Background Lead, Arsenic and Polynuclear Aromatic Hydrocarbons (PAHs) Surface Soil Levels

Terre Haute, Indiana

September 2014

Introduction

The *Remediation Closure Guide, Chapter 6, Conceptual Site Model Development: Background and Off-site Sources (2012)* provides guidance for evaluating site conditions that are not associated with site activities. The Indiana Department of Environmental Management (IDEM) is aware that sometimes soil contamination originates through air deposition as a result of historic human activities or is naturally occurring and the site owner is not responsible for remediation or closure relative to these conditions. *"IDEM recognizes the potential value of regional or state-wide background studies as a cost-effective approach for many smaller sites and welcomes the opportunity to collaborate with stakeholders in the design and execution of such studies."* [1]

IDEM and the Midwestern States Environmental Consultants Association (MSECA) partnered with Indiana University-Purdue University Indianapolis (IUPUI), Department of Earth Sciences to obtain lead, arsenic and polynuclear aromatic hydrocarbons (PAHs) urban background soil values for Terre Haute, Indiana.

The list of constituents was selected based on frequency of investigation, the likeliness of having background levels in the environment, and the relatively low screening criteria for these constituents. Due to budgetary constraints, the metals constituents were limited to lead and arsenic.

Scope

Terre Haute served as the initial investigation location due to the availability of IUPUI and Indiana State University (ISU) students with soil sampling experience in the area. All soil samples were collected from property owned by the City if Terre Haute, under the approval of the City's Parks Department. Property access was arranged through Indiana State University. The Workgroup selected these properties as they had the most probable long-term undisturbed soil and were not underlain by waste material. The specific locations were selected based on locational criteria specified in the *Pilot Test-Background Surface Soil Sampling Plan* ("Sampling Plan" provided in Attachment A) and accessibility.

The sampling team visited all potential sampling locations for reconnaissance activities and eliminated 2 locations based on access issues. Representative soil samples were collected from 14 city parks and 2 city

[1] Remediation Closure Guide, p. 97

cemeteries. Two of the parks were large enough to provide two sample locations for a total of 18 samples for arsenic, lead and PAHs. The sites were sampled on September 16 and 18, 2013.

Sampling Methodology and Locations

All surface soil sampling was conducted following the Sampling Plan. Surface soil samples were collected to a depth of 6-inches in 5 aliquots from each sample location. The specific instruction for locating the samples was defined in the Plan. At each sample location, the 5 aliquots were composited and analyzed for lead and arsenic. The PAH sample from each location was collected as a discrete sample from the central aliquot location.

The samplers used a hand-driven bucket auger to collect all soil samples. Grass, roots and pebbles were discarded. The auger was decontaminated between locations as described in the Sampling Plan.

Sampling Locations in Terre Haute Indiana

	Name	Address
TH-1.	Collett Park	7th St and Maple St
TH-2.	Coy Park	29th St and Maple St
TH-3.	Memorial Park	N 4th St and 8th Ave
TH-4.	Woodlawn Cemetery	1230 N 3rd St
TH-5.	Spencer Ball Park	1461 8th Ave
TH-6.	Herz-Rose Park	1515 Locust St
TH-7.	Gilbert Park	1431 Wabash Ave
TH-8N.	Fairbanks Park -North	1st St and Oak St
TH-8S.	Fairbanks Park - South	1st St and Oak St
TH-9.	Thompson Park	601 S 17th St
TH-10.	Washington Park	7th Ave and Maple St
TH-11.	Brittlebank Park	20th St and Grant St
TH-12.	Voorhees Park	230 Voorhees St
TH-13.	Site Eliminated	NA
TH-14.	Sheridan Park	29th St and Beech St
TH-15.	Highland Cemetery	4420 Wabash Ave
TH-16.	Site Eliminated	NA
TH-17N.	Deming Park - North	S Fruitridge Ave and Ohio Blvd
Th-17S.	Deming Park - South	S Fruitridge Ave and Ohio Blvd
TH- 18.	Dobbs Park	5150 Poplar Dr

Specific locations are depicted on the site maps with GPS coordinates and are included as Attachment B.

At Voorhees Park, the sampling team took duplicate samples for metals and PAHs .The results show comparable values. See Data Summary Tables in Attachment C.

IDEM staff completed Sample Chain of Custody sheets and dropped the samples at the Office of Land Quality's contract laboratory, Microbac, on September 18, 2013. Microbac analyzed the metals using Method 6010C and the PAHs using Method 8310/8270SIM.

OLQ's Chemistry Services Section received the analytical results and validated the data according to quality criteria in the IDEM Laboratory Services Contract (9-34) and Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW-846), Third Edition. The validation indicated the results were useable for the project.

Results

Samples collected from this study revealed arsenic concentrations ranging from 3 to 14 mg/kg and a median value of 7 mg/kg. Lead concentrations ranged from 20 to 370 mg/kg and a median value of 35 mg/kg. PAH results revealed limited detections for all the analytes, including Benzo (a) Pyrene ranging from non-detect to 380 ug/kg and Dibenzo(a,h) Anthracene ranging from non-detect to 56 ug/kg. [2] A summary of the results is provided as Table I (Arsenic and Lead) and Table II (PAHs) in Attachment C. General statistics including mean, median and standard deviation are included as Table III for Arsenic and Lead in Attachment D.

There were two deviations from the Sampling Plan. First, the Plan called for evaluation of sampling data from both urban and minimally disrupted areas. Shortly after finalization of the Plan, the U.S. Geological Survey (USGS) published results of background sampling across the U.S. The locations that USGS sampled in Indiana were generally consistent with the criteria developed in the Plan, so the Workgroup determined that the Terre Haute sampling event would not include evaluation of minimally disrupted areas and that IDEM would accept the USGS data for background determinations outside of urban areas. The second deviation from the Plan was a deviation from the elements of the Quality Assurance/Quality Control section. This section calls for an equipment blank to verify that "cross-contamination" didn't occur from the use of non-disposable sampling equipment. This process specified pouring deionized water over the freshly cleaned bucket auger and bowl, collecting the rinse water and analyzing for the metals and PAHs. While this procedure constitutes good practice, it is believed that due to very low concentrations of metals and PAHs observed in all the sampled soil, even if residual particles were transferred from one sample location to another, there would likely be very little (if any) measurable bias in the results.

Using this Information

This report and results are specific to background sampling in the City of Terre Haute, Indiana. Feel free to use this data as valid background data and use at your discretion. Extrapolation to other nearby cities, counties or the State may not be considered valid comparisons.

2 These PAH analytes are identified here as they drive the risks associated with PAH mixtures due to their toxicity

References

US EPA. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW-846). Third Edition.

IDEM. *Remediation Closure Guide*. Indiana Department of Environmental Management. March 22, 2012.

http://www.in.gov/idem/6683.htm

Attachments

A- Sampling Plan September 2013

B – Maps

C- Summary Tables

D- Statistics

Pilot Test – Background Surface Soil Sampling Plan for Arsenic, Lead and Polynuclear Aromatic Hydrocarbons at Terre Haute – September 6, 2013

1.0 Project Scope and Objectives

IDEM has initiated a project to sample, analyze, and estimate the background concentrations of arsenic, lead and 18 polynuclear aromatic hydrocarbons (PAHs) in surface soils across the state of Indiana. Arsenic, lead and the 18 PAHs identified in Section 3.0 are referenced collectively as the "constituents of interest" (COI). Identifying background concentrations of the COI is important because during remediation and/or closure it often is difficult to distinguish between COI that are present in soils as a result of releases associated with the subject closure activity versus those that are not. (The former are the responsibility of the party performing remediation/closure, whereas the latter are not.) Furthermore, risk-based screening levels for arsenic generally are lower than naturally occurring arsenic levels in soil in many regions of Indiana. Due to the cost and complexity of this project, it was determined that the initial effort would be focused on Terre Haute as a pilot project. Indiana University/Purdue University at Indianapolis (IUPUI) Department of Earth Sciences is collaborating with IDEM on this portion of the project, and has agreed to collect the samples.

1.1 Urban Background and Minimally Disrupted Areas Background

Natural background refers to the concentrations of COI that are present in environmental media without human influence. "Minimally Disrupted Areas" (MDA) is a term used in this project to address locations where ambient concentrations of COI include those understood to be present naturally plus those that are present due to deposition through widespread human activities not associated with power generation or manufacturing (e.g., historical heating with coal, use of leaded gasoline, etc.). "Urban Background" (UB) is a term used in this project to address those locations where ambient concentrations of COI include those understood to be present naturally, plus those that are present due to deposition through widespread human activities including those activities normally associated with the presence of a high population (urban) center (e.g., historical power generation and manufacturing activities).

1.2 Objectives

The objectives of this pilot project are to:

(i.) Collect surface soil samples that are representative of urban background conditions for analysis of the selected COIs;

(ii.) Collect surface soil samples that are representative of minimally disrupted areas for analysis of the selected COIs;

(iii.) Perform laboratory analysis of the samples to determine COI concentrations in the samples;

(iv.) Evaluate the data statistically to determine concentrations representative of the COIs in both urban and minimally disrupted areas of Terre Haute;

(v.) Evaluate the strengths and weaknesses of the procedures and methods applied during this pilot project, and determine modifications, if any, for application on a broader scale across the state of Indiana.

