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Ms. Jennifer Tufts
U.S. Environmental Protection Agency, Region 4
Federal Facilities Branch
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PPPO-02-264-10

Mr. Edward Winner, FFA Manager
Kentucky Department for Environmental Protection
Division of Waste Management
200 Fair Oaks Lane, 2nd Floor
Frankfort, Kentucky 40601

Dear Ms. Tufts and Mr. Winner:

TRANSMITTAL OF THE SITE EVALUATION REPORT FOR ADDENDUM 2 SOIL PILES AT THE PADUCAH GASEOUS DIFFUSION PLANT, PADUCAH, KENTUCKY (DOE/LX/07-0188&D2/R1)

Please find enclosed the certified D2/R1 *Site Evaluation Report for Addendum 2 Soil Piles at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/LX/07-0188&D2/R1, for your review. Also enclosed is a red-lined version of the document and a summary table in response to comments received from the Kentucky Department for Environmental Protection and U.S. Environmental Protection Agency.

If you have any questions or require additional information, please contact Rob Seifert at (270) 441-6823.

Sincerely,

Reinhard Knerr
Paducah Site Lead
Portsmouth/Paducah Project Office

Enclosures:
1. Certification Page
2. D2/R1 SER for Addendum 2 Soil Piles
3. Comment Response Summary
4. Red-lined SER for Addendum 2 Soil Piles

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CERTIFICATION

Document Identification: ***Site Evaluation Report for Addendum 2 Soil Piles at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,*** **DOE/LX/07-0188&D2/R1**

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons directly responsible for gathering the information, the information submitted is to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Paducah Remediation Services, LLC

C Paul Deltite — 1/15/2010

Dennis Ferrigno, PM, Site Manager — Date Signed

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons directly responsible for gathering the information, the information submitted is to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

U.S. Department of Energy (DOE)

1/15/10

Reinhard Knerr, Paducah Site Lead — Date Signed

DOE/LX/07-0188&D2/R1
Primary Document

Site Evaluation Report for Addendum 2 Soil Piles at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

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Primary Document

Site Evaluation Report for Addendum 2 Soil Piles at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

Date Issued—January 2010

Prepared for the
U.S. DEPARTMENT OF ENERGY
Office of Environmental Management

Prepared by
PADUCAH REMEDIATION SERVICES, LLC
managing the
Environmental Remediation Activities at the
Paducah Gaseous Diffusion Plant
under contract DE-AC30-06EW05001

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PREFACE

This *Site Evaluation Report for Addendum 2 Soil Piles at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/LX/07-0188&D2/R1, (SER) was prepared as a result of implementing the *Sampling and Analysis Plan for Soil Piles at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-0015&D2/R1, (DOE 2007a) and associated *Addendum 2 to the Sampling and Analysis Plan at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/LX/07-0015/A2&D2.

This SER is the second of four to address soil and rubble pile areas in the vicinity of the Paducah Gaseous Diffusion Plant, as identified in the Notification Letter submitted to U.S. Environmental Protection Agency and Kentucky Department for Environmental Protection, dated February 16, 2007 (DOE 2007b). This SER addresses soil sampling at soil piles located west of the Paducah Gaseous Diffusion Plant along Bayou Creek. It was developed in accordance with the requirement in Section IX of the Federal Facility Agreement for submittal of an integrated removal/remedial Site Evaluation and Solid Waste Management Unit Assessment Report.

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ACRONYMS

AL	action level
AOC	area of concern
ASER	Annual Site Environmental Report
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
COPC	chemical of potential concern
CSM	conceptual site model
DOE	U.S. Department of Energy
DQO	data quality objective
EPA	U.S. Environmental Protection Agency
FFA	Federal Facility Agreement
ISOCS	*In Situ* Object Counting System
KEEC	Kentucky Energy and Environment Cabinet
KPDES	Kentucky Pollutant Discharge Elimination System
MDL	method detection limit
MS	matrix spike
MSD	matrix spike duplicate
NA	not applicable
NAL	no action level
NCP	National Contingency Plan
NIST	National Institute of Standards and Technology
ORPS	Occurrence Reporting and Processing System
PAH	polyaromatic hydrocarbon
PCB	polychlorinated biphenyl
PGDP	Paducah Gaseous Diffusion Plant
PSS	plant shift superintendent
QC	quality control
RCRA	Resource Conservation and Recovery Act
RGA	Regional Gravel Aquifer
RPD	relative percent difference
SAP	Sampling and Analysis Plan
SER	Site Evaluation Report
SRM	standard reference material
SWMU	solid waste management unit
SWOU	Surface Water Operable Unit
TCE	trichloroethene
VOC	volatile organic compound
WKWMA	West Kentucky Wildlife Management Area
XRF	X-ray fluorescence

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EXECUTIVE SUMMARY

This Site Evaluation Report (SER) presents the results of the comprehensive sampling effort completed for Addendum 2 Soil Piles along Bayou Creek. Sampling and analysis were completed in accordance with the following agency-approved secondary documents:

- *Sampling and Analysis Plan for Soil Piles at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-0015&D2/R1, (SAP) 2007; and

- *Addendum 2 to the Sampling and Analysis Plan at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-0015/A2/&D2, 2008.

In December 2006, soil sampling was completed at Addendum 2 Soil Piles 14 and 15, which are located off U.S. Department of Energy (DOE) property, to assess further site conditions. The sampling effort indicated results below action levels and at or near background levels for radionuclides, metals, and polychlorinated biphenyls (PCBs). Addendum 2 Soil Piles, distributed across approximately 88 acres, represents over one-half of the total number of soil piles identified in the February 2007 notification letter. The 54 piles that comprise the Addendum 2 soil piles are located along Bayou Creek west of the Paducah Gaseous Diffusion Plant (PGDP) vary in size and shape, ranging from approximately 3 to 450 ft in length and from 2 to 8 ft in height. The field investigation was conducted between August and September 2008.

PROJECT OBJECTIVES

The study was designed to obtain sufficient data of known quality to support the following objectives:

- Establish the nature and extent of contamination of soils in Addendum 2 Soil Piles and adjacent soils.
- Establish the mean concentrations of contaminants in soils.
- Determine if soils pose imminent risks to human health.
- Determine if soils contamination exceeds regulatory thresholds.

INVESTIGATION SUMMARY

The following provides the planned sampling activities for Addendum 2 Soil Piles and an accounting of the actual number and types of samples collected. Addendum 2 to the PGDP Soil Piles SAP specified the collection and analysis of these samples:

- Fifty-four surface samples (24 small piles, 30 large piles) to undergo field measurements and fixed laboratory analysis

- One hundred seven surface samples (24 small pile locations, 83 large pile locations) to undergo field measurements only

- Sixty subsurface samples (25 small pile locations, 35 large pile locations), where subsurface is defined as soil taken at a depth below 1 ft, to undergo field measurements and fixed laboratory analysis

- Two hundred ten subsurface samples (31 small pile locations, 179 large pile locations) to undergo field measurements only
- A number of contingency samples (no more than 40), if contamination was identified

During execution of Addendum 2, the total number of soil samples collected was as follows:

- Fifty-four surface samples underwent field measurements and fixed laboratory analysis
- Fifty-five surface samples underwent field measurements only
- Fifty-six subsurface samples underwent field measurements and fixed laboratory analysis
- One hundred eleven subsurface samples underwent field measurements only
- No contingency samples were collected

The differences between planned and actual sample numbers resulted from three factors.

First, the observed differences in subsurface samples result entirely from variations in soil pile height. Because the soil pile height, on average, was less than 5 ft, a fewer number of samples than that estimated in the Addendum 2 to the SAP were required to reach the natural grade.

Second, many of the large soil piles were smaller than planned in the Addendum 2 SAP, resulting in less area to be sampled.

Third, the concentration of analytes (i.e., chemicals of potential concern) in samples was at or near background or less than the screening criteria in the Addendum 2 SAP; therefore, no contingency samples were required.

INVESTIGATION FINDINGS

Sample results indicate no PCBs detected. Generally, metals results were statistically the same as background, based upon the results being below the 95th percentile of the generic statewide ambient background values (with the mean of the results being below the 95 upper confidence limit of the mean generic statewide ambient background and at least half of the results less than the 60th percentile). Polyaromatic hydrocarbons (PAHs) were detected (benzoanthracene, pyrene, anthracene, chrysene, and fluoranthene between 0.72 and 2.1 ppm) in two samples collected from the 54 Addendum 2 soil piles. The PAHs detected are considered outliers and not indicative of contamination. Cesium-137 and plutonium-239/240 radionuclides were detected at or near background and are considered the result of fallout. Cesium-137 was detected in several piles; however, most are located upstream of PGDP. As a result, these chemicals are not considered site-related contaminants.

SUMMARY OF INVESTIGATION CONCLUSIONS

Nature and Extent of Contamination

Data of known quality were acquired in sufficient quantities to allow decision makers to formulate an informed decision as to the need for an action at any of the Addendum 2 Soil Piles, if warranted. Samples were collected from 54 soil piles and, as noted, was less than or similar to background. No documentation was found as a result of the historical document review to demonstrate the presence of wastes. Accordingly, the available information indicates that the piles do not meet the regulatory definition of a solid waste management unit (SWMU) or area of concern (AOC). As defined in the Federal Facility Agreement, a SWMU "means any discernible unit at which solid wastes have been placed at any time, irrespective of whether the unit was intended for the management of solid or hazardous waste. Such units include any area at a facility at which routine and systematic releases of hazardous wastes or hazardous constituents has occurred." AOCs "shall include any area having a probable or known release of a hazardous waste, hazardous constituent or hazardous substance which is not from a solid waste management unit and which poses a current or potential threat to human health or the environment."

It should be noted that the February 16, 2007, notification letter indicated that 102 of the 122 soil and rubble areas (including Addendum 2 54 soil piles) are being designated as a SWMU and/or AOC (DOE 2007b). It also states that DOE will be "evaluating whether the areas are SWMUs or AOCs.…" The Addendum 2 SER is the second of four SERs being provided as part of the evaluation and, as stated and detailed within the document, provides documentation to support the conclusion that Addendum 2 piles do not meet the definition of a SWMU or AOC.

Assessment of Human Health Risks

The results of the background screening for metals indicate concentrations used to quantify risks and hazards were at or near background levels for all 54 soil piles. No PCBs were detected. For uranium, the fixed-base laboratory concentrations are below the individual recreational user screening level for a 1 mrem/year dose and, therefore, below the "walk away" level in the PGDP Risk Methods Document.

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1. INTRODUCTION

This Site Evaluation Report (SER) has been developed in accordance with the requirement in Section IX of the Paducah Gaseous Diffusion Plant (PGDP) Federal Facility Agreement (FFA) for the submittal of an integrated removal/remedial SER/Solid Waste Management Unit (SWMU) Assessment Report. The report is organized as follows:

- Project Scope, Objectives, and Background
- Area Description
- Field and Analytical Methods
- Quality Assurance/Quality Control (QC)
- Discussion and Results
- Data Screening
- Conclusions
- Recommendations

1.1 PROJECT SCOPE

During November, 2006, soil piles were discovered by the U.S. Department of Energy (DOE) and the Commonwealth of Kentucky along Bayou and Little Bayou Creek, outside of the PGDP industrialized area. Initial field radiation surveys of some Little Bayou Creek soil piles indicated elevated levels of radioactivity. However, surveys of piles along Bayou Creek, west of PGDP did not indicate levels of radioactivity above background. Based on these initial field results, DOE planned to determine if any of the piles posed an immediate threat to human health or public safety. A sampling plan to evaluate Addendum 2 Soil Piles was developed and approved by the regulatory agencies. The provisions for this program are contained in two DOE secondary documents:

- *Sampling and Analysis Plan for the Soil Piles at Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-0015&D2/R1, (SAP) 2007; and

- *Addendum 2 to the Sampling and Analysis Plan at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-0015/A2/&D2, 2008.

Addendum 2 field work was implemented at the soil piles between August and September 2008. This SER presents the results of that effort and includes the data generated from field activities, an evaluation of project data quality and usability, assessment of the potential risks to human health, and conclusions. See Figure 1 for Addendum 2 Soil Pile locations along Bayou Creek.

As noted in both the SAP and Addendum 2, the focus of the investigation was to evaluate conditions in the soil piles along Bayou Creek and adjacent soils. The scope of the project was to examine conditions, evaluate potential human health risks, and compare soil pile contaminant concentrations [to background and action levels (ALs)] to support future decisions.

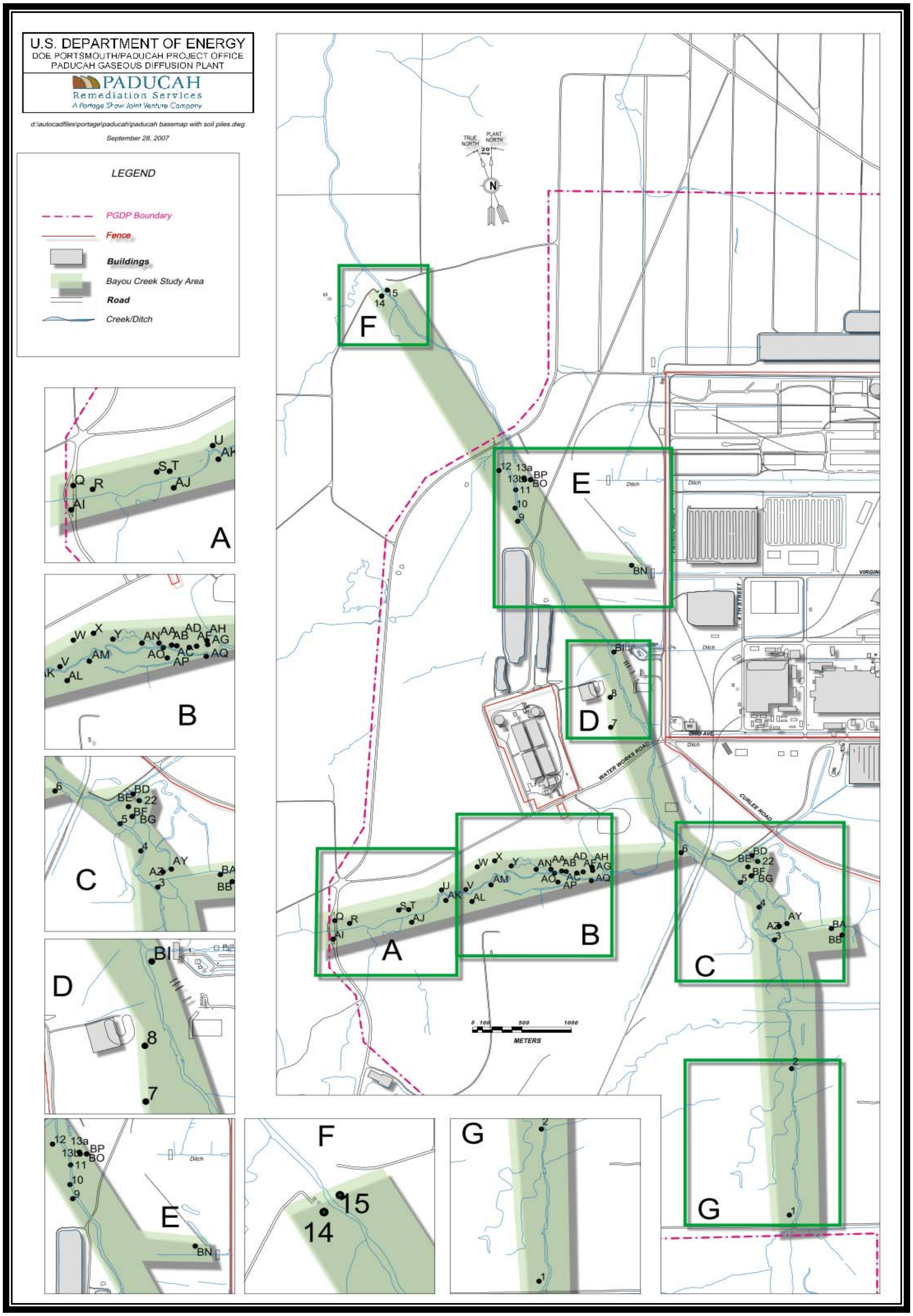

Figure 1. Addendum 2 Soil Piles

1.2 PROJECT OBJECTIVES

The principal study objective of the Addendum 2 Soil Piles sampling effort was to determine if contamination is present and, if so, determine the nature and extent of soil contamination in soil piles and adjoining soils. The data quality objectives (DQOs) include the following:

- Establish the nature and extent of contamination in Addendum 2 Soil Piles and adjacent soils.
- Establish the mean concentrations of contaminants in soils.
- Determine if soils pose imminent risks to human health.
- Determine if soils contamination exceeds regulatory thresholds.

