts conducted over consecutive years (i.e. 2011 and 2012). Consequently, separate SAPs and data quality objectives (DQOs) were prepared during each year. The following DQOs are specified in the approved 2011 SAP:

1. Complete the assessment of surface soil in the North and South Parcels,
2. Assess subsurface soil in the areas of the Benzol Plant (North Parcel), Areas of Concern on the South Parcel and/or “hot spots” identified in the historical data via soil probes;
3. Assess groundwater in the areas of the Benzol Plant (North Parcel), Areas of Concern on the South Parcel and/or “hot spots” identified in the historical data;

4. Identify up to three distinct (with regard to depth) saturated zones at strategic locations at the Property to facilitate the installation of groundwater monitoring wells;

5. Assess subsurface soil in the areas of the Benzol Plant (North Parcel), Areas of Concern on the South Parcel and/or “hot spots” identified in the historical data via test pits;

6. Utilize monitoring well survey information to aid in determining groundwater flow direction at the Property; and;

7. Sample groundwater monitoring wells to determine COC concentrations.

Surface soil assessment in the North and South Parcels is considered complete, via shallow soil probes, as described in **Sections 3.2.1.1** and **4.3.1**. Soil probes and test pits were utilized to assess soil in the areas of the Benzol Plant, Areas of Concern on the South Parcel and “hot spots” identified in the historical data; the methodology is described in **Sections 3.2.1.1** and **3.2.1.2**, respectively with analytical data being described in **Section 4.3**. Groundwater, in the specified areas on the Property, was assessed via the installation of temporary and permanent groundwater monitoring wells as described in **Section 3.2.2**. The Property appears to be underlain by a thick unconsolidated aquifer composed of sand and gravel; consequently, no hydraulically distinct saturated zones appear to be present as discussed in **Sections 2.3.3** and **4.2**. Survey information was utilized in determining groundwater flow direction as described in **Sections 3.2.3** and **4.2**. Groundwater COC concentrations were determined by the sampling and laboratory analysis of samples collected from the temporary and permanent monitoring wells as described in **Sections 3.2.2.1, 3.2.2.3,** and **4.3**. The DQOs stated in the approved 2011 SAP therefore appear to have been met.

The approved 2012 SAP specified the following data quality objectives (DQOs):

1. Complete the assessment of surface soil in the Middle Parcel;

2. Complete the assessment of subsurface soil beneath the Middle parcel;

3. Complete the assessment of shallow groundwater beneath the Middle Parcel;

4. Complete the assessment of the naphthalene plume indicated to emanate from the location of the historic Benzol Plant formerly located on the North Parcel;

5. Identify nearby water well locations; and,

6. Assess nearby downgradient water wells for potential contamination in connection with the Site.

Surface soil assessment in the Middle Parcel is considered complete, via surface soil sample collection, as described in **Sections 3.2.1.1** and **4.3.1**. Soil probes were utilized to assess subsurface soil in the Middle Parcel; the methodology is described in **Sections 3.2.1.1** with analytical data being described in **Section 4.3**. Shallow groundwater in the Middle Parcel was assessed via the installation of temporary groundwater monitoring wells as described in **Section 3.2.2**. Assessment of the inferred naphthalene plume identified during 2011 was completed via the installation and sampling of downgradient permanent groundwater monitoring wells; methodologies are described in **Section 3.2.1.2** and **3.2.2.4**, respectively. Nearby water wells were identified as described in **Section 3.2.2.5**. Select downgradient water wells were evaluated for potential contamination via sample collection and analysis, as described in **Section 4.3.8**. The DQOs stated in the approved 2012 SAP therefore appear to have been met.

5.0 SITE INVESTIGATION CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary of Results

Weaver Boos completed this Phase II Site Investigation during 2011 and 2012 for the Indiana Finance Authority/Indiana Brownfields Program for the Former Terre Haute Coke and Carbon Site located at 1341 Hulman Street in Terre Haute, Indiana. This work was funded primarily by U.S.EPA through a Section 128(a) Brownfield Grant.

Historical information indicates that the Site was utilized as a coke and manufactured gas production facility from 1926 to 1988. Surface soil, subsurface soil and groundwater have been affected by coal gasification and byproducts recovery residues leading to elevated concentrations of certain PAHs, VOCs, SVOCs, and metals as indicated by the results for historic sampling data for more than 330 soil and more than 60 groundwater samples. Future use of the Property is intended to include re-development into an industrial park and recreational trail head. The scope of the Site Investigation included the review of the professional geological literature, the historical sampling data, the collection of 98 additional soil samples, the collection of 60 additional groundwater samples, and the measurement of groundwater table elevations in numerous temporary and permanent groundwater monitoring wells during 2011 and 2012.