2.0 Sampling Strategy and Field Activities for Urban Background Determination

Sampling activities will be performed under the direction of Dr. Gabe Filippelli, Professor of Geology at the IUPUI Department of Earth Sciences, or his designees, in the manner described below. IDEM staff will provide additional guidance and coordination, and will participate in sampling activities as available.

2.1 Areas Suitable for Urban Background Sampling

Locations for urban background have been pre-selected based in part on ease of access. Anticipated sampling locations are depicted on Map TH-1 (attached). We are anticipating at this time, that all of the sampling sites are owned or under the jurisdiction of the City of Terre Haute, the County of Vigo, or the State of Indiana. However, if additional sampling locations are added which are not on public property, access will be obtained from the private property owner. Sample locations were selected based upon visual inspection, review of historical records, and review of IDEM site files. Ideally, sampling locations meet the following criteria:

(i.) The surface soils are not composed of, and are not believed to have been impacted by, engineered or structural fill.
(ii.) Areas of reported or suspected spills; reported or suspected management, treatment, handling, storage, or disposal of solid or hazardous wastes or substances, including petroleum and wastewater, are excluded.
(iii.) Located more than 10 feet from edge of parking lots
(iv.) Located more than 100 feet from major roads
(v.) Located more than 20 feet from streets and minor roads
(vi.) Highly manicured lawns are excluded (e.g., golf courses)
(vii.) Not within an obvious flood plain as determined by direct visual inspection, local anecdotal reports or reference to existing flood hazard maps
(viii.) Areas along railroad tracks and associated drainage areas are excluded
(ix.) Surface water storm drains or ditches are excluded.

Major roads are defined as those segments of road where vehicular traffic counts exceed 10,000 vehicles per day. See http://www.westcentralin.com/transport/traffic_counts/Traffic_Count_Report,072110.pdf and http://www.in.gov/indot/files/vigo(2).pdf

2.2 Sampling Equipment and Personal Protective Equipment (PPE)

Surface soil samples will be collected using hand-driven soil coring devices, such as stainless steel bucket augers or an AMS soil sampler. Based on the composite sampling strategy (discussed below), multiple sub-samples or aliquots will be composited into one

sample at each sampling location. A stainless steel mixing bowl and stainless steel spoon will be used to composite the sub-samples at each sampling location.

The hand auger/soil sampler and mixing bowl/spoon will be decontaminated after sampling at each location. Decontamination is not required between sub-sampling (aliquot) locations. However the sampling probes will be wiped "clean" with a brush or paper towels to remove clumps of soil that may adhere to the equipment and thereby reduce the possibility of soil transfer from one aliquot to the other. Decontamination will consist of washing non-disposable sampling equipment (e.g., bucket augers, bowls, etc.) with a non-phosphate detergent (such as Liquinox) and brushes, and rinsing with both tap water (primary rinse) and deionized water (final rinse).

PPE will include disposable nitrile gloves or similar protective gloves (such as polyethylene), and safety glasses. Gloves will be changed between each sample location.

2.3 Field Documentation

Sampling documentation will be recorded on IDEM field sampling note forms provided to the sampling team. Each sampling team will record the sample aliquot locations as GPS coordinates in conformance with IDEM's *Spatial Data Collection Standards* guidance found at http://www.in.gov/idem/files/spatial_data_collection_standards.pdf**.** A GPS unit capable of accurately measuring (laterally) to a meter or less (at a 95% confidence interval) is required. The sample locations will be marked in the field using temporary survey flags and a photograph will be taken to document the overall layout of the sampling area. During sampling, information to be documented includes: topography (eg. flat, gently sloping SE, steeply sloping W), soil series based on the available USDA soil survey map, vegetation type and density (mixed grasses, ~ 80% cover), geologic description of the material (including soil texture, color, consistency, and moisture content), weather conditions; sampling personnel identification; sample container type, size and quantity, preservation (if any); sample ID/number; and information regarding deviations from the procedures established in this SAP (e.g., south aliquot collected at 40 feet spacing due to presence of sidewalk).

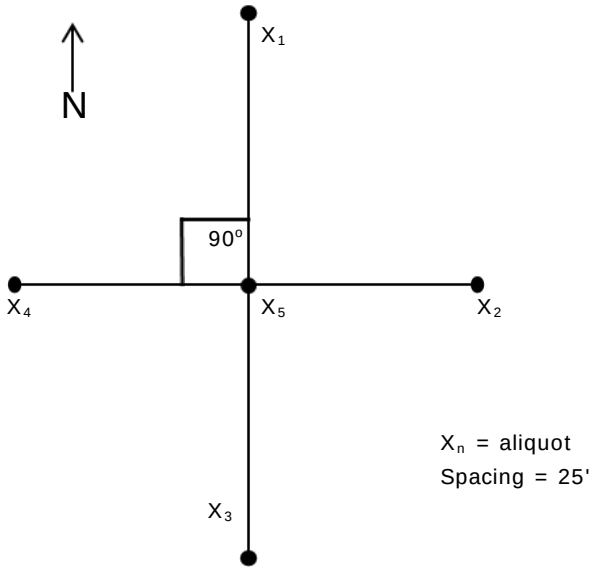
2.4 Sampling Design

Sampling is tentatively planned for 18 locations within Terre Haute. These locations are designated on the attached Map TH-1. The sample locations will be evaluated for designation as either UB or MDA areas following a site visit prior to the sampling event.

2.4(a) Sampling Design for Arsenic and Lead

Surface soil (defined here as the upper 6-inches) will be collected in 5 aliquots from each sample location for compositing into a single sample for laboratory analysis. One additional composited sample will be collected and retained for future reference by IDEM technical staff, and remaining sample may be retained by IUPUI for additional analysis. The aliquots will be collected from the intersection and the four ends of two centered 50 foot vectors oriented at a 90 degree axis for a five point composite (see diagram on next page). The vectors will generally be oriented N-S and E-W at a 90-

degree axis (right angle) with all sample points spaced 25 feet apart. The directional orientation, vector angle, and vector length may be slightly adjusted to accommodate site obstructions and distance limitations (eg. 10 feet minimum from parking areas). However such deviations should be avoided as much as possible as this configuration is intended to minimize bias in the sample aliquot locations. Any/all deviations should be documented in the field sheets.



2.4(b) Sampling Design for PAHs

The sampling design for analysis of PAHs will utilize the same soil interval and array described in 2.4(a), but a discrete – <u>not composited</u> – soil sample will be collected from the intersection of the two 50 foot vectors (sample X_5 in diagram).

2.5(a) Sampling Procedure: Arsenic and Lead

Once the sampling locations and the aliquot sampling locations are identified, a bucket auger or similar soil sampler will be advanced to collect the sample. At each aliquot location, a uniform amount of soil will be collected to a depth of 6-inches. Roots, grass, pebbles and vegetative litter should be removed from the sample before placing aliquots in a mixing bowl. The soils will be placed in the stainless steel bowl and described (refer to Section 2.3). The same procedure should be followed at the other aliquot locations, and a similar volume of soil should be collected at each aliquot location. The aliquots should then be thoroughly mixed in the stainless steel mixing bowl. The quartering technique should be used for mixing, which includes breaking the sample into four quarters, then mixing each of the quarters individually, then mixing the halves together, and finally mixing all quarters together. Once the soils are homogenized to the extent possible in the field, one 4-ounce jar (unless otherwise specified) with Teflon-lined lid

should be filled with soil. One ziplock plastic bag should be filled with a similar volume for later visual manual classification. Five 6-inch cores should provide sufficient volume – if not, retrieve an additional core from each sample location for homogenization. Information listed in Section 2.3 above should be documented for each aliquot. The samples for analytical evaluation will be labeled and placed in an iced cooler, and appropriate chain-of-custody documentation will be completed. The samples for visual manual classification will be labeled and placed in a box with no preservation. The samples will be hand-delivered to the IDEM by IUPUI personnel, and the samples designated for analytical evaluation will then be relinquished to the laboratory following appropriate chain-of-custody procedures. The laboratory will be instructed on the chain-of-custody to analyze the soil samples for the relevant COIs using the appropriate U.S. EPA SW-846 methods listed below. The laboratory will be instructed to archive remaining sample for future re-analysis, if necessary. Equipment will be decontaminated following the procedures in Section 2.3 prior to leaving the sample location.

2.5(b) Sampling Procedure: PAHs

At the central aliquot location, a uniform amount of soil will be collected to a depth of 6-inches. The procedures identified in section 2.5(a) above will be utilized for documentation, preservation and storage of each sample. The lab will be instructed to analyze the soil sample for PAHs using the U.S. EPA SW-846 methods described below.

2.6 Quality Assurance/Quality Control

A single field duplicate will be collected for every 20 composite sample locations and submitted for analysis for the same parameters. Additionally, one equipment blank will be collected for every 20 composite soil samples collected. The equipment blank will be collected by pouring laboratory-provided deionized water over the decontaminated soil sampling equipment (bucket auger and bowls) and collecting that rinse water into laboratory-provided sampling containers (with the appropriate preservative).

3.0 Sample Analysis

Soil samples will be analyzed for COIs as follows:

Constituents of Interest	**Preparation Method**	**Analytical Method**
Arsenic	SW846 3050B	SW846 6010C
Lead	"	"
Acenapthene	Lab-specific	SW846 8310/8270 SIM
Anthracine	"	"
Benz[a]anthracene	"	"
Benzo[j]fluoranthene	"	"
Benzo[a]pyrene	"	"
Benzo[b]fluoranthene	"	"
Benzo[k]fluoranthene	"	"
Chrysene	"	"

Dibenz[a,h]anthracene	“	“
Dibenzo[a,e]pyrene	“	“
(table continued next page) 7,12-Dimethylbenz[a]anthracene	“	“
Fluoranthene	“	“
Fluorene	“	“
Indeno[1,2,3-cd]pyrene	“	“
1-Methylnapthalene	“	“
2-Methylnapthalene	“	“
Napthalene	“	“
Pyrene	“	“

4.0 Data Evaluation Methods

Data evaluation methods will be specified at a later date.

