ANALYSIS OF BROWNFIELD CLEANUP ALTERNATIVES

U.S. EPA Brownfield
Revolving Loan Fund (RLF) Assistance Amendment (AA)# BL-00E48101-4
Indiana Brownfields Program
for the
Former Terre Haute Coke and Carbon Site
1341 Hulman Street, 1451 Hulman Street, and 2030 South 13th Street
Terre Haute, Indiana
November 2012

This Analysis of Brownfield Cleanup Alternatives (ABCA) was prepared in cooperation among the Indiana Brownfields Program (Program), the City of Terre Haute, and Weaver Boos Consultants (Weaver Boos) as a requirement for utilizing United States Environmental Protection Agency (U.S. EPA) Revolving Loan Fund (RLF) monies to remediate a brownfield. This ABCA presents remedial alternatives considered to mitigate potential exposure to affected soil, tar free product, and groundwater at the Former Terre Haute Coke and Carbon Site in Terre Haute, Indiana (Site). This ABCA and associated funding pertain to a specific portion of the Site that comprises three separate parcels (i.e., the North Parcel, Middle Parcel, and South Parcel). The parts of the Site to be remediated represent those determined by the Terre Haute Department of Redevelopment to be the most marketable frontages along 13th and Hulman Streets, which offer visual exposure and ready access for future business and recreational use. Approximately 20 acres of the 52-acre Site will be remediated by addressing the 13th Street frontage to a setback extending 325 feet (ft) east of the Site boundary and the Hulman Street frontage to a setback extending 325 ft south of the Site boundary. The City of Terre Haute Department of Redevelopment indicates that the future use of the overall Site is intended to include redevelopment into an industrial park and recreational trail head. Parts of the Site not currently addressed may be remediated later under separate arrangement(s).

<u>Site Details</u>

Site Name:	Former Terre Haute Coke and Carbon Site 1341 Hulman Street, 1451 Hulman Street, and 2030 South 13th Street Terre Haute, Indiana
Site Owner:	City of Terre Haute Department of Redevelopment 17 Harding Avenue, Room 200, Terre Haute, IN 47807
Site Representative:	Mr. Patrick Martin Chief Planner City of Terre Haute

Summary of Remedial Alternatives

Soil and Debris

1. Alternative 1 – Consolidate and cover contaminated soil and debris on Site.

2. Alternative 2 – Cover entire Site with engineered soil cover.

3. Alternative 3 – Excavation of contaminated soil and debris followed by ex-situ high temperature thermal desorption.

4. Alternative 4 – Excavation and off-Site disposal at a secure Subtitle D landfill followed by backfilling and restoration for future redevelopment.

Free Product Tar and Shallow Groundwater Contamination Localized to the former Tar Pit

1. Alternative 1 – Excavation, off-Site treatment, and off-site land disposal.

2. Alternative 2 – In-Situ solidification/stabilization (ISS) technology using pozzolonic reagents.

Groundwater Beneath the Balance of the Site

1. Alternative 1 – Active pumping and treatment to establish hydraulic control.

2. Alternative 2 – Institutional controls prohibiting future use of groundwater or wells at the Site.

Summary of Previous Site Activities

Site History

Information provided by the Program and City of Terre Haute indicates that the Site consists of three parcels, including the North, South, and Middle Parcels, totaling approximately 52 acres. According to the Trinity Environmental Group (TEG) (2001) Phase II Environmental Site Assessment Report, the Site 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 ceased operation in 1988, and soon after, the owners razed most of the operating facilities and removed all storage vessels. The Site is presently vacant and vegetated.

Previous Environmental Assessments/Environmental Investigations

Historical environmental assessments and the current Site Investigation indicate 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), arsenic, and lead. Historical environmental assessment documents for 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. Bruce Carter Associates, L.L.C., 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.

In consultation with the Program Project Manager for the current Site Investigation, the historical data were organized into three media groups to support completion of the current Site Investigation during 2011 and 2012:

1. Surface soil (0 to 10 ft below ground surface [bgs]),

2. Subsurface soil (>10 ft bgs), and

3. Groundwater.

In further consultation with the Program Project Manager, the concentrations for each target analyte are compared with the Indiana Department of Environmental Management (IDEM) 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.

Historical Results (2001 – 2011) Compared with RISC Closure Levels

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, and more particularly, limited to the area of the tar pit formerly located at the west end of 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. Surface soil lead concentrations exceeding soil direct contact CLs are mostly limited to eastern portion of the Middle Parcel. These four constituents of concern (COCs) were identified in consultation with the Program Project Manager as the most appropriate indicator COCsfor assessing the extent of contamination and as primary drivers of risk under the proposed redevelopment.