The database for historical sample results is tabulated as presented in **Appendix A**. Groundwater level elevations for 2011 and 2012 are listed on **Table 1-1** and **1-2**, respectively. Results for the surface soil samples are listed on **Table 2**. Results for the subsurface soil samples are listed on **Table 3**. Results for groundwater samples are listed on **Table 3**. Upper confidence limit mean concentrations for COCs in surface soil at the North, South and Middle Parcels are listed on **Tables 5**, **6**, and **7**, respectively. Relevant results from the integrated overall database representing the historical and current data are mapped to the Site as illustrated in several of the figures. Supporting data and information are appended. The following summary of results and conclusions is supported in the opinion of Weaver Boos with regard for the entire Site, including the North, South, and Middle Parcels:

1. The Site is located in an urban area situated atop glacial outwash sand and gravel that partially fills the east side of the Wabash River Valley and forms the principle unconsolidated groundwater aquifer. The depth to groundwater ranges from approximately 12 ft to 19 ft beneath the Site and the horizontal water table gradient was measured at 0.0013 ft/ft to 0.0021 ft/ft. Using the hydraulic conductivity value of 160 ft/day reported in the professional literature for this aquifer and assuming a porosity of

0.3, groundwater is calculated to flow in a west-northwesterly direction towards the Wabash River at velocities ranging from approximately 0.7 ft/day to 1 ft/day.

2. Information reviewed by Weaver Boos indicates that the Site is not located within a regulated wellhead protection area, although its physical setting is considered geologically susceptible. The public water supply in Terre Haute is provided by Indiana American Water and is widely available. Records for 379 private groundwater supply wells potentially located within a 1-mile radius of the Site were found in the Indiana DNR's online database. Records for nine (9) private water wells were found for wells located within 1-mile of the downgradient boundary of the Site and attempts were made to access these wells for sampling. No such arrangements were successfully concluded, but two (2) private wells were found in the same area by personally canvassing the area. The two private wells were sampled and analyzed for the constituents of concern. None was detected in either sample.

3. The overall surface soil sample database indicates that vertical average benzene concentrations in surface soil above the Soil Direct Contact CLs are only present on the east and west portions of the Middle Parcel. Vertical average benzo(a)pyrene concentrations above the Soil Direct Contact CLs are present over much of the Site, including the North, Middle, and South Parcels. Because benzo(a)pyrene is treated as an indicator for PAHs in general, average concentrations of other PAH exceeding Soil Direct Contact CLs are implied over similar (yet less extensive) areas of the Site. Vertical average arsenic concentrations above Soil Direct Contact CLs are present in surface soil on about ½ of the North Parcel, ½ of the Middle Parcel, and on a small fraction of the South Parcel. Vertical average lead concentrations above the Residential Soil Direct Contact CL and Interim Recreational CL are limited to a small area on the eastern portion of the Middle Parcel.

4. In surface soil at the North Parcel the overall 95% UCL concentration for benzo(a)pyrene was found to be greater than the Industrial/Commercial Soil Direct Contact CL of 1,500 ug/kg, as were several of the other PAH compounds. The 95% UCL concentration for arsenic at the North Parcel is 18.3 mg/kg, which exceeds the Interim Recreational CL of 13 mg/kg.

5. In surface soil at the South Parcel the overall 95% UCL concentration for benzo(a)pyrene was found to be greater than the Industrial/Commercial Soil Direct Contact CL of 1,500 ug/kg. The 95% UCL concentrations for several of the other PAH compounds were found to be greater than their respective Interim Recreational CLs. The 95% UCL concentration for arsenic at the South Parcel is 10.75 mg/kg, which exceeds the Residential Surface Soil Direct Contact CL of 3.9 mg/kg.

6. In surface soil at the Middle Parcel the overall 95% UCL concentration for benzo(a)pyrene was found to be greater than the Construction Worker Soil Direct Contact CL of 79,000 ug/kg, as was dibenz(a,h)anthracene. The 95% UCL concentration for arsenic at the Middle Parcel is 14.98 mg/kg, which exceeds the Recreational Surface Soil CL of 13 mg/kg.