Terre Haute - IDEM Background Soil Project - Collett Park (Map 1)

Mapped By:	Mike Hill, IDEM, Office of Land Quality, Science Services Branch, Engineering & GIS Services, April 28, 2014
Aerial Info:	2005 Statewide Orthophotography Project (1 foot resolution)
Sample Data Info:	TH-1-a & TH-1 Grab locations are typical. All samples not designated as "Grab" are composite sample types.
GPS Info:	GPS data for sample locations collected with a Trimble Geo XH 6000 September 16, 2013 by IDEM personnel.
Source Info:	Terre Haute Parks provided by Terre Haute City Engineer's Office
Location Info:	Terre Haute, Harrison Township, Vigo County, Indiana
Disclaimer:	This map is intended to serve as an aid in graphic representation only. This information is not warranted for accuracy or other purposes.

Soil Sample Location

City of Terre Haute Park (Collett Park)

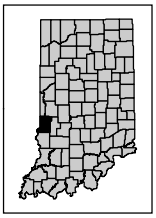
IDEM

N W E S

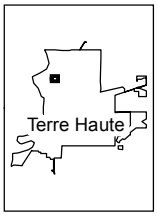
0 150 300 Feet

0 50 100 Meters

Vigo County



Project Area



Terre Haute - IDEM Background Soil Project - Coy Park (Map 2)

Mapped By:	Mike Hill, IDEM, Office of Land Quality, Science Services Branch, Engineering & GIS Services, April 28, 2014
Aerial Info:	2005 Statewide Orthophotography Project (1 foot resolution)
Sample Data Info:	TH-2-a & TH-2 Grab locations are typical. All samples not designated as "Grab" are composite sample types.
GPS Info:	GPS data for sample locations collected with a Trimble Geo XH 6000 September 16, 2013 by IDEM personnel.
Source Info:	Terre Haute Parks provided by Terre Haute City Engineer's Office
Location Info:	Terre Haute, Harrison Township, Vigo County, Indiana
Disclaimer:	This map is intended to serve as an aid in graphic representation only. This information is not warranted for accuracy or other purposes.

Soil Sample Location

City of Terre Haute Park (Coy Park)

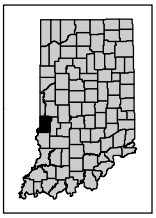
IDEM

N W E S

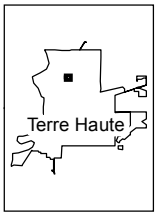
0 100 200 Feet

0 30 60 Meters

Vigo County



Project Area



Terre Haute - IDEM Background Soil Project - Memorial Park (Map 3)

Mapped By:	Mike Hill, IDEM, Office of Land Quality, Science Services Branch, Engineering & GIS Services, April 28, 2014
Aerial Info:	2005 Statewide Orthophotography Project (1 foot resolution)
Sample Data Info:	TH-3-a & TH-3 Grab locations are typical. All samples not designated as "Grab" are composite sample types.
GPS Info:	GPS data for sample locations collected with a Trimble Geo XH 6000 September 16, 2013 by IDEM personnel.
Source Info:	Terre Haute Parks provided by Terre Haute City Engineer's Office
Location Info:	Terre Haute, Harrison Township, Vigo County, Indiana
Disclaimer:	This map is intended to serve as an aid in graphic representation only. This information is not warranted for accuracy or other purposes.

Soil Sample Location

City of Terre Haute Park (Memorial Park)

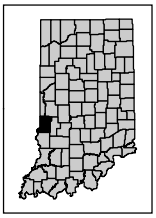
IDEM

N W E S

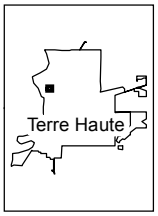
0 150 300 Feet

0 50 100 Meters

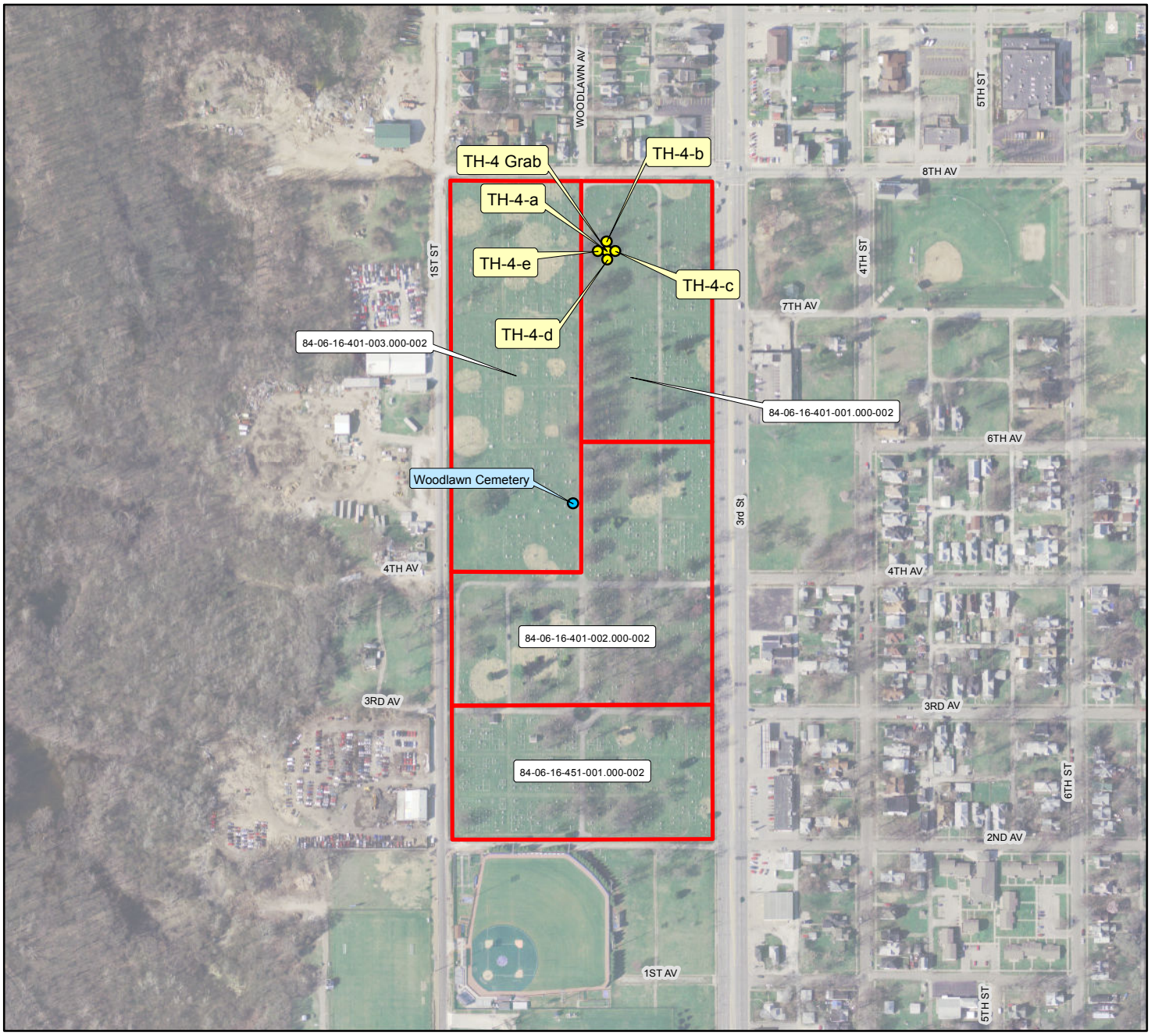
Vigo County



Project Area



Terre Haute - IDEM Background Soil Project - Woodlawn Cemetery (Map 4)



Mapped By:	Mike Hill, IDEM, Office of Land Quality, Science Services Branch, Engineering & GIS Services, April 28, 2014
Aerial Info:	2005 Statewide Orthophotography Project (1 foot resolution)
Sample Data Info:	TH-4-a & TH-4 Grab locations are typical. All samples not designated as "Grab" are composite sample types.
GPS Info:	GPS data for sample locations collected with a Trimble Geo XH 6000 September 16, 2013 by IDEM personnel.
Source Info:	Terre Haute Parks provided by Terre Haute City Engineer's Office
Location Info:	Terre Haute, Harrison Township, Vigo County, Indiana
Disclaimer:	This map is intended to serve as an aid in graphic representation only. This information is not warranted for accuracy or other purposes.