1.3 REGULATORY OVERVIEW

PGDP was placed on the National Priorities List on May 31, 1994. In accordance with Section 120 of Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), DOE entered into an FFA with the U.S. Environmental Protection Agency (EPA) Region 4 and Kentucky. The FFA established one set of consistent requirements for achieving comprehensive site remediation in accordance with CERCLA and Resource Conservation and Recovery Act (RCRA), including stakeholder involvement.

The DOE Portsmouth/Paducah Project Office is responsible for environmental management activities associated with PGDP (CERCLIS# KY8-890-008-982) and serves as the lead agency for response actions at PGDP. EPA Region 4 and Kentucky Department for Environmental Protection serve as the regulatory oversight agencies for the facility.

Addendum 2 Soil Piles are identified in the notification letter dated February 16, 2007.

1.4 PROJECT BACKGROUND

Following the November 2, 2006, discovery and notifications to the regulators of contamination found in a soil pile located along Little Bayou Creek, field efforts were initiated to identify other piles. Once a pile was identified, the initial effort included a preliminary radiological survey of soil piles and adjoining soils. Initial reconnaissance and subsequent surveys noted no elevated radioactivity in Addendum 2 soil piles.

In December 2006, soil sampling was completed at Addendum 2 Soil Piles 14 and 15 (Figure 1), which are located off DOE property, to further assess site conditions. The results of this sampling effort indicated levels below detection or at background for radionuclides, metals, and polychlorinated biphenyls (PCBs).

A complete gamma walkover survey was performed for Addendum 2 Soil Piles during 2008. The results of this survey confirmed those of the initial survey and found no elevated radioactivity for any of the 54 Addendum 2 Soil Piles along Bayou Creek.

Historical research was performed to attempt to determine the origin of the piles and in response to EPA's previous request for soil and rubble area information pursuant to RCRA 3007 (2007). The origin of the Addendum 2 Soil Piles remains unknown; however, available information (employee interviews) indicates that many of the PGDP-related soil piles may have originated from excavations associated with the creation, periodic dredging, and cleanout of the outfalls, ditches, and creeks that comprise the PGDP surface water management system. The Addendum 2 Soil Piles are not operational.

2. AREA DESCRIPTION

2.1 ADDENDUM 2 SOIL PILES

Field reconnaissance of Addendum 2 Soil Piles identified 54 piles along Bayou Creek. The majority of the soil piles are located west of PGDP industrialized area and are on DOE-owned property. Two soil piles, 14 and 15, are located on West Kentucky Wildlife Management Area (WKWMA) property just off DOE property, on the banks of Bayou Creek, west of PGDP. The soil piles are distributed across approximately 88 acres and generally are bounded by PGDP industrialized area to the east, the WKWMA/DOE boundary to the west, and the DOE boundary to the north and south. See Figure 1 in Section 1 for a map of the piles.

The Addendum 2 Soil Piles vary in size and shape, ranging from approximately 3 to 450 ft in length and from 2 to 8 ft in height. The soil piles are widely dispersed and often occur as clusters. Vegetative re-growth on and adjacent to the piles is very dense, indicating the soil piles have been in their present locations for years. Improvements that may have supported the creation of soil piles (e.g., road improvements) are not visible along the Addendum 2 Soil Piles.

2.2 GEOLOGY AND SOILS

The PGDP and Addendum 2 Soil Piles are located in the Jackson Purchase Region of Western Kentucky, which represents the northern tip of the Mississippi Embayment portion of the Coastal Plain. The Jackson Purchase Region is an area of land that includes all of Kentucky west of the Tennessee River. The stratigraphic sequence in the region consists of Cretaceous, Tertiary, and Quaternary sediments unconformably overlying Paleozoic bedrock.

Relative to the shallow groundwater flow system in the vicinity of the PGDP, the continental deposits and the overlying loess and alluvium are of key importance. The continental deposits locally consist of an upper silt member, with lesser sand and gravel interbeds, and a thick, basal sand and gravel member, which fills a buried river valley. A subcrop of the Porters Creek Clay, located beneath and immediately south of the PGDP marks the south extent of the buried river valley. Fine sand and clay of the McNairy Formation directly underlie the continental deposits. These continental deposits are continuous from beneath PGDP to beyond the present course of the Ohio River.

The general soil map for Ballard and McCracken counties indicates that three soil associations are found within the vicinity of the PGDP (USDA 1976): the Rosebloom-Wheeling-Dubbs association, the Grenada-Calloway association, and the Calloway-Henry association. The predominant soil association in the vicinity of the PGDP is the Calloway-Henry association, which consists of nearly level, somewhat poorly drained, medium-textured soils on upland positions.

Although the soil over most of the PGDP may be Henry silt loam with a transition to Calloway, Falaya-Collins, and Vicksburg away from the site, many of the characteristics of the original soil have been lost due to industrial activity that has occurred over the past 50+ years. Activities that have disrupted the original soil classifications include filling, mixing, and grading.

2.3 HYDROGEOLOGY

PGDP and Addendum 2 Soil Piles are located in the western portion of the Ohio River drainage basin, approximately 15 miles downstream of the confluence of the Ohio River with the Tennessee River and approximately 35 miles upstream of the confluence of the Ohio River with the Mississippi River. Locally, the PGDP is within the drainage areas of the Ohio River, Bayou Creek, and Little Bayou Creek.

The PGDP is situated on the divide between the two creeks. Surface flow is east-northeast toward Little Bayou Creek and west-northwest toward Bayou Creek. Bayou Creek is a perennial stream on the western boundary of the plant that flows generally northward, from approximately 2.5 miles south of the plant site to the Ohio River. Little Bayou Creek becomes a perennial stream at the east outfalls of PGDP. The Little Bayou Creek drainage originates within WKWMA and extends northward and joins Bayou Creek near the Ohio River. The drainage basins for both creeks are located in rural areas; however, they receive surface drainage from numerous swales that drain residential and commercial properties, including WKWMA, PGDP, and Tennessee Valley Authority Shawnee Steam Plant. The confluence of the two creeks is approximately 4.8 km (3 miles) north of the plant site, just upstream of the location at which the combined flow of the creeks discharges into the Ohio River (DOE 2006a).

Most of the flow within Bayou and Little Bayou Creeks is from process effluents or surface water runoff from the PGDP. Contributions from PGDP comprise approximately 85% of flow within Bayou Creek and near 100% of flow within Little Bayou Creek. A network of ditches discharges effluent and surface water runoff from PGDP to the creeks. Plant discharges are monitored at the Kentucky Pollutant Discharge Elimination System (KPDES) outfalls prior to discharge into the creeks.

The local groundwater flow system at the PGDP site occurs within the sands of the Cretaceous McNairy Formation, Pliocene Terrace Gravel, Plio-Pleistocene lower continental gravel deposits and upper continental deposits, and Holocene alluvium. The primary local aquifer is the Regional Gravel Aquifer (RGA). The RGA consists of the Quaternary sand and gravel facies of the lower continental deposits and Holocene alluvium found adjacent to the Ohio River and is of sufficient thickness and saturation to constitute an aquifer. These deposits have an average thickness of 9.1 m (30 ft), and range up to 15.24 m (50 ft) along an axis that trends east–west through the plant site. Groundwater flow is predominantly north toward the Ohio River (DOE 2006a).

2.4 POTENTIAL SOURCES OF CONTAMINATION

The following provides an evaluation of potential transport mechanisms for contaminants found at PGDP. Figure 2 provides an overview of the PGDP industrial complex and the associated surface water management system.

2.4.1 Contaminant Transport Mechanisms

Transport mechanisms likely include both dissolved constituents and sediment in storm water runoff.

The PGDP surface water management system discharges to Bayou Creek through several outfalls.

Figure 2 illustrates where outfalls discharge relative to PGDP. An investigation was conducted for on-site areas for the Surface Water Operable Unit (SWOU). Transport modeling of contaminated sediment found

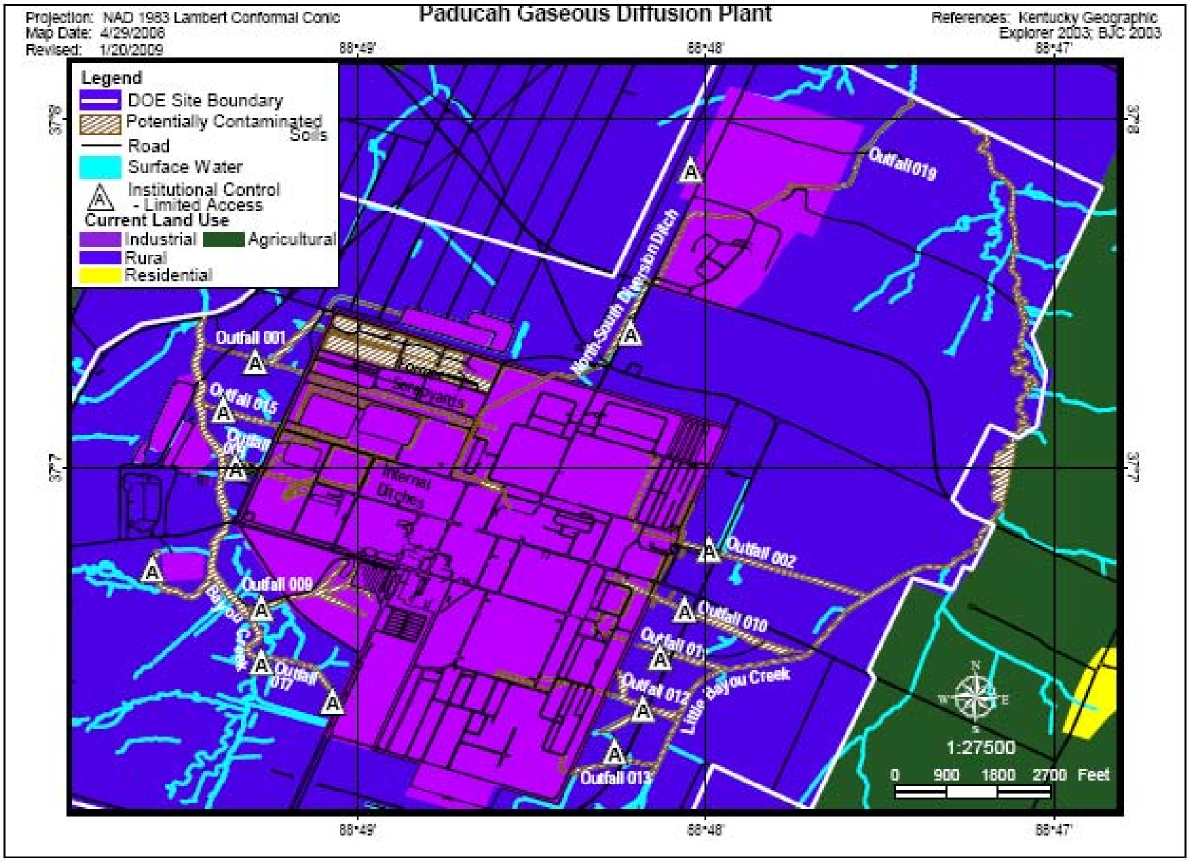

Figure 2. PGDP Outfall Locations

in Outfalls 001, 008, and 015 completed as part of the SWOU on-site investigation concluded that migration through surface water would not result in unacceptable risk to recreational users of Bayou Creek. Ongoing monitoring supports this conclusion.

2.4.2 Documented Releases/Spills

Possible contaminant sources to Bayou Creek may include releases resulting from surface water runoff, originating at spill or release sites inside the PGDP industrial complex, prior to their remediation. These include releases documented in the following reports or logs:

- Occurrence Reporting and Processing System (ORPS) spanning from approximately 1990 to the present,
- Plant shift superintendent (PSS) logs spanning from 1984 through 1990, and
- Annual Site Environmental Reports (ASERs) from 1984 through 2006.

The 3007 information request, occurrence reports and document summary forms from the PSS logs provide a description of the spills and releases and contain pertinent information such as the date and time of release, known or suspected contaminants, estimated quantities of material(s) released, and a description of the actions taken.

The types of chemicals involved in historical spills and releases contained in the ORPS include PCBs, recirculated cooling water containing chromium, chilled chromated water, landfill leachate, gasoline and diesel fuel, and various oils. The types of spills and releases documented in the PSS logs include PCBs, recirculated cooling water, trichloroethene (TCE), sanitary waste water, chromated water, paint pigment, gasoline, diesel, miscellaneous oil, uranium, technetium-99, and observed oil sheens in the outfall discharges. Spills and releases reported in the ASERs include recirculated cooling water, chilled water, TCE, battery acid, transformer oil, diesel fuel, soda ash, and landfill leachate.

2.5 SUMMARY OF RECENT ENVIRONMENTAL MONITORING RESULTS

Bayou Creek is subject to routine environmental monitoring under DOE Order 450.1 (previously DOE Order 5400.1). The KPDES Permit and DOE Orders identify the monitoring and discharge limits for surface water. Monitoring data indicate there have been no recent (2000 to present) releases that could result in unacceptable risk to human health and the environment through the PGDP surface water drainage system and that surface water and sediment transport presently are not acting as a source of contamination to Bayou Creek.

3. FIELD AND ANALYTICAL METHODS

3.1 ADDENDUM 2 SOIL PILES SAMPLING APPROACH

The Addendum 2 Soil Piles sampling approach was designed to accomplish the project objectives. This approach is detailed in the DOE-, EPA-, and Commonwealth of Kentucky-approved SAP and Addendum 2. A summary of the sampling approach and other field activities is provided in the following sections.

3.1.1 Systematic Sampling

The Addendum 2 Soil Piles were divided into two groups: small and large. Soil piles whose length and width are less than or equal to 30 ft were classified as small; soil piles whose length or width are greater than 30 ft were classified as large. A systematic sampling approach was implemented for small soil piles, and a systematic random sampling approach was implemented for large soil piles. These approaches were designed to ensure sampling results were sufficient to determine the concentration and distribution of constituents throughout the study area.

Each small soil pile was sampled at a single location from the tallest portion of the pile. Each large pile was sampled using a grid with 50-ft spacing. For both small and large piles, surface samples were collected from 0-1 ft followed by subsurface samples collected vertically at 3-ft intervals, starting at the 1 ft level (1–4, 4–7, if required) and extending down to the interface with natural grade.

For all piles, all samples underwent field analyses, and a minimum of one surface, and one subsurface sample per pile was sent to the fixed laboratory analyses. Additionally, if more than 10 samples were collected from a pile, then, at a minimum, 10% of the samples underwent fixed-base laboratory analyses. The samples undergoing fixed-base laboratory analyses subject to this 10% rule were randomly selected from all samples collected.