7. The historic subsurface sample database indicates that benzene is present above the Residential Migration to Groundwater CL beneath the former Tar Storage Tanks on the North Parcel. Benzo(a)pyrene was also detected above its Residential and Industrial/Commercial Migration to Groundwater CL beneath the former Tar Storage Tanks. Benzene was also prominently detected beneath a small area at the west end of the Middle Parcel where tar seeps were observed during historic and most recent fieldwork at the Site.

8. Historic and current groundwater sample results indicate that benzene and naphthalene affects a localized area beneath the west end of the Middle Parcel and that naphthalene affects a localized area immediately downgradient of the former Benzol Plant. Extensive groundwater sampling during 2012 indicates no evidence of off-site migration of benzene, naphthalene, or other constituents of concern from either area.

9. Historic and current groundwater sample results indicate that groundwater beneath several areas of the Site are affected by total arsenic or total lead concentrations above Groundwater CLs. However; dissolved arsenic and dissolved lead concentrations are consistently measured at non-detectable concentrations less than Groundwater CLs, indicating that neither arsenic nor lead is soluble or mobile in the groundwater beneath the Site.

5.2 Summary of Potential Risks Associated with the Site

Environmental conditions at the Property, current land use, and its proposed future redevelopment suggest that the following human exposure routes represent potential risks for the indicated media and potentially exposed populations:

1. Direct contact with surface soil by construction workers, industrial workers, and recreational users;

2. Direct contact with subsurface soil by construction workers excavating below 10 ft;

3. Ingestion of groundwater by future users of water wells that might be drilled at the Site; and,

4. Vapor intrusion to indoor air, which is only relevant for parts of the Middle Parcel where benzene was detected in soil or shallow groundwater.

6.0 REMEDIATION PLAN

6.1 Extent of Remediation

The following remedial work plan is provided consistent with the level of resources available for this project. Insufficient funding is presently available to remediate the entire Site, so the plan focuses on parts of the Site considered most marketable for redevelopment by the City of Terre Haute. The most marketable parts are the frontages along 13th and Hulman Streets offering visual exposure and ready access. Approximately 20 acres of land will be remediated under this plan by addressing the 13th Street frontage to a setback extending 325 ft east of the property boundary and the Hulman Street frontage to a setback extending 325 ft south of the property boundary. The parkway between the 13th Street sidewalk and western property boundary will be remediated, as will the natural gas transmission main easement along the western boundary of the Site. These areas are collectively designated as the "Remediation Site". The extent of the Remediation Site is illustrated on **Figure 18** and includes parts of the North, Middle, and South Parcels.

6.2 Evaluation and Selection of Remedial Alternatives

Three aspects of the Remediation Site are identified as needing corrective action to facilitate redevelopment for industrial/commercial and recreational trail use based on the results of the Site Investigation. Soil or groundwater media exceeding applicable remedial objectives or exhibiting the presence of free product tar include the following:

1. Surface Soil Media to variable depths to a maximum of 10 ft below finished grade that exceed one or more Direct Contact SLs for commercial/industrial, recreational trail, or excavation worker exposure over the majority of the Remediation Site. The volume of such soil is currently estimated at approximately 73,000 CY for the Remediation Site.

2. Free product tar and shallow groundwater contaminated with benzene and naphthalene in the immediate vicinity of the tar seep and former tar pit located at the west end of the Middle Parcel. The volume of tar, tar-affected soil, and tar-affected aquifer media (including shallow groundwater) is estimated at approximately 6,500 CY.

3. Groundwater beneath the balance of the Remediation Site indicating total arsenic or total lead concentrations above Residential Tap Water SLs, as well as localized elevated naphthalene concentrations immediately downgradient from the Benzol Plant formerly located on the North Parcel. No evidence of off-site migration was identified during the Site Investigation. The affected area of the aquifer is conservatively assumed to comprise the entire Site, including the 20-acre Remediation Site.

6.2.1 *Potentially Applicable Remedial Technologies*

Several remedial alternatives were considered for each affected media or aspect of the Remediation Site. The alternatives considered included technologies capable of removing contaminated media from the remediation site as needed to meet applicable Screening Levels, on-site consolidation of contaminated media, and on-site exposure control measures. Applicable remedial technologies are identified for each affected media or aspect of the Remediation Site and then evaluated as a basis for selection. Costs for many of the remedial alternatives were formally estimated and provided to the City for consideration, yet are only discussed in general summaries herein to protect the integrity of the pending public bidding process for the selected alternative.