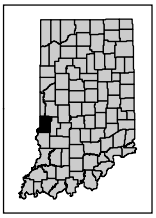
Soil Sample Location
Parcel
Cemetery - USGS

N
W E
S

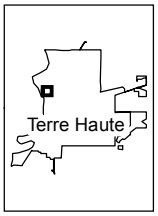
IDEM

0 250 500 Feet
0 75 150 Meters

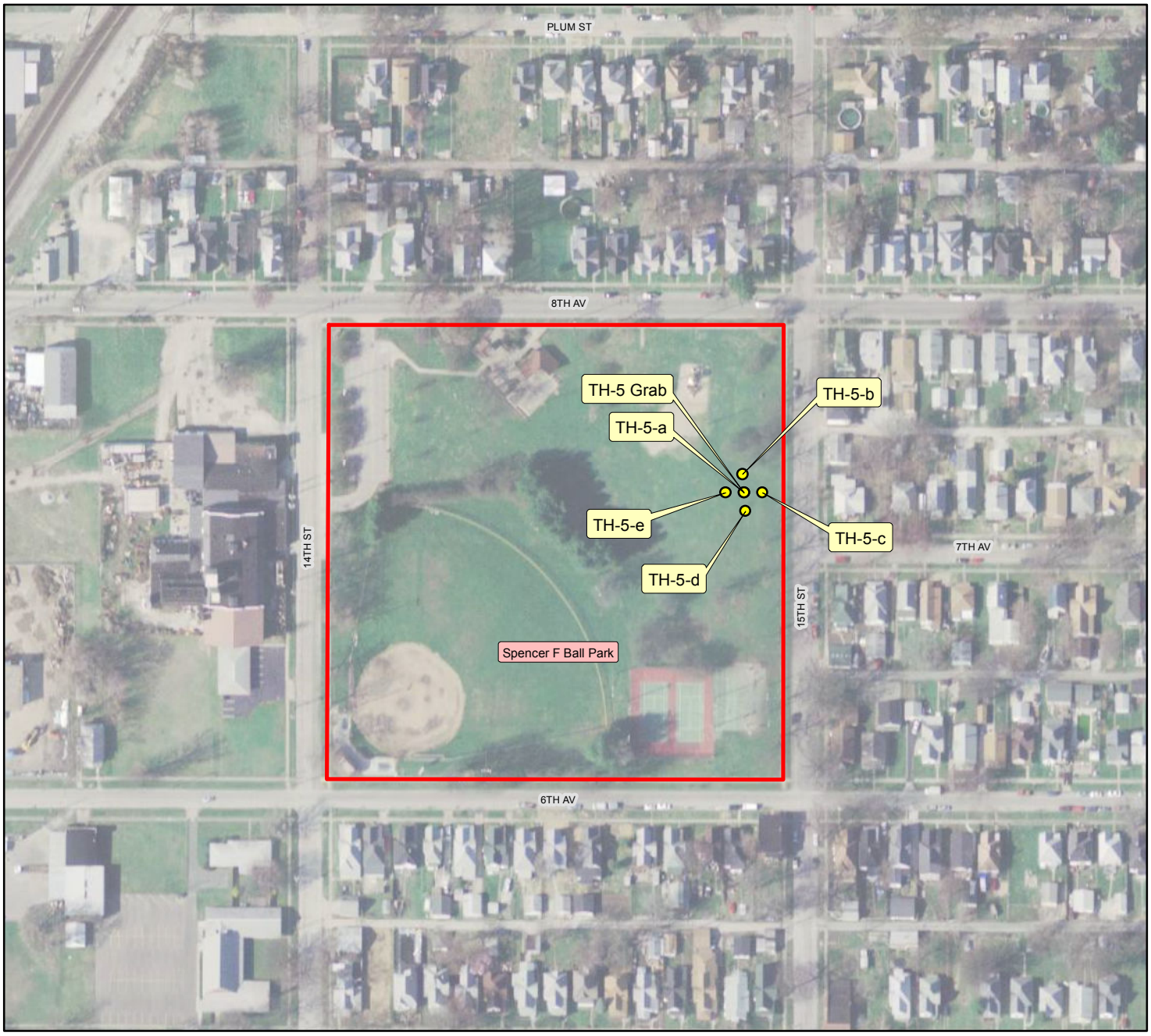
Vigo County



Project Area



Terre Haute - IDEM Background Soil Project - Spencer F Ball Park (Map 5)



Mapped By:	Mike Hill, IDEM, Office of Land Quality, Science Services Branch, Engineering & GIS Services, April 30, 2014
Aerial Info:	2005 Statewide Orthophotography Project (1 foot resolution)
Sample Data Info:	TH-5-a & TH-5 Grab locations are typical. All samples not designated as "Grab" are composite sample types.
GPS Info:	GPS data for sample locations collected with a Trimble Geo XH 6000 September 16, 2013 by IDEM personnel.
Source Info:	Terre Haute Parks provided by Terre Haute City Engineer's Office
Location Info:	Terre Haute, Harrison Township, Vigo County, Indiana
Disclaimer:	This map is intended to serve as an aid in graphic representation only. This information is not warranted for accuracy or other purposes.

Soil Sample Location

City of Terre Haute Park (Spencer F Ball Park)

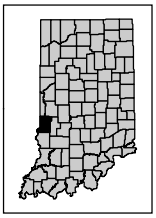
IDEM

N W E S

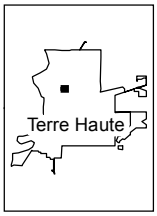
0 100 200 Feet

0 30 60 Meters

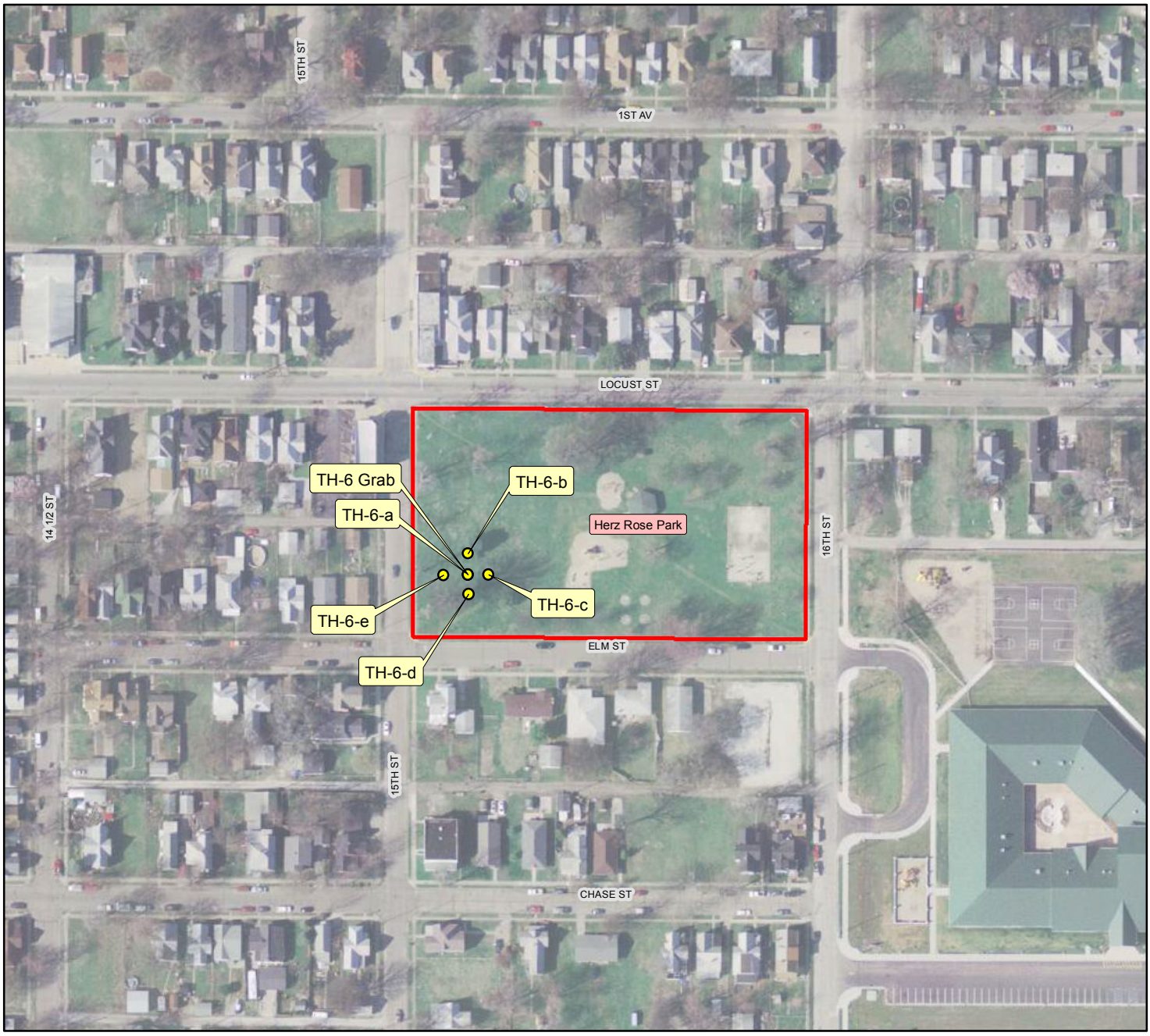
Vigo County



Project Area



Terre Haute - IDEM Background Soil Project - Herz Rose Park (Map 6)



Mapped By:	Mike Hill, IDEM, Office of Land Quality, Science Services Branch, Engineering & GIS Services, April 30, 2014
Aerial Info:	2005 Statewide Orthophotography Project (1 foot resolution)
Sample Data Info:	TH-6-a & TH-6 Grab locations are typical. All samples not designated as "Grab" are composite sample types.
GPS Info:	GPS data for sample locations collected with a Trimble Geo XH 6000 September 16, 2013 by IDEM personnel.
Source Info:	Terre Haute Parks provided by Terre Haute City Engineer's Office
Location Info:	Terre Haute, Harrison Township, Vigo County, Indiana
Disclaimer:	This map is intended to serve as an aid in graphic representation only. This information is not warranted for accuracy or other purposes.