Field methods included Resource Conservation and Recovery Act metals and uranium analysis by *ex situ* X-ray fluorescence (XRF), *ex situ* radioactivity measurements using *In Situ* Object Counting System (ISOCS), PCBs using immunoassay/colorimetric test kits, and a demonstration of polynuclear aromatic hydrocarbons (PAHs) test kits, which also employ immunoassay/colorimetric techniques.[1] The analyte list for fixed-base laboratory analyses includes the metals and radionuclides on the list of significant chemicals of potential concern (COPCs) in the PGDP Risk Methods Document (DOE 2001), PCBs, and PAHs.[2,3]

3.1.2 Contingency Sampling

The Addendum 2 Soil Piles sampling approach also included provisions for contingency sampling (up to 40 samples) to allow for the collection of data for unexpected field conditions or to augment project data based on field method results. Based upon the field data results, contingency samples were not collected. In addition, no unexpected field conditions were encountered.

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[1] Field PAH analyses were completed on only those samples submitted for fixed laboratory analyses to determine their efficacy for deployment at PGDP on future projects.

[2] PAHs were analyzed in samples sent to the fixed-base laboratory to allow comparison with results from field test kits. The results of the PAH analyses will be used to support the use of field methods in future PGDP projects.

[3] VOCs are not included in the analyte list for the fixed-base laboratory because VOCs were not detected in Soil Pile I samples at concentrations above no action risk-based screening values. Additionally, neither trichloroethene nor trichloroethane was detected in samples collected at Soil Pile I.

3.1.3 Sampling Summary and Deviations from the SAP

The following provides the planned sampling activities for Addendum 2 Soil Piles and an accounting of the actual number and types of samples collected. Addendum 2 to the PGDP Soil Piles SAP specified the collection and analysis of these samples:

- Fifty-four surface samples (24 small piles, 30 large piles) to undergo field measurements and fixed laboratory analysis
- One hundred seven surface samples (24 small pile locations, 83 large pile locations) to undergo field measurements only
- Sixty subsurface samples (25 small pile locations, 35 large pile locations), where subsurface is defined as soil taken at a depth below 1 ft, to undergo field measurements and fixed laboratory analysis
- Two hundred ten subsurface samples (31 small pile locations, 179 large pile locations) to undergo field measurements only
- A number of contingency samples (no more than 40), if contamination was identified

During execution of Addendum 2, the total number of soil samples collected was as follows:

- Fifty-four surface samples underwent field measurements and fixed laboratory analysis
- Fifty-five surface samples underwent field measurements only
- Fifty-six subsurface samples underwent field measurements and fixed laboratory analysis
- One hundred eleven subsurface samples underwent field measurements only
- No contingency samples were collected

Sample locations are shown in Figure 3.

The differences between planned and actual sample numbers resulted from three factors.

First, the observed differences in subsurface samples result entirely from variations in soil pile height. Because the soil pile height, on average, was less than 5 ft, a fewer number of samples than that estimated in the Addendum 2 to the SAP were required to reach the natural grade.

Second, many of the large soil piles were smaller than planned in the Addendum 2 SAP, resulting in less area to be sampled.

Third, the concentration of analytes (i.e., COPCs) in samples was less than the screening criteria in the Addendum 2 SAP; therefore, no contingency samples were required.

Additional deviations from the SAP Addendum 2 include one less fixed laboratory field blank and one less fixed laboratory equipment rinseate were collected (only one of each was collected compared to the requirement of 2 each as noted in the SAP Addendum). This was an inadvertent oversight by the field crew. There is minimal impact to the data assessment as these samples were collected to identify cross-contamination that could be introduced between samples. Because contamination was not found, there was no impact to collecting fewer QC samples. Also, 36 of the 110 PAH test kit sample analyses exceeded their holding times due to reagent solutions from the manufacturer not received within the 14-day time frame after sample collection. The order was placed early during project implementation; however, the manufacturer backlogged the order. PAH fixed-base laboratory analyses for the 110 samples

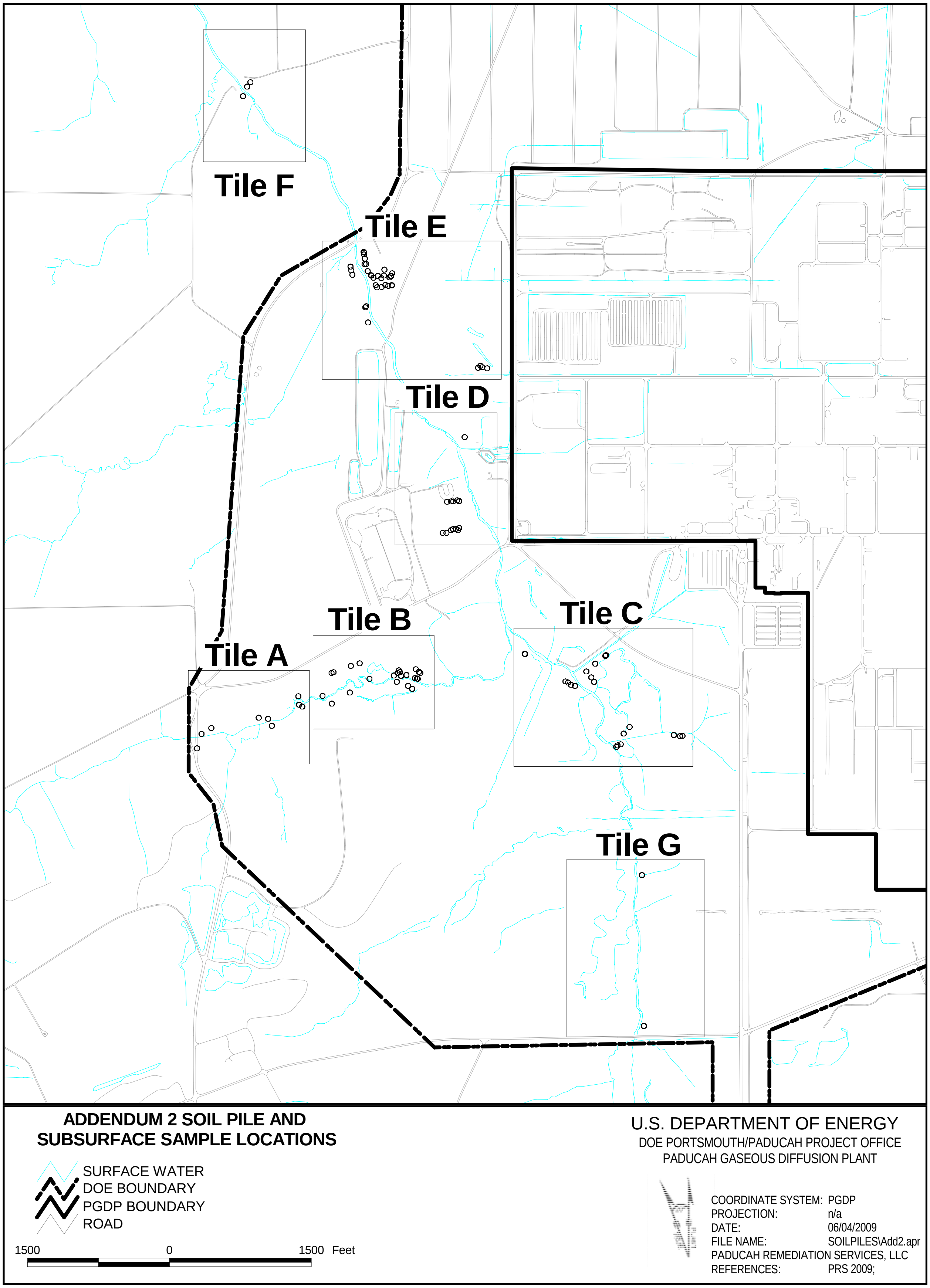


Figure 3. Addendum 2 Sampling Locations

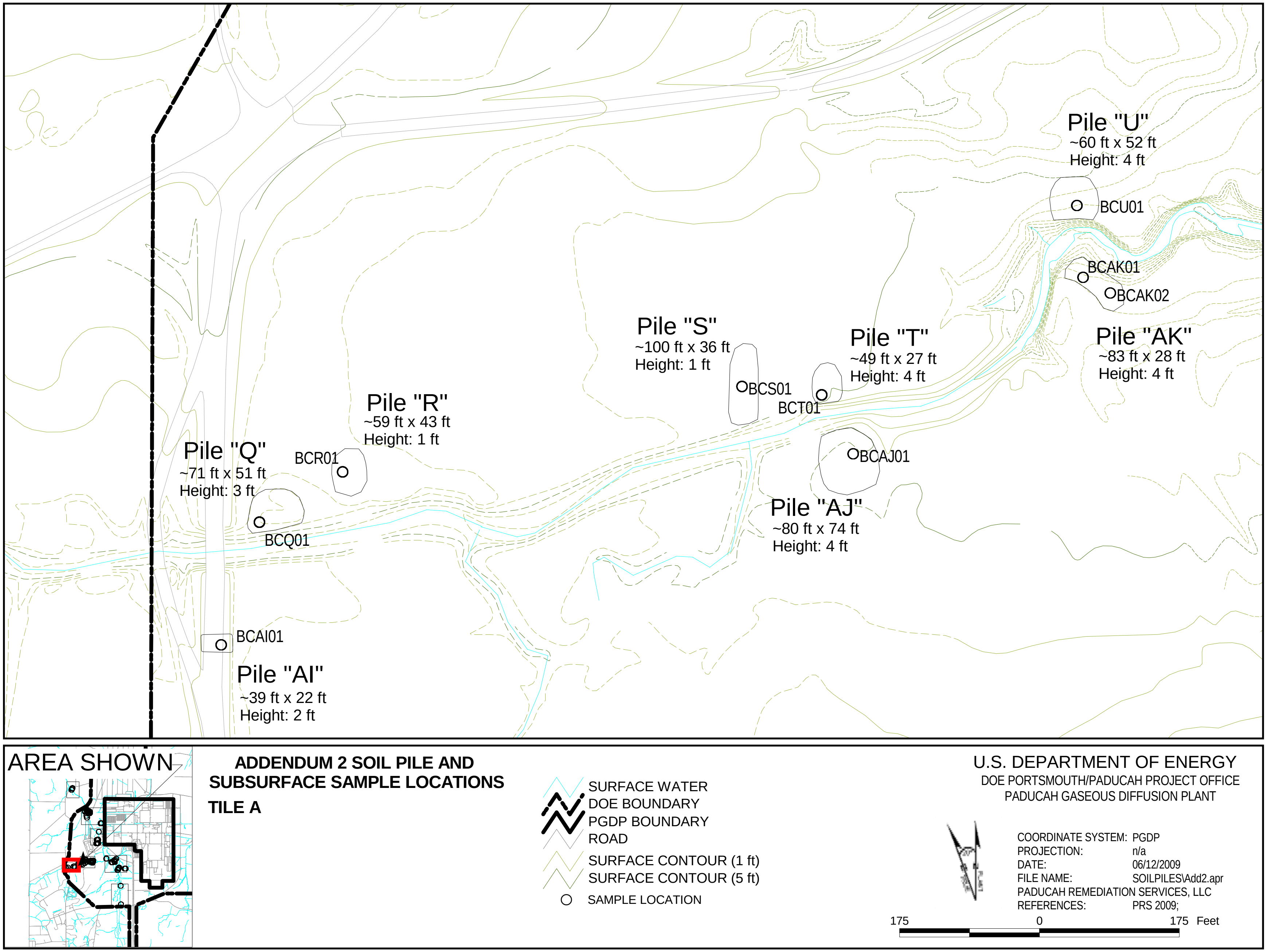


Figure 3. Addendum 2 Sampling Locations (Continued)

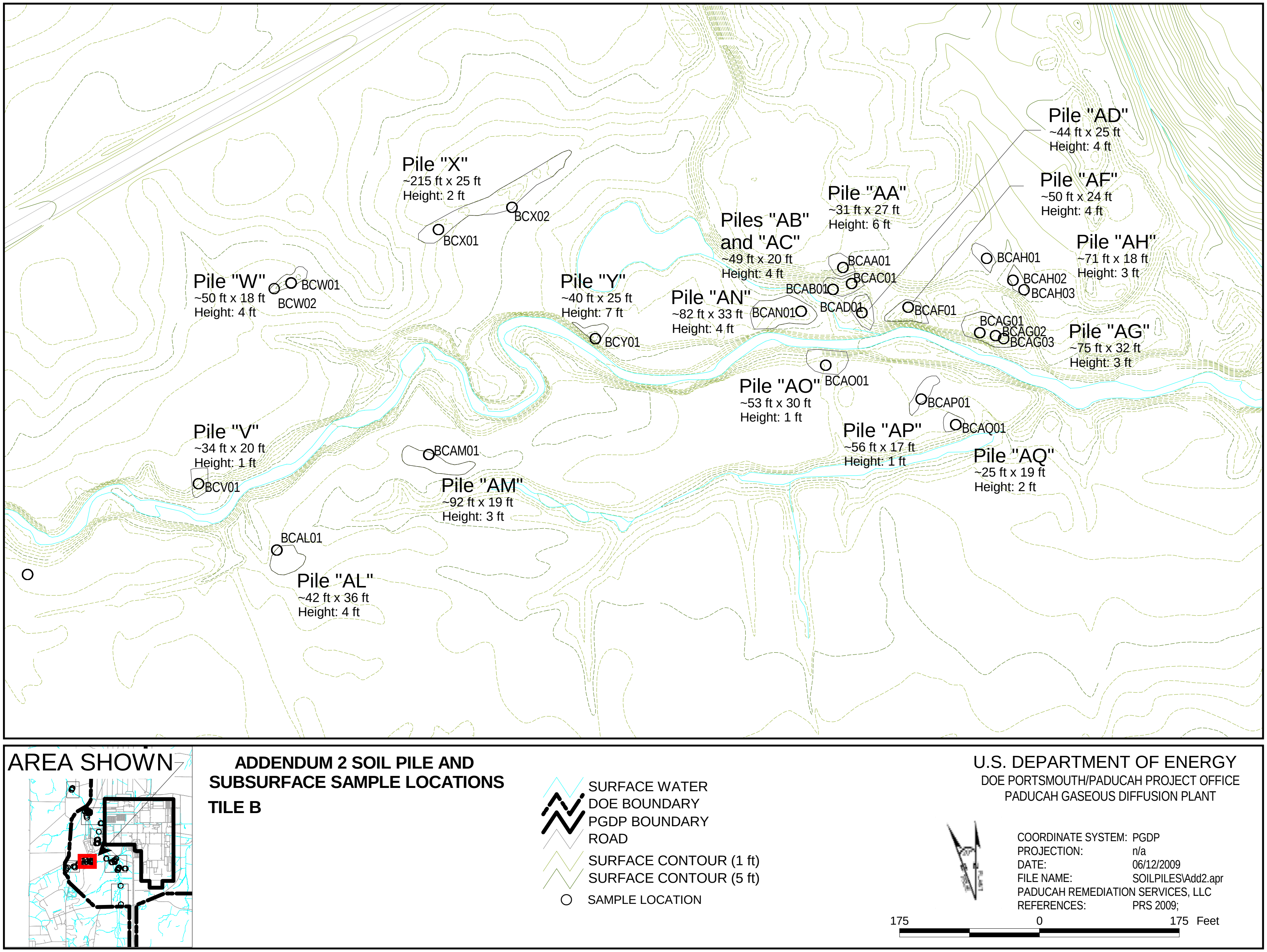


Figure 3. Addendum 2 Sampling Locations (Continued)