6.2.1.1 Evaluation of Applicable Remedial Technologies

6.2.1.1.1 Contaminated Surface Soil

The first remedial technology considered for this medium was consolidation of contaminated surface soil onto the Middle Parcel followed by covering the resulting landform to prevent future direct exposure. Apparent advantages to this approach included a cost of about $5.2 million to remediate the entire Site as it was originally conceived on September 6, 2012. Obvious disadvantaged included limited future redevelopment of the Middle Parcel owing to the need to protect the soil cover from disturbance. A less obvious difficulty realized for this alternative was the IDEM’s regulatory position that the landform would comprise a solid waste disposal facility requiring a design essentially the same as a Subtitle D landfill (i.e., base liner, leachate collection, and future groundwater monitoring). This requirement increased the price for this alternative to a value preliminarily estimated as exceeding $10 million and furthermore would require securing a solid waste disposal facility permit. This option was therefore rejected.

The second remedial alternative considered was to cover the entire Site with an engineered soil cover to mitigate potential future direct exposure. Apparent advantages included cost of about $5.0 million to “remediate” the entire Site. Obvious disadvantages included the failure of this alternative to deliver land readily suited for future development. Soil deeper than 2.0 ft would remain contaminated, rendering the property unattractive to broad base of potential future users.

The third remedial technology considered for this medium was excavation and ex-situ high temperature thermal desorption followed by replacement of the soil as backfill. Apparent advantages to this technology includes its effectiveness in reducing concentrations of organic contaminants such as PAHs and the historically low prevailing prices for fuel used in the process (i.e., natural gas). An experienced provider of this service indicated that the low price of natural gas has rendered the process economically competitive with excavation and off-site disposal for the first time in about 25 to 30 years, suggesting that the process might be priced at about $50/ton (or, assuming 1.5 tons/CY, approximately $75/CY. An additional advantage is that this technology would tend to minimize the considerable truck traffic needed to remove contaminated soil from the Site and reduce the local community's exposure to traffic-related accident risk. Relatively few truck trips would be needed because the soil would not transported off the Site and the treated soil could be used as backfill, rather than trucking in clean borrow from an off-site source. Possible disadvantages include the technology's inability to reduce metal concentrations, noting that the 95% UCL arsenic concentration for surface soil on the North Parcel is 18.3 mg/kg, which exceeds the specified remediation objective of 16 mg/kg. The IDEM technical staff indicated in response to this disadvantage that the treated soil would be characterized by an average concentration for much of the site, and should therefore meet the required objective. With consideration for its advantages and disadvantages, high temperature thermal desorption is neither rejected nor selected for implementation at the Site. It is instead identified as a potential alternate to the selected technology for bidding by qualified contractor(s) included to propose this approach.

The fourth alternative considered is the excavation and off-site disposal of the contaminated surface soil at a secure Subtitle D landfill followed by replacement of approximately one-half of the excavated volume as backfill to restore the Remediation Site to a developable final grade. Advantages to this approach include a high reliability, elimination of future maintenance, and a cost estimated for the Remediation Site that is consistent with the resources available for the project. The primary disadvantage appears to be the high number of inbound and outbound truck trips (on the order of 8,000) and the attendant exposure of the community to accident-related traffic risk. Given its reliability and acceptable estimated cost, this is the selected alternative for the contaminated surface soil medium.

6.2.1.1.2 Free Product Tar and Localized Shallow Groundwater Contamination

The first alternative considered for free product tar and localized shallow groundwater contamination at the west end of the Middle Parcel was excavation, off-site treatment, and off-site land disposal. Owing to elevated concentrations of benzene (up to 6,080 mg/kg; however, it is reasonable to assume that the media generated by this process would exhibit a TCLP concentration of benzene exceeding the 5.0 mg/l regulatory threshold for toxic hazardous waste. Unit costs for off-site treatment and disposal of such hazardous wastes are typically in the range of $250 to $500 /ton. With 6,500 CY at 1.5 tons/CY, the cost for this aspect of the project alone is estimated to range from about $2.4 million to about $4.9 million. This alternative was therefore rejected.