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.

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.

Current Site Investigations (2011 – 2012)

Additional current Site Investigations were undertaken on behalf of the Program during 2011 and 2012 to fill data gaps in the Site characterization in support of remedial action planning. Field sampling and analytical protocol for the Site Investigation were conducted as specified in the approved 2011 Quality Assurance Project Plan (QAPP) and updated 2012 QAPP, respectively. Pursuant to Program’s request, the following activities were conducted in accordance with the Sampling and Analysis Plans (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 were manually tabulated. The data and information were reviewed to develop an understanding of the physical setting, history, and environmental condition of the Site.

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 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 twenty (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 twenty-one (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 former 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 (14) 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. Ten (10) surface soil samples and five (5) subsurface soil samples were 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 implied 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 appeared 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 fifteen (15) new groundwater monitoring wells (permanent and temporary) to characterize the extent and concentration of the inferred naphthalene plume. The twelve (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 twenty-one (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.

<u>Summary of Site Characterization</u>

The following summary of results and conclusions is supported by the Site Investigation with regard for the entire Site that comprises 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. The Site Investigation 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 one (1)-mile radius of the Site were found in the Indiana Department of Natural Resources (DNR)'s online database. Records for nine (9) private water wells were found for wells located within one (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 (2) 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% Upper CL (UCL) concentration for benzo(a)pyrene was found to be greater than the Industrial/Commercial Soil Direct Contact CL of 1,500 microgram/kilogram (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 milligram/kilogram (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 affect 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.

Remedial Action Objectives

Environmental conditions at the Site, 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.

Three aspects of the "Remediation Site" as it is referenced in the RWP (i.e., 20-acre dig-haul-fill area) are identified as needing corrective action to facilitate redevelopment for industrial/commercial and recreational trail use based on the results of the Site Investigation. It is noted that risk-based numeric (RISC default Closure Levels) and non-numeric soil and groundwater remediation objectives were supplanted by the IDEM in late March 2012 with Screening Levels (SLs) listed in its new Remediation Closure Guide (RCG) non-rule policy for risk-based corrective action. The new risk-based SLs therefore comprise the numeric remediation objectives for the soil and groundwater at the Site. Soil or groundwater media exceeding applicable SLs 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 Soil Screening Levels (SLs) for commercial/industrial, recreational trail, or excavation worker exposure over the majority of the Site. The volume of such soil is currently estimated at approximately 73,000 cubic yards (CY) for the parts of the Site to be remediated.

2. Free product tar and shallow groundwater contaminated with high concentrations of 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 portion of the Site to be remediated.

Analysis of Remedial Alternatives

The remedial action alternatives considered were evaluated using the following criteria:

(1) Effectiveness

a. The degree to which the toxicity, mobility and volume of the contamination is expected to be reduced.

b. The degree to which a remedial action option, if implemented, will protect public health, safety and welfare and the environment over time.

c. Taking into account any adverse impacts on public health, safety and welfare and the environment that may be posed during the construction and implementation period until case closure.

(2) Implementability

a. The technical feasibility of constructing and implementing the remedial action option at the site or facility.

b. The availability of materials, equipment, technologies and services needed to conduct the remedial action option.

c. The administrative feasibility of the remedial action option, including activities and time needed to obtain any necessary licenses, permits or approvals; the presence of any federal or state, threatened or endangered species; and the technical feasibility of recycling, treatment, engineering controls, disposal or naturally occurring biodegradation; and the expected time frame needed to achieve the necessary restoration

3) Cost

a. The following types of costs are generally associated with the remedial alternatives:

- Capital costs, including both direct and indirect costs; b. Initial costs, including design and testing costs.

- Annual operation and maintenance costs.

<u>Soil</u>

1. *Alternative 1 – Consolidate and cover contaminated soil and debris on Site*: 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 moderate or medium-level cost of about $5.2 million to remediate the entire Site as it was originally conceived in September 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) under U.S. EPA's Corrective Action Management Unit regulations. 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.

    a. **Effectiveness** – Medium to high.
    b. **Implementability** – Low: Implementation would require a solid waste land disposal permit.
    c. **Cost** – High: Primarily due to permitting and landform design/construction requirements.

2. *Alternative 2 – Cover entire Site with engineered soil cover*: 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 cover 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 Site unattractive to a broad base of potential future users.

a. **Effectiveness** – High to low: Effectiveness of exposure prevention is considered high; effectiveness with regard for future redevelopment is considered low.
b. **Implementability** – Medium to high.
c. **Cost** – Low to medium.