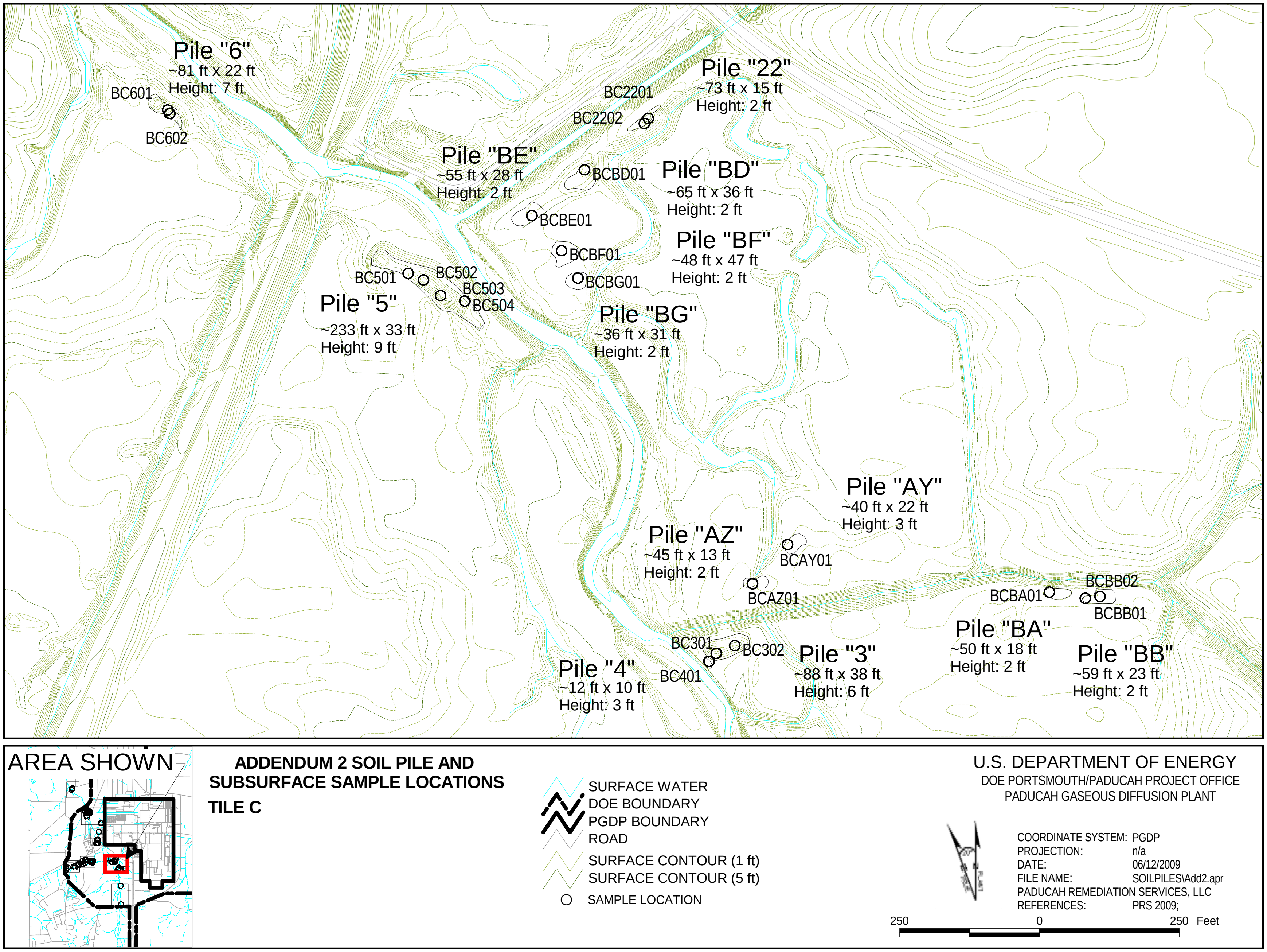


Figure 3. Addendum 2 Sampling Locations (Continued)

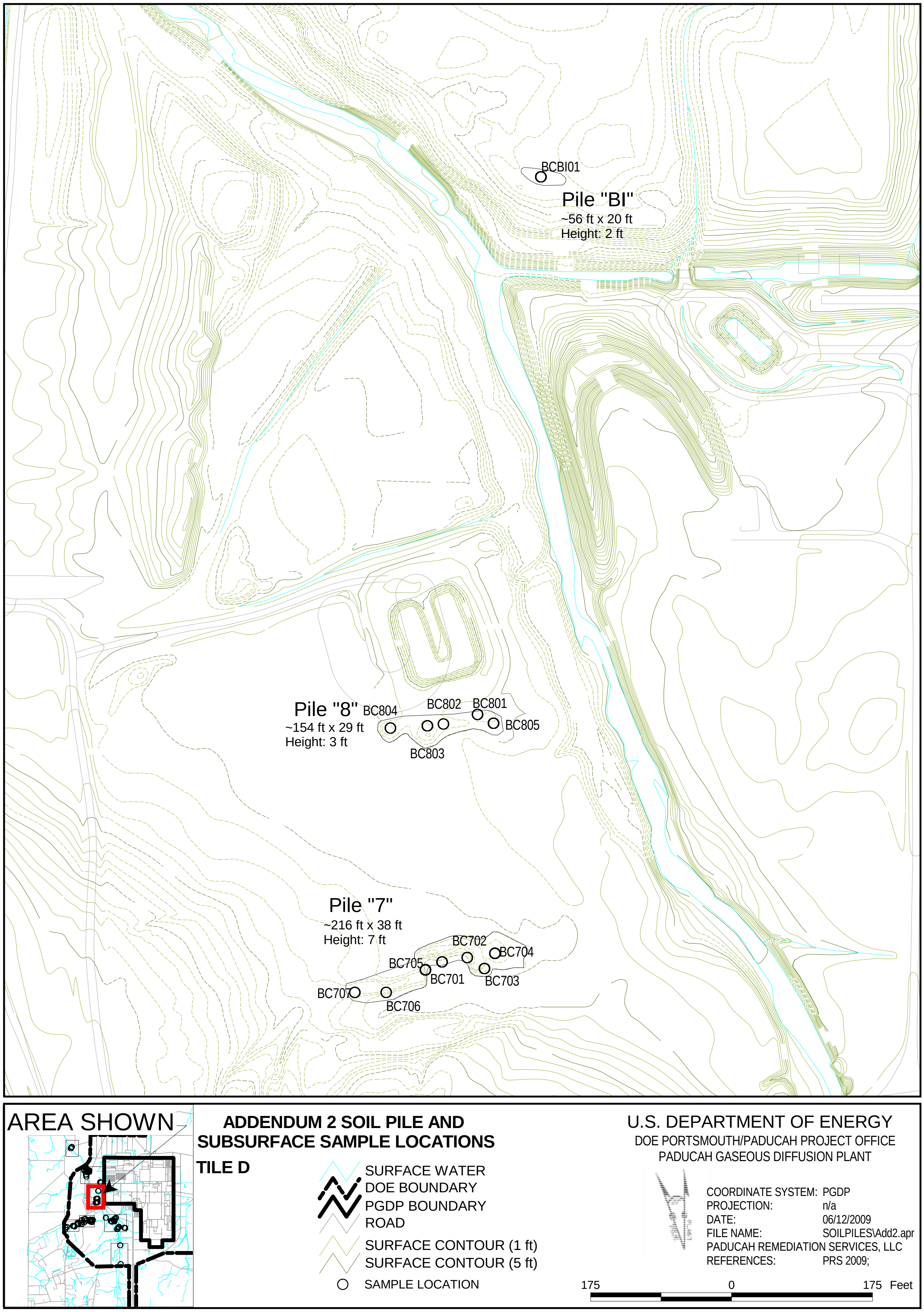


Figure 3. Addendum 2 Sampling Locations (Continued)

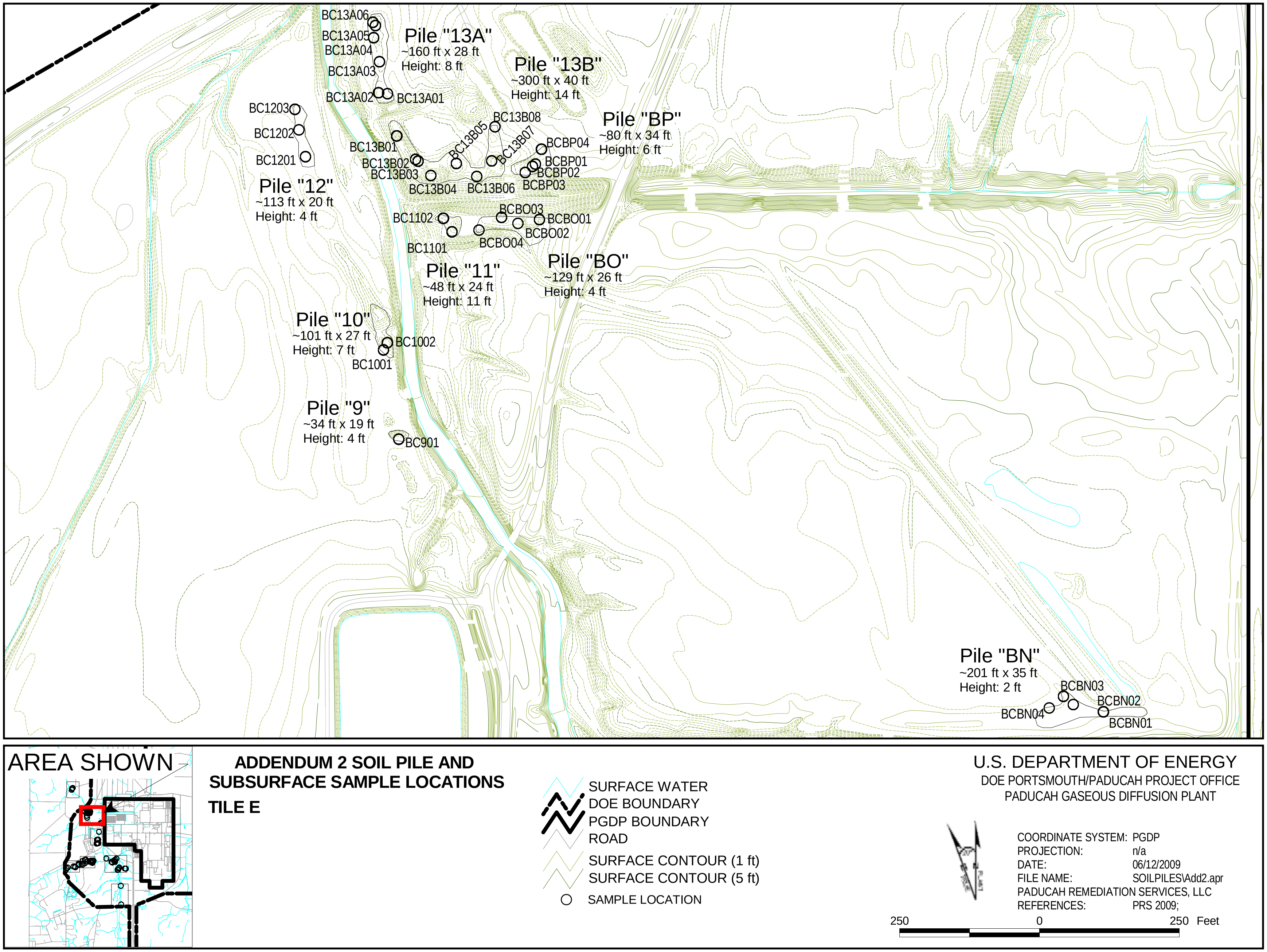
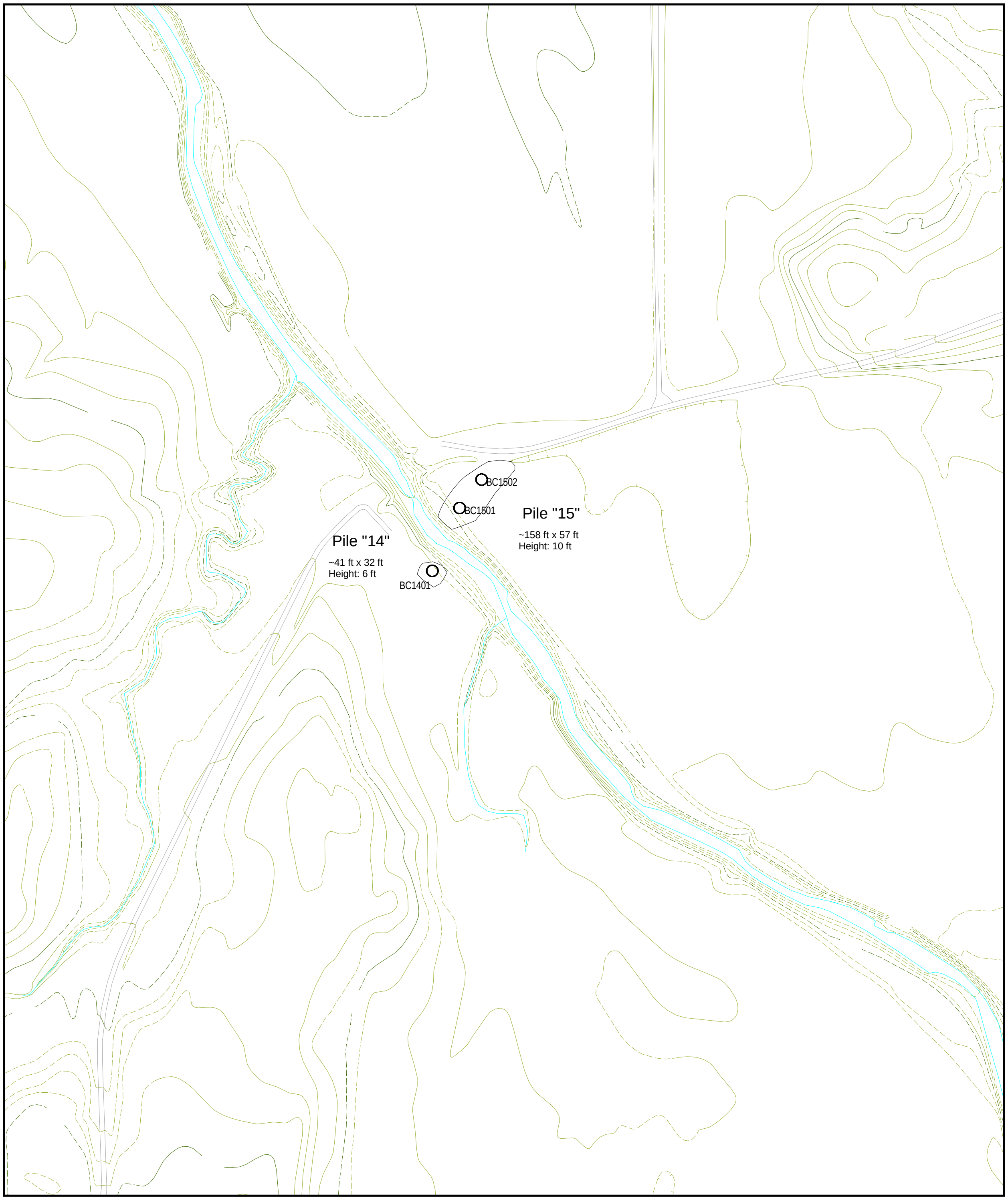


Figure 3. Addendum 2 Sampling Locations (Continued)