The second alternative considered the free product tar and localized shallow groundwater contamination is in-situ solidification/stabilization using pozzolonic reagents to immobilize the material in place. This technology has been successfully applied at several Midwestern coal gasification sites under the IDEM's jurisdiction and is therefore considered both practicable and reliable. It is also achievable for unit rates costs estimated on the order of about $60 to $70/CY, indicating an estimated cost for such treatment at about $390,000 to $455,000. This alternative is therefore selected as a means to remediate free product tar and localized shallow groundwater contamination in connection with the former tar pit located at the west end of the Middle Parcel.

6.2.1.1.3 Groundwater Beneath the Balance of the Remediation Site

The first alternative considered for potentially contaminated groundwater beneath the balance of the Remediation Site is a general yet active remedial approach such as pump-and-treat to establish hydraulic control or in-situ treatment of total metals or naphthalene localized to the former Benzol Plant. Over an extended period such as 30 years, the costs for such measures are preliminarily estimated to range from $10 to $25 million for a reasonable selection of control points and treatment technologies. Such measures appear to be wholly unwarranted; however, in that dissolved metal concentrations are already compliant with Residential Tap Water Screening levels and the naphthalene associated with the former Benzol Plant is localized to the Site. No off-site migration is currently indicated and none is expected in the future considering that it is now 24 years after Terre Haute Coke and Carbon ceased its on-site operations and no such migration has yet developed.

The second alternative considered is to establish an institutional control prohibiting the future use of groundwater or water wells at the Remediation Site. The institutional control comprises the selected alternative and is proposed to take the form of an Environmental Restrictive Covenant (ERC) as provided in **Appendix F** (Note: The ERC provided in Appendix F is a template that will be finalized and recorded after the remedy has been completed based on post-remediation test results and as-built drawings). The advantages to this approach include reasonable costs for implementation and effectiveness in eliminating future potential exposure. No specific disadvantages are identified with respect to future water supply because the Remediation Site is served by the public water utility.

6.2.2 Treatability Studies

Treatment of contaminated media is limited to the in-situ solidification/stabilization of the tar free product, contaminated soil, and contaminated shallow groundwater localized to the former tar pit located at the west end of the Middle Parcel. Prior to implementation of the ISS technology, the Contractor will obtain representative core samples and perform a treatability study of the material consistent with his proposed implementation methods. The treatability study will verify a mix design capable of meeting the following performance criteria for the stabilized material:

1. Achieve an unconfined compressive strength of not less than 25 psi.
2. Achieve a permeability of not more than 1 x 10^{-5} cm/s, which is at least three orders of magnitude lower than the matrix of the aquifer (5 x 10^{-2} cm/s).

6.3 Description of Selected Remedial Alternative

The following subsections of the RWP describe the selected remedial alternatives. General and technical specifications further describing have been prepared and are provided as **Appendix G**. Detailed constructions plan drawings have been prepared and are provided as **Appendix H**. Flexibility in the sequencing of the remedial technologies is expected to be beneficial and will therefore be determined mainly by the Contractor.

6.3.1.1 <u>Surface Soil (0 to 10 ft)</u>

Approximately 73,000 CY of surface soil will be remediated by excavation using conventional earth-moving equipment such as excavators, dozers, and loaders. **Figure 18** illustrates the boundaries of the Remediation Site and depth to which excavation is expected to extend in order to meet the remedial action objectives listed in **Section 1.4**. The contaminated soil will be loaded onto trucks and transported to a secure off-site Subtitle D landfill for disposal. **Figure 20** illustrates the Remediation Site and excavation subgrade representing the exposed soil surface would be expected to appear when remediation is complete. Because the work is likely to be conducted in stages and actual excavation depths are likely to vary based on conditions encountered, the Site is unlikely to ever appear exactly as shown. Remedial excavation will extend to variable subject to verification grid sampling. Grid intersections failing to meet the required remedial objectives will be excavated deeper, and re-sampled to a maximum of 10 ft below final grade.

Subsurface structures such as structural foundations, pipes, sumps, or other historical utilities will be demolished and removed wherever they are encountered within the Remediation Site footprint to depths of at least 10 ft below final grade. This activity will not apply to the parkway between 13th Street, nor to the natural gas transmission main easement along the western boundary of the property.