Soil Sample Location

City of Terre Haute Park (Herz Rose Park)

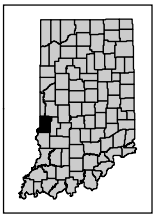
IDEM

N W E S

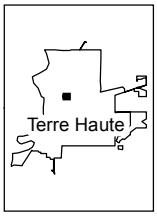
0 100 200 Feet

0 30 60 Meters

Vigo County



Project Area



Terre Haute - IDEM Background Soil Project - Curtis Gilbert Park (Map 7)

Mapped By:	Mike Hill, IDEM, Office of Land Quality, Science Services Branch, Engineering & GIS Services, May 1, 2014
Aerial Info:	2005 Statewide Orthophotography Project (1 foot resolution)
Sample Data Info:	TH-7-a & TH-7 Grab locations are typical. All samples not designated as "Grab" are composite sample types.
GPS Info:	GPS data for sample locations collected with a Trimble Geo XH 6000 September 16, 2013 by IDEM personnel.
Source Info:	Terre Haute Parks provided by Terre Haute City Engineer's Office
Location Info:	Terre Haute, Harrison Township, Vigo County, Indiana
Disclaimer:	This map is intended to serve as an aid in graphic representation only. This information is not warranted for accuracy or other purposes.

Soil Sample Location

City of Terre Haute Park (Curtis Gilbert Park)

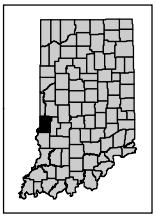
IDEM

N W E S

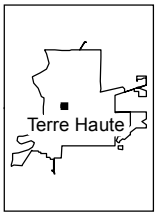
0 100 200 Feet

0 25 50 Meters

Vigo County



Project Area



Terre Haute - IDEM Background Soil Project - Fairbanks Park (Map 8)

Mapped By:	Mike Hill, IDEM, Office of Land Quality, Science Services Branch, Engineering & GIS Services, May 1, 2014
Aerial Info:	2005 Statewide Orthophotography Project (1 foot resolution)
Sample Data Info:	TH-8 North-a & TH-8 North Grab locations are typical. TH-8 South-a & TH-8 South Grab locations are typical. All samples not designated as "Grab" are composite sample types.
GPS Info:	GPS data for sample locations collected with a Trimble Geo XH 6000 September 18, 2013 by IDEM personnel.
Source Info:	Terre Haute Parks provided by Terre Haute City Engineer's Office
Location Info:	Terre Haute, Harrison Township, Vigo County, Indiana
Disclaimer:	This map is intended to serve as an aid in graphic representation only. This information is not warranted for accuracy or other purposes.

Soil Sample Location

City of Terre Haute Park (Fairbanks Park)

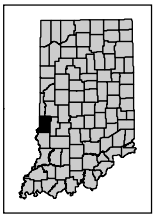
N W E S

IDEM

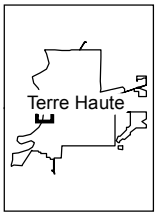
0 400 800 Feet

0 100 200 Meters

Vigo County



Project Area



Terre Haute - IDEM Background Soil Project - Thompson Park (Map 9)

Mapped By:	Mike Hill, IDEM, Office of Land Quality, Science Services Branch, Engineering & GIS Services, June 17, 2014
Aerial Info:	2005 Statewide Orthophotography Project (1 foot resolution)
Sample Data Info:	TH-9-a & TH-9 Grab locations are typical. All samples not designated as "Grab" are composite sample types.
GPS Info:	GPS data for sample locations collected with a Trimble Geo XH 6000 September 18, 2013 by IDEM personnel.
Source Info:	Terre Haute Parks provided by Terre Haute City Engineer's Office
Location Info:	Terre Haute, Harrison Township, Vigo County, Indiana
Disclaimer:	This map is intended to serve as an aid in graphic representation only. This information is not warranted for accuracy or other purposes.

Soil Sample Location

City of Terre Haute Park (Thompson Park)

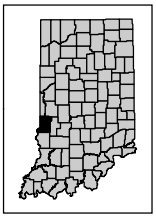
IDEM

N W E S

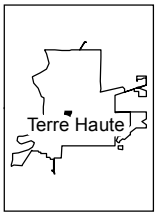
0 100 200 Feet

0 30 60 Meters

Vigo County



Project Area



Terre Haute - IDEM Background Soil Project - Washington Park (Map 10)

Mapped By:	Mike Hill, IDEM, Office of Land Quality, Science Services Branch, Engineering & GIS Services, June 17, 2014
Aerial Info:	2005 Statewide Orthophotography Project (1 foot resolution)
Sample Data Info:	TH-10-a & TH-10 Grab locations are typical. All samples not designated as "Grab" are composite sample types.
GPS Info:	GPS data for sample locations collected with a Trimble Geo XH 6000 September 18, 2013 by IDEM personnel.
Source Info:	Terre Haute Parks provided by Terre Haute City Engineer's Office
Location Info:	Terre Haute, Harrison Township, Vigo County, Indiana
Disclaimer:	This map is intended to serve as an aid in graphic representation only. This information is not warranted for accuracy or other purposes.

Soil Sample Location

City of Terre Haute Park (Washington Park)

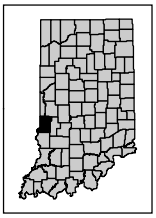
IDEM

N
W E
S

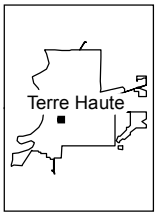
0 100 200 Feet

0 30 60 Meters

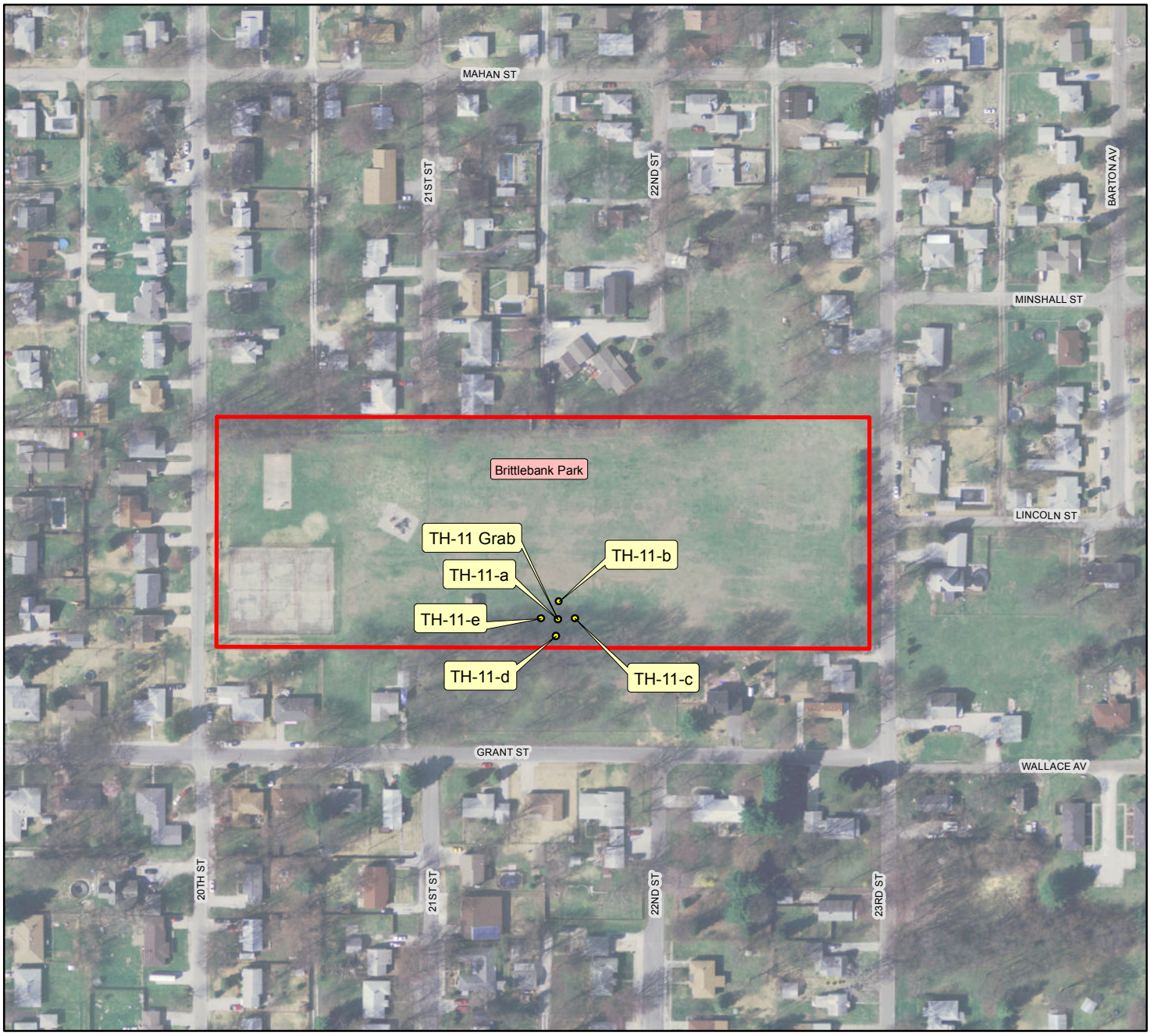
Vigo County



Project Area



Terre Haute - IDEM Background Soil Project - Brittlebank Park (Map 11)



Mapped By:	Mike Hill, IDEM, Office of Land Quality, Science Services Branch, Engineering & GIS Services, June 17, 2014
Aerial Info:	2005 Statewide Orthophotography Project (1 foot resolution)
Sample Data Info:	TH-11-a & TH-11 Grab locations are typical. All samples not designated as "Grab" are composite sample types.
GPS Info:	GPS data for sample locations collected with a Trimble Geo XH 6000 September 18, 2013 by IDEM personnel.
Source Info:	Terre Haute Parks provided by Terre Haute City Engineer's Office
Location Info:	Terre Haute, Harrison Township, Vigo County, Indiana
Disclaimer:	This map is intended to serve as an aid in graphic representation only. This information is not warranted for accuracy or other purposes.