AREA SHOWN

ADDENDUM 2 SOIL PILE AND SUBSURFACE SAMPLE LOCATIONS

TILE F

SURFACE WATER
DOE BOUNDARY
PGDP BOUNDARY
ROAD
SURFACE CONTOUR (5 ft)
SURFACE CONTOUR (10 ft)
SAMPLE LOCATION

U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

COORDINATE SYSTEM:	PGDP
PROJECTION:	n/a
DATE:	06/12/2009
FILE NAME:	SOILPILES\Add2.apr
PADUCAH REMEDIATION SERVICES, LLC	
REFERENCES:	PRS 2009;

250 0 250 Feet

Figure 3. Addendum 2 Sampling Locations (Continued)

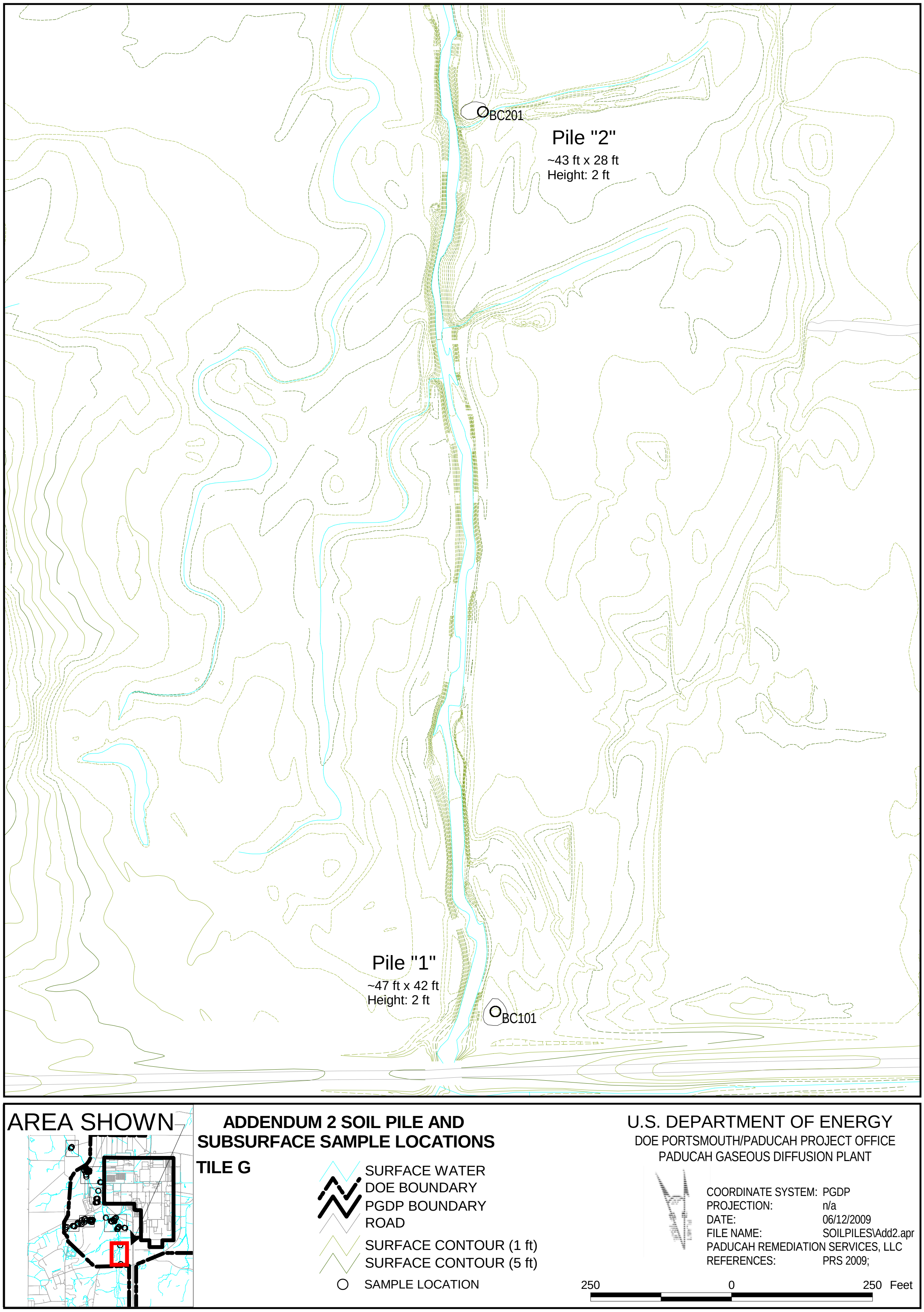


Figure 3. Addendum 2 Sampling Locations (Continued)

(no holding time exceedances) and the PAH test kit data was collected to determine utility for future projects. The exceedances of holding times on the 36 field samples does not negatively impact the characterization of the Addendum 2 soil piles.

In addition, it should be noted that the method detection limits were not always the same as contract required detection limits for fixed-base laboratory data; however, the data is of sufficient quality to meet the project objectives.

3.1.4 Fixed Laboratory Analysis

As noted, a total of 54 surface soil samples and 56 subsurface soil samples underwent fixed laboratory analysis. Each was analyzed in accordance with the method requirements outlined in Table 1 with the exception that six samples were randomly selected for waste characterization (ignitability, reactivity, corrosivity, paint filter, and moisture) in case a removal action was required.

3.1.5 Field Analysis

All of the surface and subsurface samples collected for Addendum 2 Soil Piles underwent field analysis. The total field analysis included 109 surface samples and 167 subsurface samples. The area was surveyed but not posted for radiological occupational exposure. Field measurements included the following:

- RCRA metals and uranium using a XRF spectrometer (*ex situ*)
- Gamma radionuclides using a Canberra® ISOCS (*ex situ*)
- PCBs using Hach® immunoassay sample extraction and colorimetric analysis methods
- PAHs using RaPID Assay® immunoassay sample extraction and colorimetric analysis methods
- Both fixed laboratory and field results for the Addendum 2 Soil Piles Investigation are provided on a CD. The CD also provides a comparison of field and fixed laboratory analyses. It should be noted that field screening methods used may not have always achieved detection limits below background due to limitations of the screening method.

The XRF provides a value and/or delimiter for each metal analyzed for as well as a range of error. This range of error is vital in interpreting XRF results. For example, if the XRF provided a detection of a certain metal at a value of 10 mg/kg with an error of +/-10, the actual result would be between 0–20 mg/kg. For lead, taking into consideration the range of error values, the XRF results were very close to the results provided by the lab. XRF detections for uranium and chromium were mostly < method detection limits (MDLs), so interpretation is limited. Even though readings of <MDL do not produce an actual value, these still provide valuable information. Knowing that field levels for metals of concern are less than a specific value can help make important decisions in the field. Chromium levels in all of our samples were less than 65 mg/kg, which was the MDL. Analytical data proved that the chromium levels all were less than 65 mg/kg. It should be noted that there were a few chromium detections in which the XRF provided an actual value that was less than 65 mg/kg rather than the <MDL. When applying the error associated with this value, the estimated value was very close to the MDL. MDLs and errors for the XRF are presented in Table 2.

The range of detections for sample using the Canberra® ISOCS (*ex situ*) are listed in Table 3.

Table 1. Fixed Laboratory Analysis Requirements for Soils

CHARACTERIZATION PARAMETERS	ANALYTICAL METHOD
PAHs	SW846-8270
PCBs (Aroclors/Total)	SW846-3540/8082
Inorganic Target Analyte List (Total Metals)	SW846-6010B or SW846-6020
^{241}Americium	Alpha Spectroscopy Nitric Only Digestion (RL-7128)
^{137}Cesium	Gamma Spectroscopy (RL-7124)
^{237}Neptunium	Alpha Spectroscopy Nitric Only Digestion (RL-7128)
^{238}Plutonium	Alpha Spectroscopy Nitric Only Digestion (RL-7128)
$^{239/240}$Plutonium	Alpha Spectroscopy Nitric Only Digestion (RL-7128)
^{99}Technetium	Liquid Scintillation (RL-7100)
^{228}Thorium	Alpha Spectroscopy Nitric Only Digestion (RL-7128)
$^{230/232}$Thorium	Alpha Spectroscopy Nitric Only Digestion (RL-7128)
Total Uranium	Alpha Spectroscopy Nitric Only Digestion (RL-7128)
^{234}Uranium	Alpha Spectroscopy Nitric Only Digestion (RL-7128)
^{235}Uranium radioactivity	Alpha Spectroscopy Nitric Only Digestion (RL-7128)
^{238}Uranium	Alpha Spectroscopy Nitric Only Digestion (RL-7128)
Arsenic	SW846-6020[1]
Barium	SW846-6010B[1]
Cadmium	SW846-6020[1]
Chromium	SW846-6010B[1]
Lead	SW846-6020[1]
Mercury	SW846-7471[1]
Selenium	SW846-6020[1]
Silver	SW846-6010B[1]
Ignitability	SW846-1010

ASTM = American Society for Testing and Materials
EPA = U.S. Environmental Protection Agency
PAH = polyaromatic hydrocarbon
PCB = polychlorinated biphenyl
[1] Toxicity Characteristic Leaching Procedure (TCLP) analyses will be performed only if Underlying Hazardous Constituents (UHC) exceed 20 times the TCLP limit.

Table 2. XRF SRM Recovery Information

Element	MDL (mg/kg)	Associated Error (mg/kg)
Antimony	7.9	+/- 0.6
Arsenic	17.7	+/- 0.8
Barium	968.0	+/- 40
Cadmium	0.38	+/- 0.01
Chromium	130.0	+/- 4.0
Cobalt	13.4	+/- 0.7
Copper	34.6	+/- 0.7
Lead	18.9	+/- 0.5
Manganese	535.0	+/- 17.0
Mercury	1.40	+/- 0.08
Nickel	88.0	+/- 5.0
Selenium	1.57	+/- 0.06
Silver	0.41	+/- 0.03
Strontium	231.0	+/- 2.0
Thallium	0.74	+/- 0.05
Uranium	3*	N/A
Vanadium	112.0	+/- 5.0
Zinc	106.0	+/- 3.0

*Noncertified value–NIST Standard 2709
N/A–Not available

Table 3. Canberra® ISOCS Range of Detections*

Element	Count of Samples	Minimum Activity (pCi)	Maximum Activity (pCi)	Mean Activity (pCi)	Median Activity (pCi)	Standard Deviation (pCi)
Cesium-137	274	0.00781	0.856847	0.103742949	0.04280447	0.133794435
Uranium-238	274	0.846	20.3621	2.411435252	1.3370765	2.160625678

*Due to short count times and small sample volume, the results have a large degree of uncertainty. Please see Appendix A.

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4. QUALITY ASSURANCE/QUALITY CONTROL

4.1 DATA QUALITY/DATA USABILITY

The following sections summarize the results of data verification, data validation, reconciliation of measurement quality objectives, and the comparisons of field and laboratory data obtained from the Addendum 2 Soil Piles investigation.

4.1.1 Precision

Precision is the measure of agreement or reproducibility between individual measurements for the same property under the same analytical conditions.

Precision for Addendum 2 Soil Piles data was measured based on the performance of field and laboratory duplicate samples and laboratory matrix spike (MS) and matrix spike duplicate (MSD) pairs.

NOTE: Precision does not affect the quality or usability of organic analyses whose precision is measured by MS/MSD pairs. As the SAP notes, precision results do not impact on PCBs, semivolatile organic compounds, or volatile organic compounds (VOCs) in terms of data quality/data usability. Where performance criteria for precision are exceeded, there is less confidence in the reported result because of error introduced from sampling or analysis caused by unequal representation of target compounds or analytes between the two sample pairs.

The SAP required that a minimum of 9 of 10 samples (90%) for each analysis type meet method prescribed precision criteria. Based on the data received from the fixed-base laboratory, each analysis met this goal.

4.1.2 Accuracy

Accuracy is the comparison of a known quantity of a reference standard to the value measured during analysis. Accuracy for Addendum 2 Soil Piles data was assessed by evaluating the performance of the following QC standards designed to monitor accuracy during sample preparation and analysis:

- Laboratory control samples
- Radioactive tracers
- MS
- MSDs
- Surrogate compounds

The SAP required that a minimum of 9 of 10 samples (90%) for each analysis type meet method/PGDP prescribed accuracy criteria. Based on the data received from the fixed-base laboratory, each analysis type met this goal.

4.1.3 Completeness

Completeness is defined as the number of valid data points obtained from a sampling effort, compared with the total number of data points obtained. Valid data are those generated when analytical systems and the resulting analytical data meet all of the quantitative measurement objectives for the project.

The SAP required that a minimum of 9 of 10 samples (90%) for each analysis type meet completeness criteria. Based on the data received from the fixed-base laboratory, each analysis type met this goal.

4.1.4 Detection Limits

To ensure the fixed laboratory data acquired from Addendum 2 Soil Piles supports the DQOs, MDLs were pre-established for each analysis type and defined in the laboratory scope of work. The contract required detection limits in the SAP were to be attained if possible, however, if not, the MDLs were to be low enough to compare to background. The MDLs were designed to ensure that sufficiently sensitive data were obtained from the contract laboratories to enable comparison to background and other action/no action levels.

For field analytical methods, method sensitivity was a variable determined during the project. Field MDLs were determined in accordance with manufacturer analytical protocols. The field analytical methods do not achieve the same level of sensitivity as fixed-base laboratory methods. However, sufficient sensitivity was achieved for each method to support/direct field activities should actions be necessary at Addendum 2 Soil Piles.

Reporting limits were met as specified in the SAP.

4.1.5 Comparability

Comparability is the degree to which one data set can be compared to another, when both are obtained from the same sample population. Comparability can be achieved only through the use of consistent sampling procedures, experienced sampling personnel, the same or comparable analytical methods, standard field and laboratory documentation, and traceable laboratory standards.

Because the samples were collected from the nearly identical locations, samplers employed similar sampling techniques, and similar analytical methods. As a result, the data are comparable.

4.1.6 Representativeness

Representativeness is a measure of the degree to which data accurately and precisely represents the characteristics of a population at a sampling point, process condition, or environmental condition. Representativeness is a qualitative term evaluated to determine if sample measurements and physical sample locations result in data that appropriately reflects the population parameter of interest in the media and phenomenon measured or studied.

The data provides a good representation of the environmental conditions of Addendum 2 soil piles based upon data verification, validation, and assessment. The investigation has successfully determined that there is no contamination that warrants immediate action at soil piles along Bayou Creek.

4.1.7 Field Quality Control Summary

Field QC samples are independently generated samples from a pre-defined sampling scheme, designed to monitor the reproducibility, cleanliness, and accuracy of the sampling and analytical process. The following are the field QC samples prescribed for the Addendum 2 Soil Piles investigation:

- Field split samples
- Field blanks

- Trip blanks
- Equipment rinseate blanks

QC samples were required for Addendum 2 at a frequency of 1 QC sample for every 20 samples collected or 5%. The collection frequency for QC samples applied to all samples whether undergoing field analysis or fixed laboratory analysis.

Field split samples were collected and analyzed to evaluate the reproducibility (precision) of sampling techniques, laboratory methods, and to monitor the natural variability of the sample matrix. Field split samples were submitted as separate samples, with separate field identification numbers to the contract laboratory. The prescribed collection frequency was met with field split samples collected and analyzed at a frequency of 5% for the investigation.

Field blanks were collected and analyzed to evaluate any cross contamination attributable to field methods including sample container handling. As noted previously, one less field blank was collected compared to the SAP Addendum requirement (two were planned, however, one collected).

Field rinseate blanks were collected and analyzed where subsurface samples were collected and sampling equipment was decontaminated and reused. Field rinseate blanks provide a measure of cross-contamination attributable to field equipment decontamination procedures. As noted previously, one less rinseate blank was collected compared to the SAP Addendum requirement (two were planned, however, one collected).