Additional activities are anticipated to include sealing and abandonment of any historic water supply wells encountered within the Remediation Site footprint. The post-excavation subgrade will be adjusted and prepared for backfilling and final grading and drainage. Approximately 52,000 CY of common borrow will be delivered, placed, and compacted to achieve final grading plan. Approximately 3,230 CY of topsoil capable of sustaining healthy landscape plantings in the parkway between the 13th Street sidewalk and natural gas transmission main easement will be delivered and placed. Stormwater management facilities will be constructed. Approximately 4,500 SY of bituminous concrete recreational trail will be laid atop the natural gas transmission main easement along the western boundary of the Site to prevent potential future recreational exposure in this area where excavation is considered impracticable. The site will be restored, including hydroseeding with mulch and fertilizer over approximately 20 acres and erosion control mat in specified area(s).

6.3.1.2 Tar Pit and Associated Shallow Groundwater

Approximately 6,500 CY of tar, tar-impacted soil, tar-impacted shallow aquifer soil, and tar and benzene-impacted shallow groundwater will be solidified and stabilized in place to remediate the former tar pit at the west end of the Middle Parcel. This volume extends to a depth of approximately 20 ft below existing grade, and therefore addresses shallow groundwater in this area. The solidified in-situ (ISS) mass will be covered with a minimum of 2 ft of clean common borrow to mitigate potential future direct exposure. The extent and depth of ISS is expected to be as shown in **Figure 19**, subject to field verification by the Contractor under review of the Engineer.

The completed area is expected to be suitable for supporting driveways, landscaping, or unoccupied structures during redevelopment. The solidified mass and a 50-ft wide buffer zone will not be suitable for supporting occupied structures owing to the potential for future benzene vapor intrusion and will therefore be excluded from such future use as described in the ERC provided in **Appendix F** (Note: The ERC provided in Appendix F is a template that will be finalized and recorded after the remedy has been completed based on post-remediation test results and as-built drawings).

The technical approach and mix design for ISS will be determined by the Contractor based on the required treatability study before it is implemented. In general terms, the approach is expected to include a bucket mixing approach and mix design consisting of 2 percent Portland concrete and 6 percent ground granulated blast furnace slag by weight.

6.3.1.3 Groundwater Beneath Balance of the Site

Active remediation of groundwater is not believed necessary and none is therefore proposed. Potential future exposure to groundwater beneath the Remediation Site will be prevented using the institutional control provided by the proposed ERC in **Appendix F** (Note: The ERC provided in Appendix F is a template that will be finalized and recorded after the remedy has been completed based on post-remediation test results and as-built drawings).

6.3.2 No Need for Risk Assessment

The remedies and remediation objectives proposed herein rely on default risk-based numerical Screening Levels determined by the IDEM as listed in the RCG or on institutional controls. No further risk assessment is therefore believed necessary or proposed.

6.3.3 State or Federal Permits

Other than Indiana Brownfields Program approval of this proposed RWP, no state permit is believed to be necessary for the activities described herein. No federal permit is believed to be necessary for the activities described herein.

6.3.4 Waste Disposal Approvals

Remediation of surface soil assumes excavation and off-site disposal of contaminated soil and debris at a secure off-site Subtitle D landfill. Approval of the Subtitle D landfill will be necessary before the materials can be accepted.

6.4 Monitoring and Sampling Plan

Monitoring and sampling will be conducted to support the implementation of the remedy and to verify that the remedial objectives are met. The following description is general. More detailed information is provided for the specific sampling and analytical methods as specified in the QAPP approved for the Site during 2012. Remedial objectives include numeric Screening Levels for contaminant concentrations and also several physical parameters to verify the ISS strength and permeability as achieved in the field. Specific data quality objectives (DQOs) identified for the project include the following:

1. Verify that remediation-derived waste (soil and debris) to be generated during surface soil remediation meets the requirements for disposal at a secure Subtitle D land disposal.

2. Verify that remediation of the surface soil medium is complete by demonstrating that post-remediation soil concentrations meet the specified numerical remediation objectives.

3. Verify that off-site borrow soil meets applicable remedial objectives before it is brought to the Remediation Site for use as backfill.

4. Verify that ISS of the former tar pit and its effected media have been solidified and stabilized by demonstrating that the solidified mass meets the required unconfined compressive strength and permeability remediation objectives.

6.4.1 Sampling Plan Detail

Sampling at the Remediation Site will be generally based upon a 50 ft x 50 ft grid as shown on **Figure 21**. The grid will provide reference information and provide a systematic approach to sample location selection for several purposes as outlined below.