Soil Sample Location

City of Terre Haute Park (Brittlebank Park)

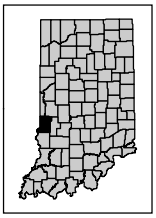
IDEM

N W E S

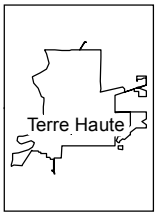
0 100 200 Feet

0 30 60 Meters

Vigo County



Project Area



Terre Haute - IDEM Background Soil Project - Voorhees Park (Map 12)

Mapped By:	Mike Hill, IDEM, Office of Land Quality, Science Services Branch, Engineering & GIS Services, September 16, 2014
Aerial Info:	2005 Statewide Orthophotography Project (1 foot resolution)
Sample Data Info:	TH-12-a, & TH-12 Grab locations are typical. All samples not designated as "Grab" are composite sample types.
GPS Info:	GPS data for sample locations collected with a Trimble Geo XH 6000 September 18, 2013 by IDEM personnel.
Source Info:	Terre Haute Parks provided by Terre Haute City Engineer's Office
Location Info:	Terre Haute, Harrison Township, Vigo County, Indiana
Disclaimer:	This map is intended to serve as an aid in graphic representation only. This information is not warranted for accuracy or other purposes.

Soil Sample Location

City of Terre Haute Park (Voorhees Park)

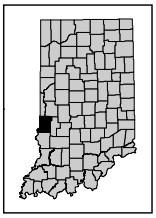
IDEM

N W E S

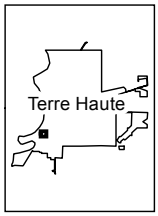
0 150 300 Feet

0 50 100 Meters

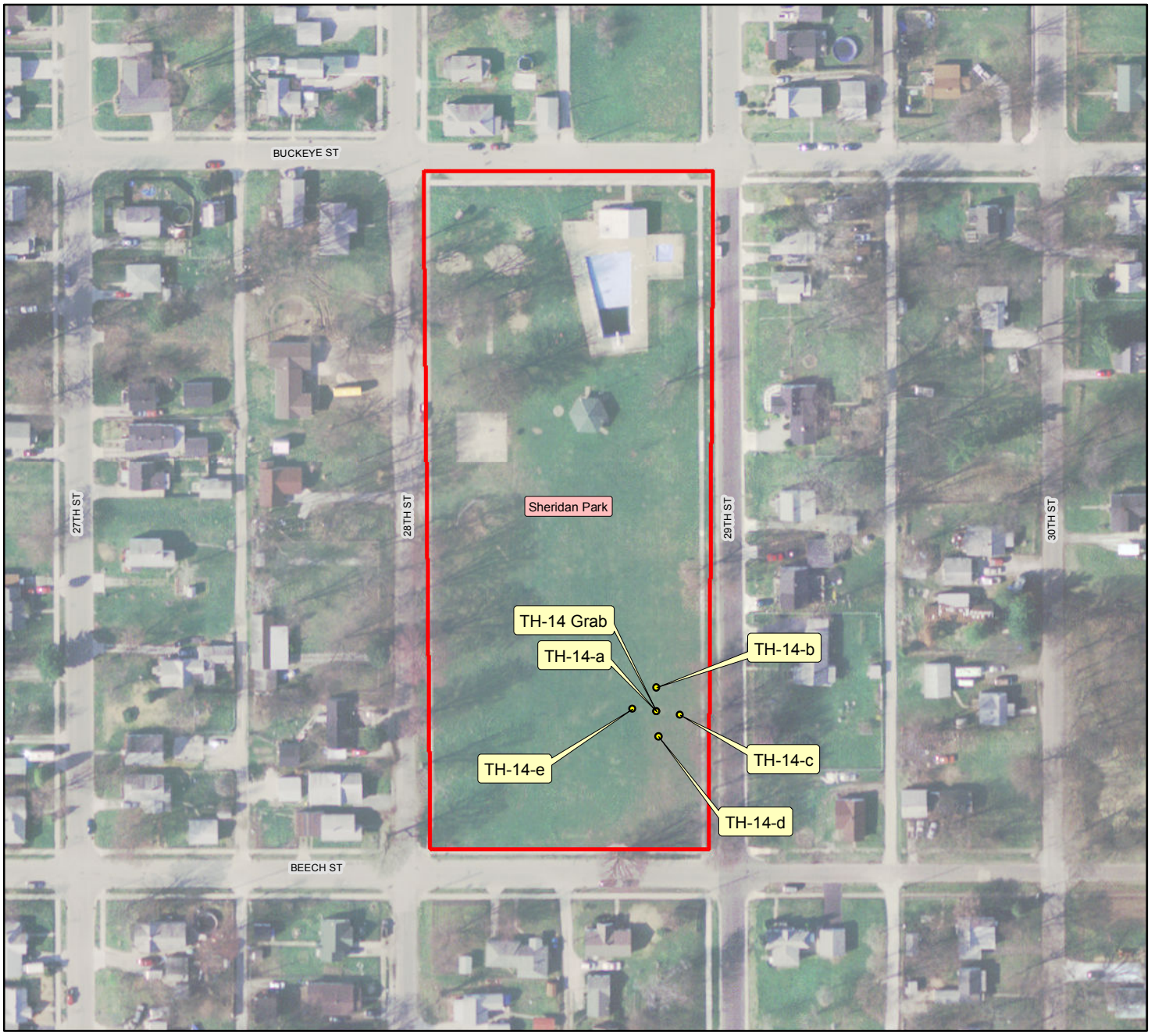
Vigo County



Project Area



Terre Haute - IDEM Background Soil Project - Sheridan Park (Map 14)



Mapped By:	Mike Hill, IDEM, Office of Land Quality, Science Services Branch, Engineering & GIS Services, June 17, 2014
Aerial Info:	2005 Statewide Orthophotography Project (1 foot resolution)
Sample Data Info:	TH-14-a & TH-14 Grab locations are typical. All samples not designated as "Grab" are composite sample types.
GPS Info:	GPS data for sample locations collected with a Trimble Geo XH 6000 September 16, 2013 by IDEM personnel.
Source Info:	Terre Haute Parks provided by Terre Haute City Engineer's Office
Location Info:	Terre Haute, Harrison Township, Vigo County, Indiana
Disclaimer:	This map is intended to serve as an aid in graphic representation only. This information is not warranted for accuracy or other purposes.

Soil Sample Location

City of Terre Haute Park (Sheridan Park)