In summary, field, trip, and rinseate blanks were analyzed to verify the cleanliness of the sampling, decontamination, and the overall analytical process. Each is designed to monitor at least one aspect of the process, with all providing meaningful information as to the reliability of low-level contaminant results.

4.1.8 Data Quality Summary/Fixed Laboratory Data

As stated, the DQOs for the Addendum 2 Soil Piles investigation were to acquire sufficient data of known quality to support decision making. Experience and properly trained field personnel were utilized to execute the sampling and operating procedures. Project samples were collected, preserved, handled, and shipped in accordance with the SAP and industry and PGDP standard procedures. A reputable analytical laboratory using industry standard analytical procedures was utilized to generate sample data that complies with the requirements of the laboratory statements(s) of work and specified protocols.

Project data underwent 10% Level C validation, with all data undergoing verification. Precision, accuracy, and completeness criteria were met for all fixed-base laboratory data indicating the data set will support decision making.

4.1.9 Data Quality Summary/Field Analytical Data

Each of the field techniques employed for the Addendum 2 Soil Piles investigation utilized QC measures to monitor the accuracy, precision, and drift of the method during use. The following summarizes the results of QC analysis.

4.1.9.1 XRF

To support field XRF analysis, three types of QC samples were analyzed with each batch of 20 samples. These included (1) blanks, (2) duplicates, and (3) standard reference materials (SRMs). The XRF blank was vendor-provided, consisting of silica-certified clean for use as a blank.

Blank results for XRF analysis showed no positive detections during execution of the investigation for those parameters such as uranium. Precision for XRF duplicates was < 35% relative percent difference (RPD) for all field-laboratory duplicates.

Three SRMs were analyzed daily to monitor XRF accuracy. They represent low [National Institute of Standards and Technology (NIST) 2709], moderate (NIST 2711), and high (NIST 2710) level standards for soil analysis for metals. SRM performance was mixed for the three standards, with the low-level standard performing well for lead and barium, and moderately well for arsenic. The low concentrations for the remaining metals were outside the operating range of the XRF (below the MDL).[4] The mid-range standard performed well for barium and lead, with moderate performance for arsenic, zinc, and cadmium. The high-end standard performed very well for arsenic, barium, uranium,[5] and lead. The remaining metals concentrations were below the MDL for the XRF.

4.1.9.2 Field PCBs

To support field PCB analysis, three types of QC samples were analyzed with each batch of 20 samples: (1) blanks, (2) duplicates, and (3) calibration verification standards. The following summarizes QC performance.

- No positive detections were noted in any of the PCB method blanks.
- Precision for PCB duplicates was < 35% RPD for all field-laboratory duplicates.
- All calibration verifications had recoveries within 90–110%.

4.1.9.3 ISOCS

To support *ex situ* ISOCS field analysis, two types of QC samples were analyzed daily. Daily checks included (1) a background and (2) a NIST traceable calibration/check source.

Background results for ISOCS analysis were all within acceptable limits (i.e., two sigma of weekly background). In addition to daily QC checks, a chamber background count was performed weekly for a predetermined count time. The predetermined background count time was equal to or greater than the sample count time. The weekly background count is used for background subtraction in the activity calculation. An accurate representation of the background for the detector is necessary to produce high quality sample results.

The NIST traceable calibration/check source consists of a mixed radionuclide with gamma peaks that cover the range (i.e., low, mid, high) of detections, generally 59 keV to 2,000 keV. All daily check source results for ISOCS analysis were within acceptable limits (i.e., 2 sigma).

4.1.10 PAH Summary

Correlation between laboratory and field PAH results were consistent as most all results were below the detection limits. A better comparison of data is recommended as a result of Addendum 1-B soil pile investigation due to the nondetects obtained from the Addendum 2 soil piles investigation.

[4] Selenium was not added to any of the standards.
[5] Chromium and uranium levels for the NIST SRMs are not certified values.

5. DISCUSSION AND RESULTS

The following section presents and evaluates the results for the Addendum 2 Soil Piles investigation. It includes a discussion of the conceptual site model (CSM) as it was defined for investigation planning and a discussion of findings. This section also provides data screening versus PGDP decision levels.

5.1 CONCEPTUAL SITE MODEL

The following description of the CSM is taken from the PGDP soil piles SAP (DOE 2007a). It summarizes the expected receptors and exposures for Soil Pile I, however, also applies to others including Addendum 2 soil piles. See Figure 4 for the CSM representation.

Recreational activities known to take place in and near some of the PGDP soil piles include the following:

- Bow hunting
- Field trials (horses and dogs)
- Other recreational uses (e.g., hiking)

Recreational user exposure to surface soils is the primary exposure pathway. The recreational user could be exposed to contaminants through contact with surface soils through the following exposure routes:

- External exposure to ionizing radiation
- Dermal contact
- Incidental ingestion
- Inhalation

Recreational user exposure to surface soils through the dermal contact, incidental ingestion, and inhalation is likely limited given that most soil piles and soils in the adjoining areas are covered by continuous vegetation. Industrial worker exposure would be similar for nonintrusive activities.

Addendum 2 Soil Piles are located adjacent to Bayou Creek. This proximity to surface water drainage areas could have resulted in potential secondary exposure routes that could impact human health and the environment. The majority of the secondary routes assume the soils or contaminants they contain have been released to adjacent waterways or moved through the food chain.

Precipitation could result in contaminant migration from the soil piles if contaminated; however, PGDP historical monitoring data indicate little if any migration is occurring.

The majority of the contaminants analyzed for samples collected at Addendum 2 Soil Piles do not bioaccumulate in plants to a great degree. As a result, plant uptake and corresponding accumulation in animal tissue is unlikely, but soil ingestion as part of normal feeding activities is likely a complete pathway. Ecological receptors also may be exposed to on-site contaminants; however, the primary focus of the characterization effort is to determine risks to human health.

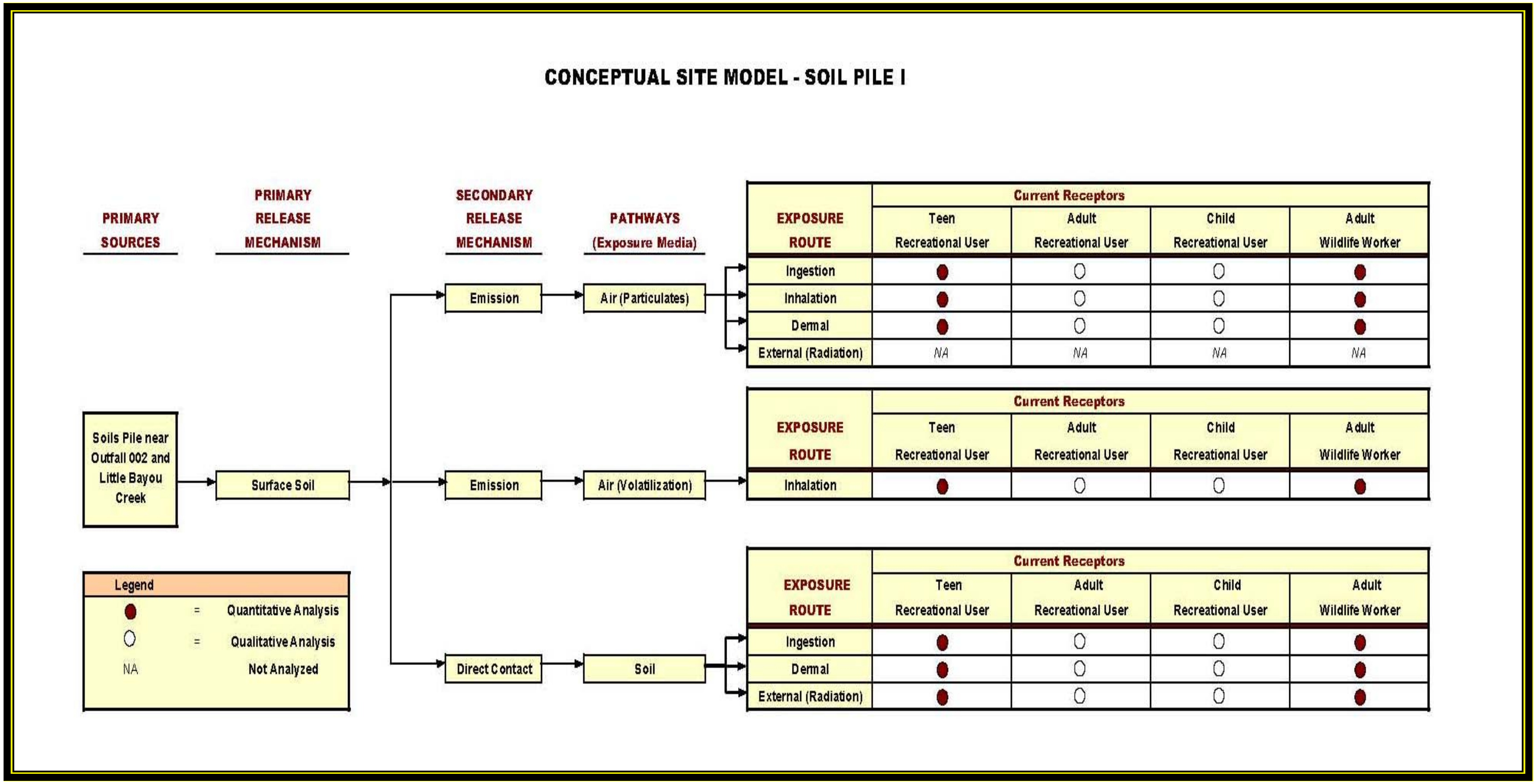

Figure 4. Conceptual Site Model for Soil Piles

5.2 EXAMINATION OF SAMPLE POPULATIONS

As part of project planning, the Soil Piles operating hypothesis for investigative purposes was that each pile likely represents a unique population, in terms of contaminant type, concentrations, and distribution. To examine this hypothesis, the data from each subpile of Soil Pile I was examined to determine if individual sample populations were present. Following this examination, each pile was compared to all the other piles to determine if any/all were the same population (DOE 2008).

The Soil Pile I comparison has been applied by this project to the Soil Piles from Addendum 2. Soil Piles 1–54 are similar to one another in that all were believed to have been created for maintenance actions and are considered one population for this project.

5.3 SURFACE DISTRIBUTION OF CONTAMINANTS

The first step in examining project data from Addendum 2 Soil Piles was to perform a data screening to establish which constituents will be retained for further consideration as COPCs. The data screening steps employed for Addendum 2 Soil Piles include the following:

- Comparison of maximum contaminant concentrations to PGDP background levels for soils;
- Comparison of contaminant concentrations to established teen recreational user no action levels (NALs); [6]
- Evaluation of frequency of detection for each contaminant.

See Section 6 for further discussion of the data screening. As constituents detected were near background ranges, no migration of contamination is occurring.

[6] No Action Levels were taken from the PGDP Risk Methods Document (DOE 2001).

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6. DATA SCREENING

This data screening used data collected in the summer 2008 from Addendum 2 Soil Piles. The principal objective of this screening is to inform risk managers in support of decision making for the site. Key considerations include the following:

- Determine whether all or portions of the study area may be eliminated from concern.
- Identify where risk characterization suggest actions may be needed.
- Determine whether additional data gathering and/or risk assessments are warranted.

The data screening provides information to the stakeholders based on the Commonwealth of Kentucky and nationally accepted risk assessment methods. These objectives are consistent with the goals, objectives, and requirements identified in the *Methods for Conducting Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant Paducah, Kentucky, Volume 1, Human Health* (DOE 2001).

The scope of the Addendum 2 Soil Piles data screening is to assess risks to human receptors who, through use of the Addendum 2 Soil Piles area, may be exposed to chemicals or radionuclides through normal use of the site. This data screening does not examine ecological risks.

6.1 METHODOLOGY

The following describes the process used to develop the data screening activity.

6.1.1 Data Screening

Following background comparisons, those contaminants retained were evaluated for comparison to other criteria as described below.

Data collected as part of Addendum 2 Soil Piles sampling was screened first against PGDP background values. These values are documented in DOE 2001. Screening against other values representing the range of background (i.e., additional background information) also was used to determine whether a chemical exceeded background in order to better focus on chemicals presenting potential concern for the soil piles. Additional background information included the generic statewide ambient background value available in Kentucky Energy and Environment Cabinet (KEEC) guidance (KEEC 2004) for metals and values expected from global fallout for radionuclides (ANL 2007).

Secondly, maximum concentrations were compared to the PGDP Risk Methods Document and site-specific health guidelines. To complete this evaluation, NALs for the teen recreational use scenario listed in Table A-17 of the Risk Methods Document (DOE 2001) were used for comparisons with maximum concentrations. Site-specific ALs and NALs for the teen recreational use scenario and the wildlife worker scenario were developed as part of *Site Evaluation Report for Soil Pile I at the Paducah Gaseous Diffusion Plant Paducah, Kentucky* (DOE 2008), specifically found within Appendix Q. These values are presented in Tables 4–6.

Figure 5 presents a data screening flow chart that was used for evaluating the results of this sampling effort.

Table 4. Comparison of Teen Recreational Site-Specific and PGDP NALs

		Site-Specific Teen Recreational User NALs[1]			PGDP Risk Methods Document Teen Recreational User NALs[1]		
Contaminants	**Units**	**Hazard**	**Carcinogen**	**NAL**	**Hazard**	**Carcinogen**	**NAL**
Aluminum	mg/kg	100,000		100,000	3,010		3,010
Antimony	mg/kg	26.4		26.4	0.242		0.242
Arsenic	mg/kg	13.8	1.79	1.79	5.98	0.346	0.346
Barium	mg/kg	40,707		40,707	148		148
Beryllium	mg/kg	67.9	466,490	67.9	0.606	60,200	0.606
Iron	mg/kg	100,000		100,000	1,350		1,350
Lead[2]	mg/kg	NA	NA	1,420			400
Manganese	mg/kg	17,263		17,263	29.0		29.0
Uranium	mg/kg	529		529	14.7		14.7
Vanadium	mg/kg	4,036		4,036	2.12		2.12
Total PCB	mg/kg	0.436	0.636	0.436	0.191	0.127	0.127
Total PAH	mg/kg		0.066	0.066		0.0133	0.0133
Cesium-137	pCi/g		1.19	1.19		0.178	0.178
Plutonium-239	pCi/g		237	237		30.3	30.3
Thorium-230	pCi/g		302	302		39.0	39.0
Uranium-234	pCi/g		407	407		52.2	52.2
Uranium-235	pCi/g		5.53	5.53		0.826	0.826
Uranium-238	pCi/g		24.6	24.6		3.64	3.64

[1]No action level (NAL) values are based on a risk of 1E-6 and a hazard index of 0.1. Site-Specific values were derived in DOE 2008. The PGDP Risk Methods Document values are presented in DOE 2001.

[2]The value for lead is a regulatory value provided by the Commonwealth of Kentucky Risk Assessment Branch.