6.4.1.1 Remediation-Derived Waste

Prior to applying for approval for disposal of soil and debris to be generated during remediation, the in-situ surface soils will be systematically sampled and analyzed for the parameters specified by the chosen receiving facility. Such parameters generally focus on establishing whether the remediation-derived soil and debris is ordinary solid waste as opposed to hazardous solid waste, and that it does not contain contaminants that may be specifically excluded from the receiving facility's permit. Considering the somewhat heterogeneous nature of surface soil deposits and the relatively large volume of soil and debris (73,000 CY), sampling for this purpose will be conducted using the Remediation Site grid such that the sampling frequency is approximately one sample per 5,000 CY. This will be implemented by sampling sixteen (16) approximately evenly-spaced grid points identified in the SAP and analyzing the soil for the following general parameters:

1. TCLP metals, TCLP volatile organic compounds, and TCLP semivolatile organic compounds.

2. Reactive cyanide and reactive sulfide.

3. pH.

4. Flash point.

5. Free liquids.

6. Other parameters as specified by the facility.

Pre-disposal approval samples will be collected as vertical composites through the soil depth interval requiring excavation at the particular sampling grid point.

6.4.1.2 Remediation Completion for Surface Soil

The completeness of remediation of surface soil will be assessed by grid sampling of the post-remediation excavation subgrade at each point of the Remediation Site sampling grid within the Remediation Site footprint, indicating approximately 300 such sampling locations as shown on **Figure 21**. Based upon Site Investigation and detailed site characterization, analysis of these samples will focus on the following analytical parameters:

1. Total arsenic and Total Lead.
2. Polycyclic Aromatic Hydrocarbons (PAHs)

Insomuch as the upper 2 ft of the remaining soil is of particular concern for potential soil direct exposure, these samples will be collected as vertical composites representing the 2-ft interval from the extant surface of the subgrade. At any grid intersection where the sample result does not meet the specified remediation objectives, an additional 0.5 to 1.0 ft of soil will be removed from the specific 50 ft x 50 ft area and the sample will be repeated. The depth of additional removal will be determined by the Engineer based on visual observations of site conditions and experience that will be gained as the work is completed.

6.4.1.3 Verification of Borrow used as Backfill

The borrow area is not yet determined, so sampling locations cannot presently be illustrated. Additionally, the City owns a borrow area near the Site that was previously vetted for a similar project, and so suitable data are likely available if this source is ultimately used. Unless the borrow site is already adequately characterized, the selected borrow area will be sampled and analyzed at a frequency of not less than 1 sample per 5,000 CY. In that approximately 52,000 CY of borrow is needed, a total of approximately ten (10) samples will be collected and analyzed for the following parameters:

1. Total arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver.
2. Total volatile organic compounds
3. Total semivolatile organic compounds
4. Polycyclic aromatic hydrocarbons by low-level SIM

5. Organochlorine herbicides and pesticides
6. Polycyclic aromatic hydrocarbons

Such samples will be collected as grab samples using either surface and subsurface sampling methodologies to represent the entire volume of soil to be borrowed. Results will be compared initially with RCG Residential Soil Direct and Migration to Groundwater Screening Levels. If all residential SLs are met, the borrow will be accepted. If less than 1 percent of the results exceed a specific Residential SL, consideration will be given to calculating an average concentration to further assess the overall expected concentration of the borrow. Consideration will also be given to comparing the results with Industrial/Commercial SLs. Such consideration will be made in consultation with Indiana's Project Manager, who will have final authority to approve a variance from Residential SLs.

6.4.1.4 In-Situ Solidification/Stabilization

The strength and permeability of the ISS mix design will be verified by casting a set of 8 test cylinders for each 1,000 CY of stabilized mass. Each set will consist of standard and reduced size cylinders. The standard cylinders will be used to measure unconfined compressive strength at typical test intervals extending to 28 days. The reduced size cylinders will be tested for permeability using either falling head or triaxial test methods. All such tests will be conducted according to standard ASTM International Methods of the type used for testing concrete. Such testing will only be conducted by a geotechnical laboratory that is qualified and experienced with such services.

6.4.1.5 Schedule for Submittal of Results

Sampling and analysis results will be compiled in an electronic data base as they are received and made available to Indiana's Project Manager as frequently as desired. Weekly reports are suggested at this time while data are being developed. All results will be compiled, tabulated, and provided as part of a Remediation Completion Report to be prepared within 60 days of completing the remediation project.