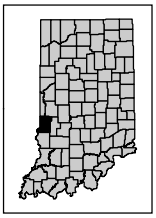
IDEM

N W E S

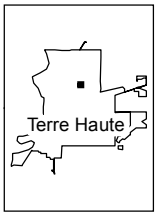
0 75 150 Feet

0 25 50 Meters

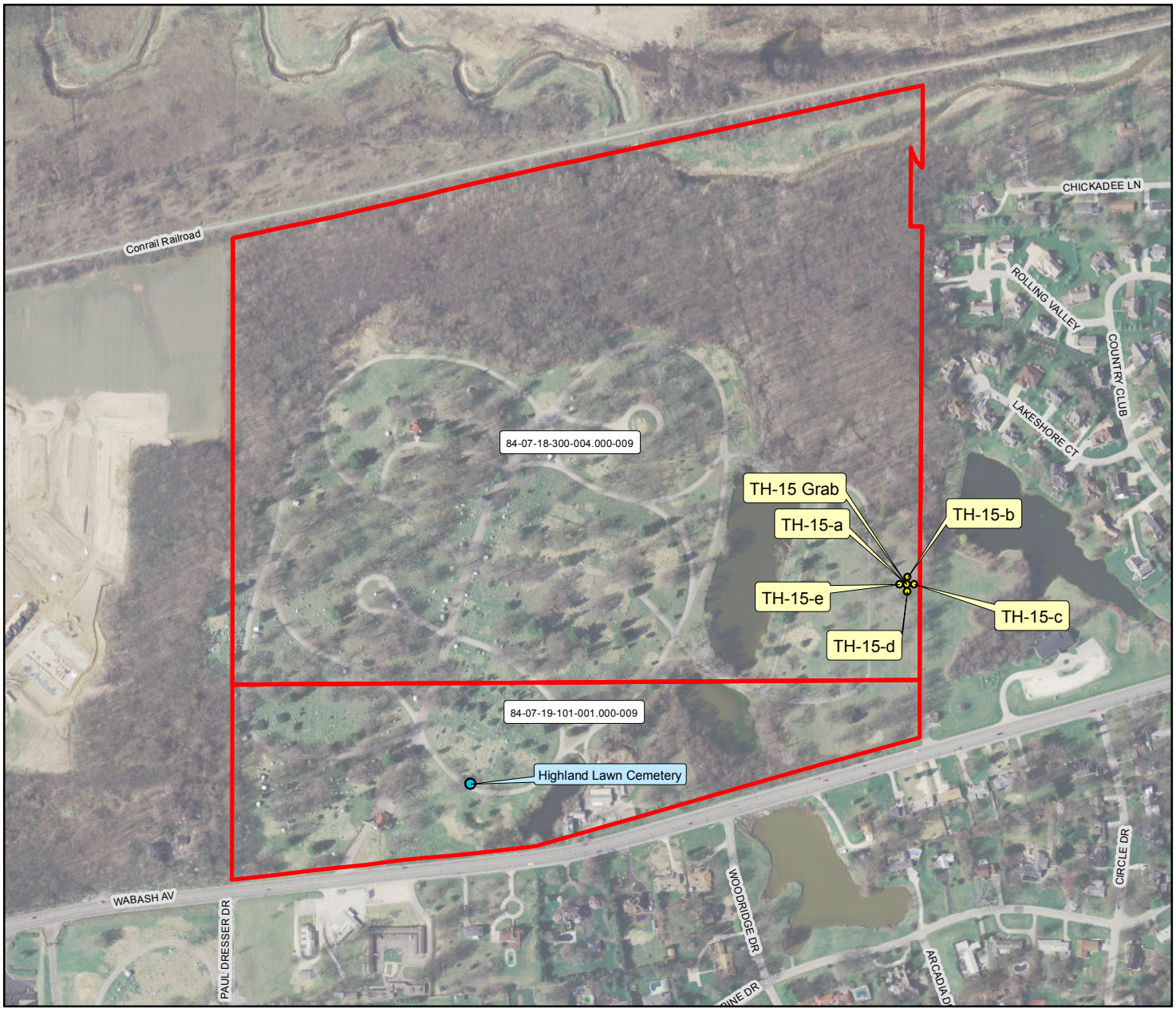
Vigo County



Project Area



Terre Haute - IDEM Background Soil Project - Highland Lawn Cemetery (Map 15)



Mapped By:	Mike Hill, IDEM, Office of Land Quality, Science Services Branch, Engineering & GIS Services, June 17, 2014
Aerial Info:	2005 Statewide Orthophotography Project (1 foot resolution)
Sample Data Info:	TH-15-a & TH-15 Grab locations are typical. All samples not designated as "Grab" are composite sample types.
GPS Info:	GPS data for sample locations collected with a Trimble Geo XH 6000 September 16, 2013 by IDEM personnel.
Source Info:	Terre Haute Parks provided by Terre Haute City Engineer's Office
Location Info:	Terre Haute, Harrison Township, Vigo County, Indiana
Disclaimer:	This map is intended to serve as an aid in graphic representation only. This information is not warranted for accuracy or other purposes.

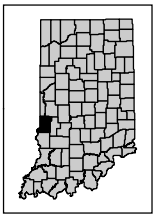
Soil Sample Location
Parcel
Cemetery - USGS

IDEM

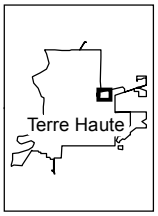
N
W E
S

0 300 600 Feet
0 100 200 Meters

Vigo County



Project Area



Terre Haute - IDEM Background Soil Project - Deming Park (Map 17)

Mapped By:	Mike Hill, IDEM, Office of Land Quality, Science Services Branch, Engineering & GIS Services, June 18, 2014
Aerial Info:	2005 Statewide Orthophotography Project (1 foot resolution)
Sample Data Info:	TH-17 North-a & TH-17 North Grab locations are typical. TH-17 South-a & TH-17 South Grab locations are typical. All samples not designated as "Grab" are composite sample types.
GPS Info:	GPS data for sample locations collected with a Trimble Geo XH 6000 September 16, 2013 by IDEM personnel.
Source Info:	Terre Haute Parks provided by Terre Haute City Engineer's Office
Location Info:	Terre Haute, Harrison Township, Vigo County, Indiana
Disclaimer:	This map is intended to serve as an aid in graphic representation only. This information is not warranted for accuracy or other purposes.

Soil Sample Location

City of Terre Haute Park (Deming Park)

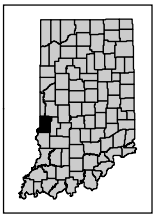
IDEM

N
W E
S

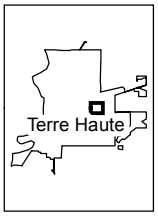
0 300 600 Feet

0 100 200 Meters

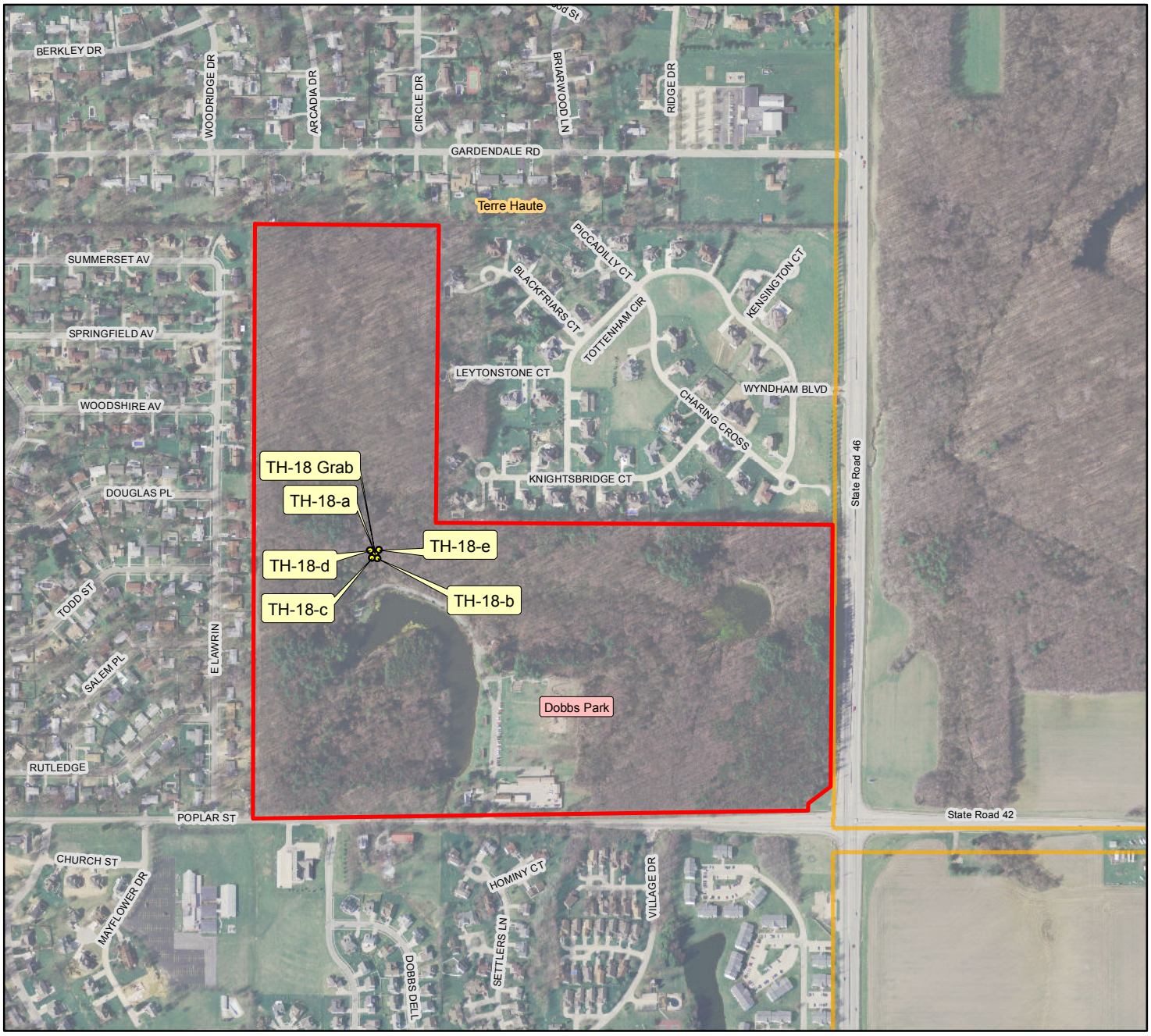
Vigo County



Project Area



Terre Haute - IDEM Background Soil Project - Dobbs Park (Map 18)



Mapped By:	Mike Hill, IDEM, Office of Land Quality, Science Services Branch, Engineering & GIS Services, June 18, 2014
Aerial Info:	2005 Statewide Orthophotography Project (1 foot resolution)
Sample Data Info:	TH-18-a & TH-18 Grab locations are typical. All samples not designated as “Grab” are composite sample types.
GPS Info:	GPS data for sample locations collected with a Trimble Geo XH 6000 September 16, 2013 by IDEM personnel.
Source Info:	Terre Haute Parks provided by Terre Haute City Engineer’s Office
Location Info:	Terre Haute, Harrison Township, Vigo County, Indiana
Disclaimer:	This map is intended to serve as an aid in graphic representation only. This information is not warranted for accuracy or other purposes.