3. *Alternative 3 – Excavation and ex-situ high temperature thermal desorption*: 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.

   a. **Effectiveness** – High to low: This alternative would be highly effective for PAHs, but will not reduce the metals concentration of the treated soil and is thus low for metals, particularly arsenic.
   b. **Implementability** – Medium to high.
   c. **Cost** – Medium.

4. *Alternative 4 – Excavation and off-Site disposal at a secure Subtitle D landfill followed by backfilling and restoration for future redevelopment*: 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 two-thirds of the excavated volume as backfill to restore the "Remediation Site" to a well-drained and 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 project-related traffic risk.

   a. **Effectiveness** – High: This alternative removes contamination from the Site.

b. **Implementability** – Medium to high.
c. **Cost** – Medium.

Free Product Tar and Localized Shallow Groundwater Contamination

1. *Alternative 1 – Excavation, off-Site treatment, and off-site land disposal*: 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.

    a. **Effectiveness** – High to low: This alternative removes soil contamination from the Site, but does not address high concentrations of benzene or naphthalene in shallow groundwater localized to the former tar pit.
    b. **Implementability** – Medium to high.
    c. **Cost** – High.

2. *Alternative 2 – In-Situ solidification/stabilization (ISS) technology using pozzolonic reagents*: 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.

    a. **Effectiveness** – High: This alternative will immobilize tar free product, soil, and shallow groundwater contamination localized to the former tar pit.
    b. **Implementability** – Medium to high: A treatability study is specified to support the final mix design.
    c. **Cost** – Low to medium.

Groundwater Beneath the Balance of the Site

1. *Alternative 1 – Active pumping and treatment to establish hydraulic control*: 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.

a. **Effectiveness** – High: The effectiveness of this alternative is expected to be high; yet it is unnecessary. Groundwater contamination is not migrating from the Site.
b. **Implementability** – Medium to high.
c. **Cost** – Very high.

2. *Alternative 2 – Institutional controls prohibiting future sue of groundwater or wells at the Site*: The second alternative considered is to establish an institutional control prohibiting the future use of groundwater or water wells at the "Remediation Site." 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.

   a. **Effectiveness** – High.
   b. **Implementability** – High.
   c. **Cost** – Very low.

<u>Recommendation for Site Remedy</u>

Alternative 1 for the soil medium (Consolidate and cover contaminated soil and debris on Site) is an effective alternative with low implementability and high cost owing to design, permitting, and construction requirements for on-site land disposal of solid waste. Alternative 2 for the soil medium (Cover entire Site with engineered soil cover) is an effective alternative with medium to high implementability and low to medium cost; however, the end result will be land unattractive for future development, and hence of little or no benefit for economic redevelopment. Alternative 3 for the soil medium (Excavation and ex-situ high temperature thermal desorption) is not effective in that the metals concentrations will not be reduced. Alternative 4 for the soil medium (Excavation and off-site disposal at a secure Subtitle D landfill) is an effective alternative that is implementable at a medium or moderate cost, and is therefore recommended for implementation.

Alternative 1 for the free product tar, contaminated soil, and contaminated shallow groundwater localized to the former tar pit (Excavation, off-Site treatment, and off-site land disposal) is effective for the free product and soil; yet it leaves the contaminated shallow groundwater unaddressed. Alternative 2 (In-Situ solidification/stabilization (ISS) technology using pozzolonic reagents) is effective and implementable at a low medium cost and is therefore recommended for implementation.

Alternative 1 for the groundwater beneath the balance of the Site (Active pumping and treatment to establish hydraulic control) is an effective yet very expensive and unnecessary alternative because contamination is not migrating from the Site. Alternative 2 (Institutional controls prohibiting future use of groundwater or wells at the Site) effectively mitigates potential exposure to groundwater immediately beneath at a very low cost and is therefore recommended for implementation.

Decision Document

A decision document will be issued at the close of the public comment period with additional details on the selected alternative for site remedy. The decision document will serve as a notice to proceed with the RLF-funded remediation activities and will be available in the local information repository for public review, along with this Site ABCA and other Site-related documents.