Table 5. Comparison of Site-Specific Action Levels and PGDP Risk Methods Action Levels

		Site-Specific Teen Recreational User ALs			PGDP Risk Methods Document Teen Recreational User ALs		
Contaminants	**Units**	**Hazard**	**Carcinogen**	**Action**	**Hazard**	**Carcinogen**	**Action**
Aluminum	mg/kg	100,000		100,000	100,000		100,000
Antimony	mg/kg	793		793	344		344
Arsenic	mg/kg	413	179	179	2,590	314	314
Barium	mg/kg	100,000		100,000	100,000		100,000
Beryllium	mg/kg	2,036	46,649,028	2,036	884	100,000	884
Iron	mg/kg	100,000		100,000	100,000		100,000
Lead[2]	mg/kg			400			400
Manganese	mg/kg	100,000		100,000	39,100		39,100
Uranium	mg/kg	15,877			6,830		6,830
Vanadium	mg/kg	121,076		121,076	3,090		3,090
Total PCB	mg/kg	13.1	63.6	13.1	2.02	10.5	2.02
Total PAH	mg/kg		6.60	6.60		4.24	4.24
Cesium-137	pCi/g		119	119		1.28	1.28
Plutonium-239	pCi/g		23,724	23,724		222	222
Thorium-230	pCi/g		30,237	30,237		285	285

Table 5. Comparison of Site-Specific Action Levels and PGDP Risk Methods Action Levels (Continued)

		Site-Specific Teen Recreational User ALs[1]			PGDP Risk Methods Document Teen Recreational User ALs[1]		
Contaminants	**Units**	**Hazard**	**Carcinogen**	**Action**	**Hazard**	**Carcinogen**	**Action**
Uranium-234	pCi/g		40,716	40,716		381	381
Uranium-235	pCi/g		553	553		5.91	5.91
Uranium-238	pCi/g		2,461	2,461		26.1	26.1

[1] The action levels (ALs) are based on a risk of 1E-4 and a hazard index of 3. Site-Specific values were derived in DOE 2008. The PGDP Risk Methods Document values are presented in DOE 2001.
[2] The value for lead is a regulatory value provided by the Commonwealth of Kentucky Risk Assessment Branch.
[3] Toxicity values for radionuclides account for short-lived daughter products, where applicable.

Table 6. Site-Specific NALs for the Wildlife Worker

		Site-Specific Wildlife Worker NALs[1]		
Contaminants	**Units**	**Hazard**	**Carcinogen**	**NAL**
Aluminum	mg/kg	100,000		100,000
Antimony	mg/kg	98.0		98.0
Arsenic	mg/kg	64.3	8.22	8.22
Barium	mg/kg	62,819		62,819
Beryllium	mg/kg	374	976,375	374
Iron	mg/kg	100,000		100,000
Lead[2]	mg/kg			50
Manganese	mg/kg	40,173		40,173
Uranium	mg/kg	211		211
Vanadium	mg/kg	3,057		3,057
Total PCB	mg/kg	11,789	3.24	3.24
Total PAH	mg/kg		0.368	0.368
Cesium-137	pCi/g		1.53	1.53
Plutonium-239	pCi/g		103	103
Thorium-230	pCi/g		137	137
Uranium-234	pCi/g		179	179
Uranium-235	pCi/g		6.93	6.93
Uranium-238	pCi/g		29.3	29.3

[1]No action level (NAL) values are based on a risk of 1E-6 and a hazard index of 0.1. Site-Specific values were derived in DOE 2008. The PGDP Risk Methods Document values are presented in DOE 2001.
[2]The value from the Risk Methods Document (50 ppm) has since been withdrawn by the Commonwealth of Kentucky. Currently, 400 and 800 ppm are used for screening lead at PGDP, consistent with EPA guidance.

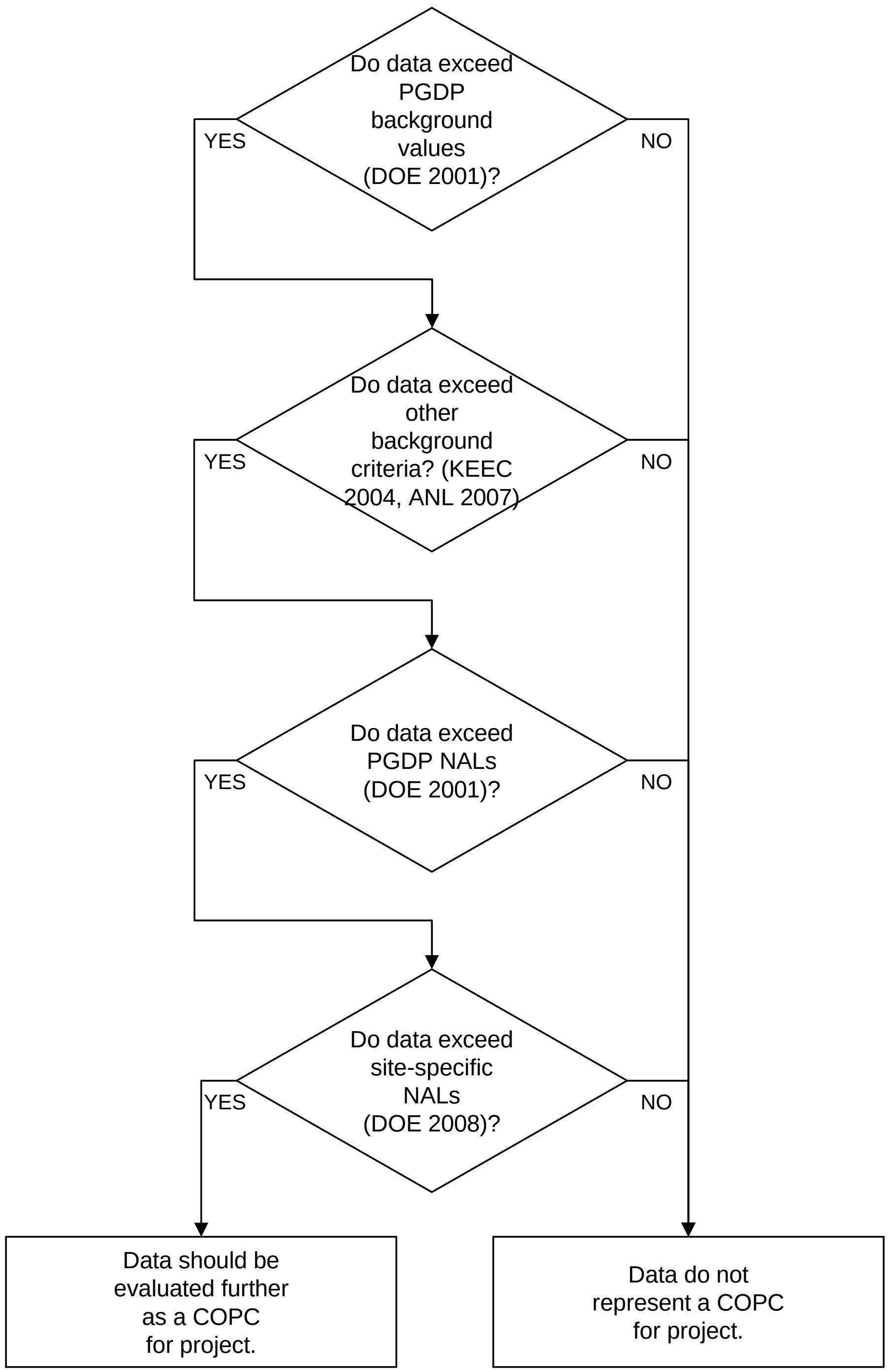

Figure 5. Data Screening

6.1.2 Addendum 2 Soil Piles Receptors

Addendum 2 Soil Piles are part of the WKWMA. Access to the portion of the WKWMA adjoining PGDP is controlled to the public throughout the year. In order to legally access the site, members of the public must check in with the United States Enrichment Corporation security force at the main guard outpost to PGDP. Known uses of DOE lands included in the WKWMA are defined in the CSM and include a) recreational users and b) wildlife workers.[7]

Known recreational uses of Addendum 2 Soil Piles include field trials, which incorporate horseback riding and dog trials, bow hunting, and similar outdoor activities. Generally, the defined recreational uses will be engaged in by teens and adults.

The soil piles CSM, as defined in the SAP, details the routes of exposure (as included in the derivation of the NALs and ALs shown in the previous tables) to be considered in a risk assessment and includes the following:

- Incidental ingestion of soil
- Inhalation of soil particles (i.e., dust)
- Inhalation of vapors emitted from soil
- Dermal contact with soil
- External exposure to ionizing radiation

6.1.3 Chemicals of Potential Concern

See Table 7 for data screening results. Table 8 shows twelve chemicals exceeding site-specific PGDP background in Addendum 2 Soil Piles as defined in the Risk Methods Document (DOE 2001). These chemicals indicate the detects are statistically at background. Appendix B provides additional information regarding the background comparisons. Additionally in Appendix B, detections noted were evaluated graphically to determine if detects were clustered or random and then compared from low to high.

KEEC has provided generic statewide background values for inorganic chemicals to assist in comparing site data and background data. The criteria for comparing these values to site results to demonstrate that the site data is background are the following:

1. The mean site concentration for inorganic constituents must be below the 95% upper confidence limit of the mean concentrations of background for inorganic constituents.

2. At least half of the data points should be less than the 60th percentile.

3. No data points should be above the upper bound value (95th percentile).

Analytical results of the metals that exceeded site-specific background meet all of these criteria and can be considered background.

Two radionuclides also exceeded site-specific PGDP background, cesium-137 and plutonium-239. The concentrations for these chemicals are below that associated with fallout. Cesium-137 and plutonium-239/240 are major contributors to global fallout due to atmospheric testing of nuclear weapons in the

[7] The receptors for Addendum 2 soil piles are current use receptors only.

1950s to the early 1960s. A summary from Argonne National Laboratory states that concentrations up to 1 pCi/g cesium-137 and 0.1 pCi/g plutonium-239/240 are expected from fallout (ANL 2007).

NALs for specific parameters were exceeded; however, the parameters are not recommended for further evaluation as COPCs in regard to risk due to their existence being below values that could be reasonably expected to occur naturally.

6.1.4 Radiation Dose Comparison

The PGDP Risk Methods Document provides radionuclide screening concentrations derived for human health based target doses for 1, 15, and 25 mrem/year. Of the two known receptors (recreational user and wildlife worker) at Addendum 2 Soil Piles, screening concentrations for the recreational user are considered for this analysis because the recreational user's screening concentration is less than the wildlife worker's screening concentration at the same target risk and hazard levels. The target dose of 25 mrem/year is based on criteria in DOE Order 5400.5, Chapter II. The target dose of 15 mrem/year is based on the U.S. EPA memorandum dated August 22, 1997. The PGDP Risk Methods Document and *National Council on Radiation Protection and Measures* (NCRP) 116 describes a screening level from the target dose of 1 mrem/year as the "walk away" level. See Table 9 for a comparison of radiological results to the human health based target doses.

The concentrations (range of concentration noted in Table 9) are from the fixed-base laboratory data obtained as a result of all samples collected for Addendum 2 soil piles and are below the individual recreational user screening levels for a 1 mrem/year dose and, therefore, below the "walk away" level in the PGDP Risk Methods Document. Negative concentration data (as noted in Table 9) sometimes is reported for radionuclides when data represents activity below background.

6.1.5 PCB Comparison

All piles sampled for Addendum 2 Soil Piles show no detection of PCBs; therefore, a comparison was not performed.

Table 7. Data Screening Results

Analysis	Units	Detected Results			Frequency of Detection	Exceeds Background[1]	Exceedances of No Action Levels				Detection Limit Range
		Minimum	Maximum	Average			Site-Specific Teen Recreational User	PGDP-Specific Teen Recreational User	Site-Specific Wildlife Worker	PGDP-Specific Child Resident	
Aluminum	mg/kg	1.95E+03	1.31E+04	6.75E+03	110/110	2/110	0/110	108/110	0/110	110/110	17 - 194
Antimony	mg/kg				0/110	0/110	0/110	0/110	0/110	0/110	6.6 - 9.97
Arsenic	mg/kg	1.96E+00	1.02E+01	4.28E+00	110/110	3/110	110/110	110/110	4/110	110/110	0.849 - 1
Barium	mg/kg	1.78E+01	1.35E+02	6.17E+01	110/110	0/110	0/110	0/110	0/110	90/110	2.12 - 2.5
Beryllium	mg/kg	4.44E-01	7.16E-01	5.59E-01	26/110	3/110	0/110	6/110	0/110	26/110	0.425 - 0.5
Cadmium	mg/kg	4.66E-01	6.74E-01	5.47E-01	14/110	14/110	N/A	0/110	N/A	0/110	0.425 - 0.5
Calcium	mg/kg	1.24E+02	6.62E+04	1.87E+03	108/110	2/110	N/A	N/A	N/A	N/A	84.9 - 898
Chromium	mg/kg	6.36E+00	5.46E+01	1.22E+01	110/110	6/110	N/A	0/110	N/A	0/110	2.12 - 2.5
Cobalt	mg/kg	2.93E+00	1.26E+01	5.29E+00	110/110	0/110	N/A	0/110	N/A	0/110	0.849 - 1
Copper	mg/kg	2.45E+00	1.71E+01	6.49E+00	110/110	0/110	N/A	0/110	N/A	0/110	2.12 - 2.5
Iron	mg/kg	5.55E+03	2.13E+04	1.03E+04	110/110	0/110	0/110	110/110	0/110	110/110	17 - 20
Lead	mg/kg	3.02E+00	2.88E+01	1.05E+01	110/110	1/110	0/110	0/110	0/110	0/110	0.849 - 4.82
Magnesium	mg/kg	1.30E+02	2.13E+03	7.37E+02	110/110	0/110	N/A	0/110	N/A	0/110	4.25 - 5
Manganese	mg/kg	8.51E+01	1.58E+03	4.91E+02	110/110	1/110	0/110	110/110	0/110	110/110	2.12 - 2.5
Mercury	mg/kg	1.30E-02	8.60E-02	2.66E-02	97/110	N/A	N/A	0/110	N/A	0/110	0.011 - 0.017
Molybdenum	mg/kg				0/110	N/A	N/A	0/110	N/A	0/110	4.25 - 5
Nickel	mg/kg	4.54E+00	1.15E+01	7.82E+00	75/110	0/110	N/A	0/110	N/A	0/110	4.25 - 5
Selenium	mg/kg				0/110	0/110	N/A	0/110	N/A	0/110	0.849 - 1
Silver	mg/kg				0/110	0/110	0/110	0/110	0/110	0/110	1.65 - 2.49
Sodium	mg/kg				0/110	0/110	0/110	0/110	0/110	0/110	170 - 200
Thallium	mg/kg				0/110	0/110	N/A	0/110	N/A	0/110	1.7 - 2
Uranium	mg/kg	9.48E-01	3.74E+00	1.38E+00	45/110	0/110	0/110	0/110	0/110	2/110	0.849 - 1
Vanadium	mg/kg	1.07E+01	3.77E+01	1.76E+01	110/110	1/110	0/110	110/110	0/110	110/110	2.12 - 2.5
Zinc	mg/kg	1.82E+01	5.82E+01	2.61E+01	70/110	0/110	N/A	0/110	N/A	0/110	17 - 20
Americium-241	pCi/g				0/110	N/A	N/A	0/110	N/A	0/110	0.0214 - 0.0259
Cesium-137	pCi/g	3.91E-02	9.79E-01	2.72E-01	75/110	15/110	0/110	41/110	0/110	75/110	0.0359 - 0.0747
Neptunium-237	pCi/g				0/110	0/110	N/A	0/110	N/A	0/110	0.0169 - 0.0554
Plutonium-238	pCi/g				0/110	0/110	N/A	0/110	N/A	0/110	0.0107 - 0.014
Plutonium-239/240	pCi/g	1.22E-02	3.53E-02	2.07E-02	15/110	3/110	0/110	0/110	0/110	0/110	0.00977 - 0.018
Technetium-99	pCi/g	6.83E-01	1.45E+00	9.42E-01	23/110	0/110	N/A	0/110	N/A	0/110	0.632 - 0.655
Thorium-228	pCi/g	1.41E-01	5.11E-01	3.06E-01	108/110	0/110	N/A	108/110	N/A	108/110	0.112 - 0.118
Thorium-230	pCi/g	1.30E-01	4.71E-01	2.34E-01	103/110	0/110	0/110	0/110	0/110	0/110	0.127 - 0.133
Thorium-232	pCi/g	1.19E-01	5.38E-01	3.33E-01	110/110	0/110	N/A	0/110	N/A	0/110	0.0739 - 0.0803
Uranium	pCi/g	2.32E-01	1.80E+00	5.64E-01	32/110	N/A	N/A	N/A	N/A	N/A	0.218 - 0.294
Uranium-234[2]	pCi/g	1.22E-01	7.99E-01	2.24E-01	37/110	0/110	0/110	0/110	0/110	0/110	0.119 - 0.154
Uranium-235[2]	pCi/g	1.49E-02	4.55E-02	2.54E-02	12/110	0/110	0/110	0/110	0/110	8/110	0.0117 - 0.0345
Uranium-238[2]	pCi/g	8.90E-02	9.56E-01	2.47E-01	68/110	5/110	0/110	0/110	0/110	68/110	0.0859 - 0.118

[1] Background Values from DOE 2001. Samples whose bottom depth less than or equal to 1 screened against surface values those with depth greater than 1 screened against subsurface values.
[2] Uranium isotopes are compared to screening values using an incremental adjustment, as appropriate. N/A = not applicable or not available.