- Soil Sample Location
- City of Terre Haute Park (Dobbs Park)
- Terre Haute Incorporated Line

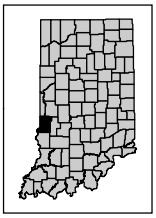
IDEM

N W E S

0 400 800 Feet

0 100 200 Meters

Vigo County



Project Area

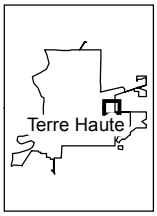


TABLE I

Arsenic and Lead Analysis

Site Name:	Terre Haute Background Soil Sampling
Site Number:	NA
Location:	Terre Haute, Vigo Co. Indiana
Date Sampled:	September 16-18, 2013
Lab:	Microbac

Soil

UNITS: **mg/kg**

Sample #		Type/ID#	Arsenic	Lead	
Lab	IDEM				
13I0994-02	LQ8082	TH-18 a to e, 5 aliquots composited	6.7	20	
13I0994-03	LQ8083	TH-17 south, a,b,c,d,e	3.1	24	
13I0994-06	LQ8089	TH-17 north, a,b,c,d,e, 6" root zone removed	2.8	32	
13I0994-08	LQ8088	TH-15, a,b,c,d,e composited, 6" root zone removed	7.2	22	
13I0994-10	LQ8090	TH-14 a,b,c,d,e composited, 6" root zone removed	5.1	22	** FIELD DUPLICATE
13I0994-12	LQ8092	TH-2, a,,b,c,d,e, 6" root zone removed	8.9	370	
13I0994-14	LQ8094	TH-1, a,b,c,d,e, 6" root zone removed	5.7	27	
13I0994-16	LQ8096	TH-3, a,b,c,d,e, 6" root zone removed	9.9	100	
13I0994-18	LQ8098	TH-4, a,b,c,d,e, 6" root zone removed	5.5	26	
13I0994-20	LQ8100	TH-5, a,b,c,d,e, 6" root zone removed	10	40	
13I0994-22	LQ8124	TH-6, a,b,c,d,e, 6" root zone removed	7.2	73	
13I0994-24	LQ8126	TH-7 a,b,c,d,e, 6" root zone removed	11	140	
13I0994-26	LQ8144	TH-8 South, abcde, 6" root zone removed	7.4	63	
13I0994-27	LQ8140	TH-8 North abcde, 6" root zone removed	8.8	120	
13I0994-31	** LQ8134	TH-12, a,b,c,d,e, 6" root zone removed	13	51	
13I0994-33	** LQ8136	TH-12, a,b,c,d,e, 6" root zone removed	14	55	
13I0994-37	LQ8129	TH-10 a,b,c,d,e, 6" root zone removed	7.5	38	
13I0994-40	LQ8128	TH-9, a,b,c,d,e, 6" root zone removed	6.8	32	
13I0994-41	LQ8131	TH-11 a,b,c,d, 6" root zone removed	5.7	26	

TABLE II

PAHs Analysis

Site Name: Terre Haute Background Soil Sampling
Site Number: NA
Location: Terre Haute, Vigo Co. Indiana
Date Sampled: September 16-18, 2013
Lab: Microbac

Soil

UNITS: **ug/kg**

Sample #		Type/ID#	Benzo (a)	Chrysene	Pyrene	Anthracene	Fluoranthene	Fluorene	Naphthalene	Benzo (k)	Benzo (a)	Benzo (b)	Benzo (g,h,i)	Acenaphthene	Acenaphthylene	Indeno (1,2,3-cd)	Phenanthrene	Dibenzo (a,h)
Lab	IDEM		Anthracene							Fluoranthene	Pyrene	Fluoranthene	Perylene			Pyrene		Anthracene
13I0994-01	LQ8081	TH-18, 9 locations for all PAHs samples	12 J	16 J	15 J	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
13I0994-04	LQ8084	TH-17 south, removing root zone	12 J	15 J	17 J	BDL	16 J	BDL	11 J	BDL	BDL	BDL	BDL	BDL	5.9 J	BDL	BDL	BDL
13I0994-05	LQ8085	TH-17 north, 6" root zone removed	11 J	16 J	14 J	BDL	15 J	BDL	BDL	BDL	8.6 J	13 J	BDL	BDL	BDL	BDL	BDL	BDL
13I0994-07	LQ8087	TH-15, 6" root zone removed	BDL	12 J	15 J	BDL	12 J	BDL	BDL	BDL	12 J	22 J	10 J	BDL	BDL	BDL	BDL	BDL
13I0994-09	LQ8086	TH-14, 6" root zone removed	11 J	20 J	21 J	BDL	27 J	BDL	BDL	BDL	13 J	20 J	13 J	7.0 J	9.5 J	11 J	11 J	BDL
13I0994-11	LQ8091	TH-2, 6" root zone removed	95	120	220	21 J	270	7.1 J	14 J	45 J	100	150	70	12 J	11 J	64	160	18 J
13I0994-13	LQ8093	TH-1, 6" root zone removed	14 J	19 J	22 J	BDL	27 J	BDL	BDL	BDL	19 J	35 J	16 J	BDL	BDL	12 J	11 J	BDL
13I0994-15	LQ8095	TH-3, 6" root zone removed	59 J	86 J	120 J	10 J	170 J	BDL	BDL	41 J	69 J	100 J	61 J	BDL	7 J	50 J	110 J	16 J
13I0994-17	LQ8097	TH-4, 6" root zone removed	BDL	18 J	20 J	BDL	23 J	BDL	BDL	BDL	13 J	27 J	13 J	BDL	BDL	11 J	9 J	BDL
13I0994-19	LQ8099	TH-5, 6" root zone removed	BDL	31 J	42 J	BDL	53 J	BDL	BDL	14 J	29 J	44 J	21 J	BDL	BDL	20 J	36 J	BDL
13I0994-21	LQ8101	TH-6, 6" root zone removed	55 J	72	85	BDL	110	BDL	BDL	38 J	57	90	45 J	BDL	BDL	38 J	58	17 J
13I0994-23	LQ8125	TH-7, 6" root zone removed	78	110	160	13 J	250	BDL	BDL	46 J	95	150	77	BDL	9.8 J	65	86	17 J
13I0994-25	LQ8143	TH-8 South, lots of pebbles & cobbles	36 J	49 J	66	BDL	81	BDL	BDL	25 J	38 J	64	40 J	BDL	BDL	33 J	42 J	14 J
13I0994-28	LQ8141	TH-8, 6" root zone removed	330	420	760	120	950	41 J	14 J	240	380	510	270	20 J	51 J	240	590	56
13I0994-30	** LQ8133	TH-12, 6" root zone removed	60	110	140	14 J	120	BDL	11 J	BDL	66	94	88	BDL	BDL	51 J	120	18 J
13I0994-32	** LQ8135	TH-12, 6" root zone removed	42 J	70	97	BDL	89	BDL	9.5 J	32 J	45 J	84	54	BDL	BDL	41 J	84	13 J
13I0994-38	LQ8130	TH-10, 6" root zone removed	100	140	180	19 J	240	BDL	18 J	78	110	200	85	BDL	44 J	86	150	24 J
13I0994-39	LQ8127	TH-9, 6" root zone remvoed	23 J	38 J	45 J	BDL	60	BDL	BDL	10 J	30 J	58	25 J	BDL	BDL	23 J	29 J	BDL
13I0994-42	LQ8132	TH-11, 6" root zone removed	22 J	29 J	30 J	BDL	38 J	BDL	BDL	11 J	19 J	38 J	22 J	BDL	BDL	16 J	27 J	BDL

BDL- Below Detection Limit

** FIELD DUPLICATE

J = Analyte concentration detected between reporting limit and method detection limit

Matrix Spike/Matrix Spike Duplicate (MS/MSD) was not performed on a site-specific sample for PAHs. Therefore, the matrix interference cannot be assessed and the results for PAHs are estimated.

The details of data validation can be found in the Chemistry Services Section Memorandum entitled: "Anaytical Results for Terre Haute Background Soil Sampling", November 1, 2013 (VFC # 69143911).

TABLE III

Background Arsenic and Lead Surface Soil Levels

Terre Haute, Indiana

		Concentrations		Statistical Information			
		Arsenic	Lead	Arsenic		Lead	
Sample Locations	LAB ID #	mg/kg	mg/kg		mg/kg		mg/kg
Dobbs Park	2	6.7	20	Min.	2.8	Min.	20
Deming Park - South	3	3.1	24				
Deming Park - North	6	2.8	32	Max.	14	Max.	370
Highland Lawn Cemetery	8	7.2	22				
Sheridan Park	10	5.1	22	Average:	7.4	Average:	68
Coy Park	12	8.9	370				
Collet Park	14	5.7	27	Median:	7.2	Median:	35
Memorial Park	16	9.9	100				
Woodlawn Cemetery	18	5.5	26	Geomean:	6.9	Geomean:	46
Spencer F Ball Park	20	10	40				
Herz Rose Park	22	7.2	73	Variance:	7.2	Variance:	6962
Curtis Gilbert Park	24	11	140				
Fairbanks Park - South	26	7.4	63	St. Dev.	2.7	St. Dev.	83
Fairbanks Park - North	27	8.8	120				
Voorhees Park	31/33 (Dup.)	13.5	53				
Washington Park	37	7.5	38				
Thompson Park	40	6.8	32				
Brittlebank Park	41	5.7	26