6.4.1.6 Data Management

Data management will be in accordance with the procedures listed in the QAPP, Section 2.0. In summary, this will include the following procedures:

- Data Reduction
- Data Validation

- Data Reporting

- Comparison of Results with Applicable Remedial Objectives

The final step in the DQO process will be to report the results in a uniform tabular format and compare the results with applicable remedial objectives to support the decision-making process for each of the applicable sampling strategies. Deliverable materials will include sections of the Remediation Completion Report describing the results of the overall DQO process and the conclusions that may be drawn from the available data.

6.5 Projected Work Schedule

6.5.1 Implementation

The remediation work described herein will be let for public bid during November 2012. Given the nature of the work, the planning, investigations, and approvals are expected to require approximately 45 to 60 days. Site work is expected to begin either late 2012 or early 2013. Construction will require approximately 180 days. The Remediation Completion Report will require approximately 60 days. Overall project completion is therefore anticipated during the 3rd quarter of calendar year 2013.

6.5.2 Operations and Maintenance

The overall project is designed to require little active operations or maintenance (O&M). Two aspects of the project will include periodic inspections, and if variances are identified from the relevant requirements, corrective action or maintenance will be appropriate. These aspects of the project include the following:

1. Compliance with Institutional Control(s) IC(s) listed in the ERC.

2. The bituminous concrete trail.

6.5.2.1 <u>Compliance with Institutional Controls</u>

The City will inspect the property at intervals of not more than five (5) years to assess compliance with IC(s) listed in the ERC. Such inspections will include a visual component, and after redevelopment takes place, visit(s) to interview commercial/industrial occupants. The results of each inspection will be recorded in the form of a written letter to the IDEM and will be retained on file for the project at least until the completion of the subsequent inspection. In the event that instance(s) of non-compliance are identified, the non-compliant occupant will be informed in writing by the City the nature of non-compliance and potential consequences of such non-compliance.

6.5.2.2 Bituminous Concrete Trail

The City will inspect the bituminous concrete trail at intervals of not more than five (5) years and rate its Pavement Condition Index (PCI) using the methods listed in ASTM D 6433-07: Standard Practice for Roads and Parking Lots Pavement Condition Index Surveys. The results of each inspection will be recorded in the form of a written letter to the IDEM supported by the inspection worksheets and calculated PCI and will be retained on file for the project at least until the completion of the subsequent inspection. Maintenance will be considered to correct deficiencies at any time the trail or part of the trail's PCI falls below 70. Maintenance will definitely be performed at any time the trail or part of the trail's PCI falls below 55.

6.6 Health and Safety Plan

A Health and Safety Plan (H&S Plan) for use during construction monitoring activities by Weaver Boos is provided as **Appendix I**. The information in the H&S Plan has been developed based on a review of 29 CFR 1910.120, the hazards likely to be encountered, and a review of the elements required for such a plan as listed under 29 CFR 1910.120 (b)(4)(ii). To the extent required, the following elements are therefore included in the plan:

1. A safety and health risk or hazard analysis for each site task and operation
2. Employee training assignments
3. Personal protective equipment
4. Medical surveillance requirements
5. Frequency and types of air monitoring
6. Site access control measures
7. Decontamination procedures
8. Contingency plan

The Contractor who implements construction during the proposed remediation is required to prepare a comprehensive H&S Plan for use during construction activities. It shall be the responsibility of the Contractor to determine and comply with all applicable Occupational Safety and Health Administration (OSHA), local, state, and federal regulations or any other worker safety codes with respect to the project.

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South Bend, IN 46628

7.0 QUALIFICATIONS AND LIMITATIONS

Weaver Boos prepared this Remediation Work Plan using a defined scope of services considered appropriate and agreed upon by all parties on the date the service was authorized. Weaver Boos has provided it services in accordance with generally accepted practices in a manner consistent with that level of care exercised by other members of our profession in the same locality and practicing under similar circumstances. Our professional opinions are based upon our review of historical information describing the Site, our visual observations of the subsurface conditions, and the results we obtained for widely spaced samples of soil and groundwater. Conditions in areas not specifically sampled or analyzed may differ significantly from those inferred in this assessment. Although the scope of work specified in the Remediation Work Plan is believed by Weaver Boos to be appropriate to address the stated objectives, we note that no environmental assessment can completely eliminate uncertainty with respect to the presence, concentration, or extent of COCs in soil or groundwater, and that no such Remediation Work Plan is likely to anticipate all relevant environmental conditions that may be encountered as remediation is performed.

8.0 REFERENCES CITED

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