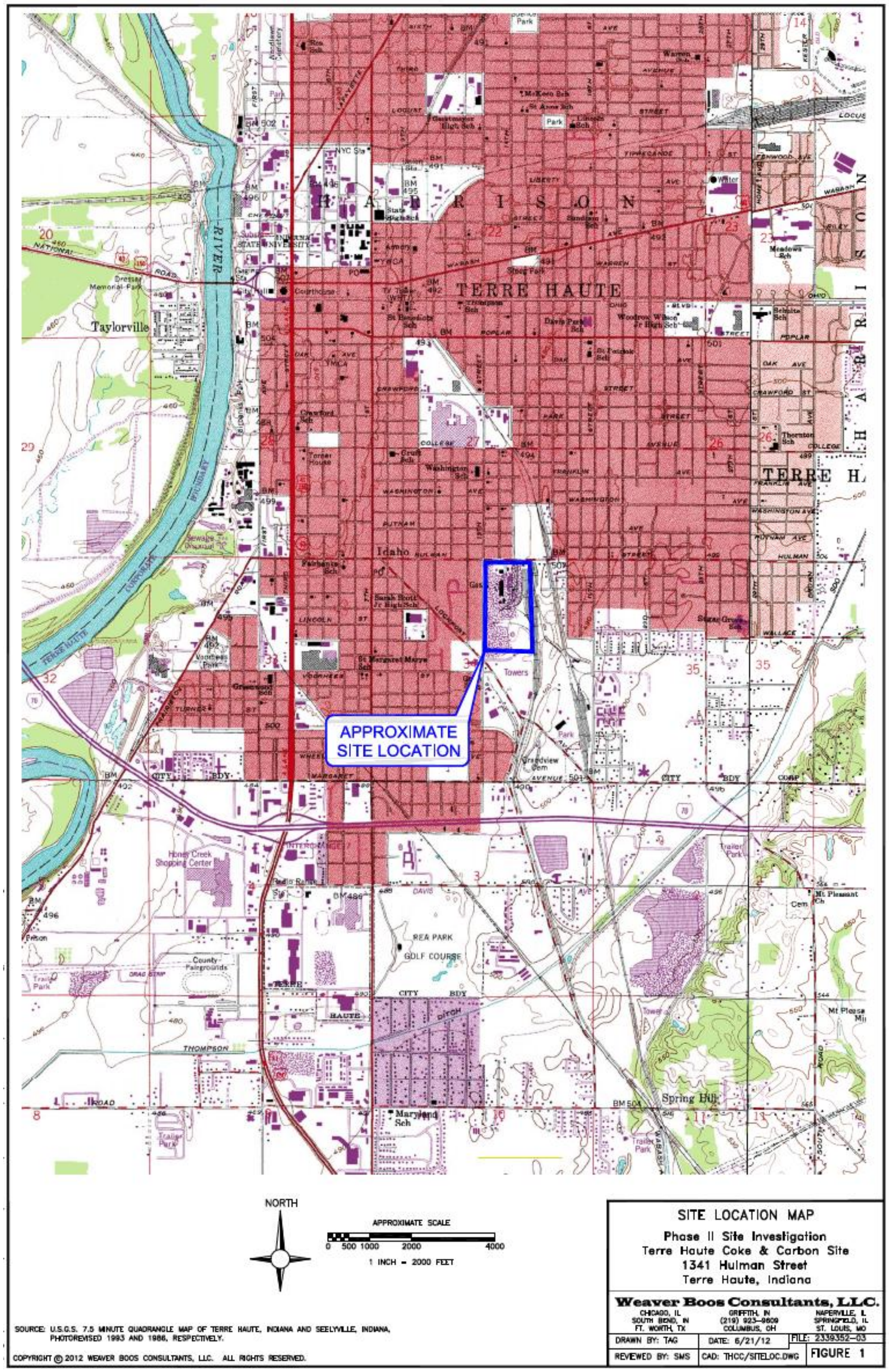
TERRE HAUTE
Taylorville
APPROXIMATE
SITE LOCATION
NORTH
APPROXIMATE SCALE
0 500 1000 2000 4000
1 INCH = 2000 FEET
SITE LOCATION MAP
Phase II Site Investigation
Terre Haute Coke & Carbon Site
1341 Hulman Street
Terre Haute, Indiana
Weaver Boos Consultants, LLC.
CHICAGO, IL
SOUTH BEND, IN
FT. WORTH, TX
GRIFFITH, IN
(219) 923-8609
COLUMBUS, OH
NAPERVILLE, IL
SPRINGFIELD, IL
ST. LOUIS, MO
DRAWN BY: TAG
DATE: 6/21/12
FILE: 2339352-03
REVIEWED BY: SMS
CAD: THCC/SITELOC.DWG
FIGURE 1
SOURCE: U.S.G.S. 7.5 MINUTE QUADRANGLE MAP OF TERRE HAUTE, INDIANA AND SEELYVILLE, INDIANA, PHOTOREVISED 1993 AND 1986, RESPECTIVELY.
COPYRIGHT © 2012 WEAVER BOOS CONSULTANTS, LLC. ALL RIGHTS RESERVED.

FIGURE 1

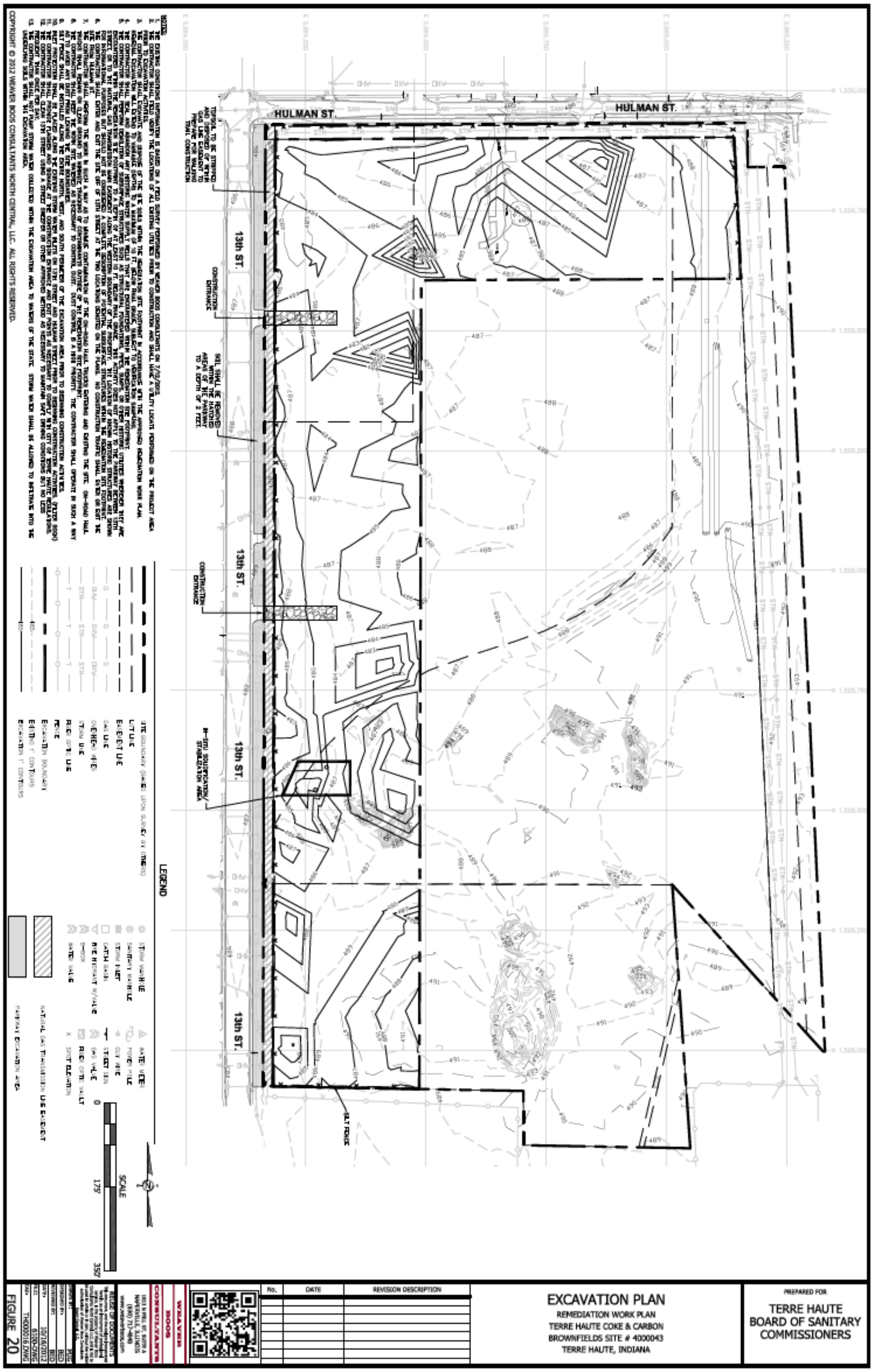
HULMAN ST.
13th ST.
No.
DATE
REVISION DESCRIPTION
EXCAVATION PLAN
REMEDIATION WORK PLAN
TERRE HAUTE COKE & CARBON
BROWNFIELDS SITE # 4000043
TERRE HAUTE, INDIANA
PREPARED FOR
TERRE HAUTE
BOARD OF SANITARY
COMMISSIONERS

FIGURE 2