Table 8. Chemicals Exceeding PGDP Background

Analysis	Depth	Frequency Exceeding Site-Specific PGDP Background[1, 2]
Aluminum	Subsurface	2/56
Arsenic	Subsurface	4/56
Beryllium	Surface	3/54
Cadmium	Surface Subsurface	6/54 8/56
Calcium	Subsurface	3/56
Chromium	Surface Subsurface	5/54 1/56
Lead	Subsurface	1/56
Manganese	Surface	1/54
Vanadium	Subsurface	1/56
Cesium-137	Surface Subsurface	6/54 9/56
Plutonium-239/240	Surface	3/54
Uranium-238[3]	Surface Subsurface	3/54 2/56

[1] Background values taken from the provisional background values provided in DOE 2001.
[2] These eleven chemicals exceed site-specific PGDP background; however, Appendix B provides additional information to show these chemicals are not COPCs.
[3] Isotopic uranium were compared to screening values using an incremental adjustment, as appropriate.

Table 9. Comparison of Addendum 2 Soil Piles Radionuclide Concentrations and Radiation Dose/Concentration Limits

Radionuclide	Range of Concentration (pCi/g)	Teen Recreator Screening Level (pCi/g)[b]			Residual Concentration Limit for Release of DOE Property (pCi/g)
		1 mrem/year	15 mrem/year	25 mrem/year	
Cesium-137	-0.0229 – 0.979	1.07E+01	1.60E+02	2.67E+02	
Thorium-230	-0.00525 – 0.471	1.38E+03	2.07E+04	3.44E+04	5/15[c]
Thorium-232	0.119 – 0.538	2.88E+02	4.33E+03	7.21E+03	5/15[c]
Uranium-234	-0.0357 – 0.799	2.72E+03	4.07E+04	6.79E+04	
Uranium-238	0.0112 – 0.956	2.44E+02	3.67E+03	6.11E+03	

[ab] From the PGDP Risk Methods Document. All Risk Methods Document values are presented for comparison purposes; however, not all of these values may be appropriate for response action decision making.
[c] 5 pCi/g, averaged over the first 15 cm of soil below the surface; 14 pCi/g, averaged over 15-cm-thick layers of soil more than 15 cm below the surface.

7. CONCLUSIONS

The following provides a summary of the major findings and conclusions for the Addendum 2 soil piles evaluation. The following lists the objectives of the Addendum 2 soil piles investigation:

- Establish the nature and extent of contamination in Addendum 2 Soil Piles and adjacent soils.
- Establish the mean concentrations of contaminants in soils.
- Determine if soils pose imminent risks to human health.
- Determine if soils contamination exceeds regulatory thresholds.

Consistent with Section 40 *CFR* § 300.420(c)(5) of the National Contingency Plan (NCP), information on the nature of waste handling, known contaminants, pathways of migration of contaminants, human and environmental targets, and a recommendation on further action is contained in this report.

Consistent with Section 40 *CFR* § 300.415(b)(2) of the NCP, the factors that should be considered in determining the appropriateness of a removal action for Addendum 2 soil piles are discussed below.

(i) **Actual or potential exposure to nearby human populations, animals, or food chain from hazardous substances or pollutants or contaminants.**
The screening (Appendix B) found that the detects are statistically at background based upon the results being below the 95th percentile of the generic statewide ambient background values. PCBs were not detected.

(ii) **Actual or potential contamination of drinking water supplies or sensitive ecosystem.**
There is no known use of groundwater for drinking water, feedstock watering, or crop irrigation from the Addendum 2 soil piles area.

(iii) **Hazardous substances or pollutants or contaminants in drums, barrels, banks, or other bulk storage containers that may pose a threat of release.**
There are no containers or tanks associated with the Addendum 2 soil piles.

(iv) **High levels of hazardous substances or pollutants or contaminants in soils largely at or near the surface that may migrate.**
Sampling results from Addendum 2 and PGDP historical monitoring data indicate no migration is occurring.

(v) **Weather conditions that may cause hazardous substances or pollutants or contaminants to migrate or be released.**
Sampling results from Addendum 2 and PGDP historical monitoring data indicate no migration is occurring.

(vi) **Threat of fire or explosion.**
The Addendum 2 soil piles do not present a threat of fire or explosion.

(vii) **The availability of other appropriate federal or state response mechanisms to respond to the release.**
This factor is not applicable to the Addendum 2 soil piles.

(viii) **Other situations or factors that may pose threats to public health or welfare of the United States or the environment.**
There are no other situations or factors at Addendum 2 soil piles that would pose a threat to public health or the environment.

7.1 NATURE AND EXTENT OF CONTAMINATION

As expected, the soil does not pose imminent risks to human health and are at or near background, based upon field and fixed laboratory samples collected from the 54 soil pile samples. Data (see Appendix A) of known quality were acquired in sufficient quantities to allow decision makers to formulate an informed decision as to the need for an action at any of the Addendum 2 soil piles, if warranted. No evidence was found of a release of hazardous waste or hazardous constituents that would pose a current or potential threat to human health or the environment. Additionally, no indication was found of treatment, storage, or disposal of solid or hazardous waste.

7.2 HUMAN HEALTH RISKS

The results of the background screening for metals indicate concentrations used to quantify risks and hazards were at or near background levels for all 54 soil pile samples. Eleven chemicals exceeded site-specific background; however, the results either were below the 95^{th} percentile of the generic statewide ambient background values (with the mean of the results being below the 95 upper confidence limit of the mean generic statewide ambient background and at least half of the results less than the 60^{th} percentile) or are considered as a result of fallout.

7.2.1 Radiation Dose Limits

Concentrations of radiological parameters detected in Addendum 2 soil piles are below recreational user screening levels for a 1 mrem/year dose and, therefore, below the "walk away" level in the PGDP Risk Methods Document.

7.2.2 PCB Remediation Waste

PCBs were not detected in any of the field and laboratory samples collected from the 54 soil piles.

8. RECOMMENDATIONS

The following provides recommendations for future activities at Addendum 2 Soil Piles. The recommendations are based on the findings of the investigation and lessons learned during the planning and execution of study efforts at Addendum 2 Soil Piles.

8.1 FUTURE ACTIVITIES

The following are recommendations and future actions to be taken based on the findings of the Addendum 2 Soil Piles:

- The Addendum 2 piles do not meet the definition of a SWMU or AOC because the constituent concentrations in soil are at or near background levels or do not exceed NALs, and no documentation exists to indicate the presence of wastes. The soil piles do not pose a current or potential threat to human health or the environment. As a result, no further investigation is recommended for the 54 soil piles along Bayou Creek (Addendum 2 Soil Piles).

- The PAH test kit evaluation will be completed in the Addendum 1-B SER because most all results for Addendum 2 Soil Piles were below the detection limit for both field and fixed laboratory results.

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APPENDIX A

SER ADDENDUM 2 DATA

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SER ADDENDUM 2 DATA

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APPENDIX B

SCREENING OF DETECTED CHEMICALS EXCEEDING PGDP SITE-SPECIFIC BACKGROUND

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Background Exceedances for Addendum 2 Soil Pile Sampling

Twelve chemicals exceeded site-specific Paducah Gaseous Diffusion Plant (PGDP) background during the Addendum 2 sampling. Four of those chemicals exceeded background in both surface and subsurface sampling. The twelve chemicals are listed in Table 1.

Table 1. Addendum 2 Chemicals Exceeding PGDP Background

Analysis	Depth	Frequency Exceeding Site-Specific PGDP Background*
Aluminum	Subsurface	2/56
Arsenic	Subsurface	4/56
Beryllium	Surface	3/54
Cadmium	Surface	6/54
	Subsurface	8/56
Calcium	Subsurface	3/56
Chromium	Surface	5/54
	Subsurface	1/56
Lead	Subsurface	1/56
Manganese	Surface	1/54
Vanadium	Subsurface	1/56
Cesium-137	Surface	6/54
	Subsurface	9/56
Plutonium-239/240	Surface	3/54
Uranium-238	Surface	3/54
	Subsurface	2/56

*Background values for this analysis were taken from the provisional background values provided in DOE 2001. Material presented later in this section considers estimates of background concentrations from other sources. Isotopic uranium results were compared to screening values using incremental adjustments, as appropriate.

Of the soil piles with results exceeding background, Soil Pile BP has the most background exceedances with 6 [2 surface exceedances (cadmium and chromium) and 4 subsurface exceedances (cadmium, lead, cesium-137, and uranium-238)]. The next highest ranking soil piles have 4 background exceedances each: Soil Piles AG, BI, and W. [Soil Pile AG has 1 surface exceedance (cadmium) and 3 subsurface exceedances (aluminum, cadmium, calcium). Soil Pile BI has 1 surface exceedance (cadmium) and 3 subsurface exceedances (arsenic, cadmium, cesium-137). Soil Pile W has 4 surface exceedances (beryllium, manganese, cesium-137, plutonium-239/240).] Soil Piles AH, AB, and X have 3 background exceedances each. Several other soil piles have 1 or 2 background exceedances.

The following soil piles have no background exceedances:

2	8	15	AN	Q
3	10	AD	AY	R
4	12	AI	BD	U
5	13A	AJ	BF	V
7	13B	AK	BO	Y

The following text describes and illustrates the spatial distribution of these background exceedances with accompanying charts of results compared to background. The 2001 Risk Methods Document (DOE 2001) was the primary source used for comparing Addendum 2 results with background; however, in order to better focus on chemicals presenting potential concern for the soil piles, additional screening values were considered. These screening values used for comparison are the revised site background values for PGDP published for review in 2009 (DOE 2009),[1] the generic statewide ambient background value available in Kentucky Energy and Environment Cabinet (KEEC) guidance (KEEC 2004), and values expected from global fallout (ANL 2007). The background screen is not meant necessarily to screen against the most conservative of the background values available, but to screen results that are below values that reasonably could be expected to occur naturally. The documents and values presented in this appendix define values that reasonably could be expected to occur.

To apply the guidance established by the KEEC, the criteria were used as listed here:

1. The mean site concentration for inorganic constituents must be below the 95% upper confidence limit (UCL) of the mean concentrations of background for inorganic constituents.

2. At least half of the data points should be less than the 60th percentile.

3. No data points should be above the upper bound value (95th percentile).

Aluminum–Subsurface. Aluminum values in subsurface soil samples exceed the background value of 12,000 mg/kg in 2 of 56 samples. The two exceeding values are 12,300 and 13,100 mg/kg. The locations from which the exceeding samples were collected are from different soil piles and are not related. Further, several other samples were collected near these two and did not exceed background. The criteria for applying ambient background values established by KEEC were met: (1) the mean site concentration (6,740 mg/kg) is below the 95% UCL of the mean concentrations of KEEC background (11,314 mg/kg), (2) at least half of the data points are less than the 60th percentile (10,800 mg/kg), and (3) no data points are above the upper bound value (21,000 mg/kg) (KEEC 2004); therefore, aluminum is not present in the Addendum 2 soil piles as a contaminant.

Figure B.1 graphically shows the results with the background value and other comparison values. Figure B.2 illustrates the spatial distribution of the sampling locations in which the background value was exceeded.

[1] The draft site background values published for review in 2009 represent two times the log-transformed median (mean for radionuclides) value for use in screening to determine if inorganic chemical or radionuclide detected at naturally occurring concentration in surface or subsurface soil.

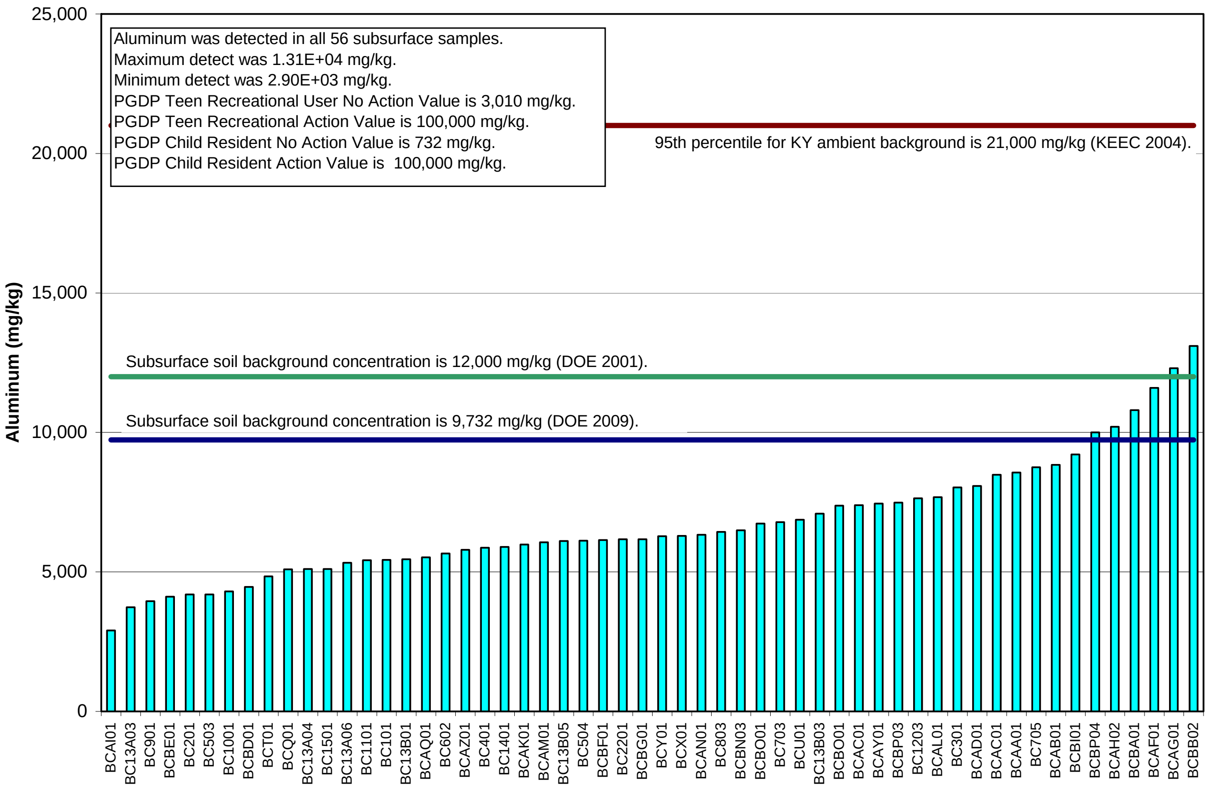


Figure B.1. Comparison between Aluminum Concentrations in Samples from Soil Piles Addendum 2 and Subsurface Soil Background Concentrations

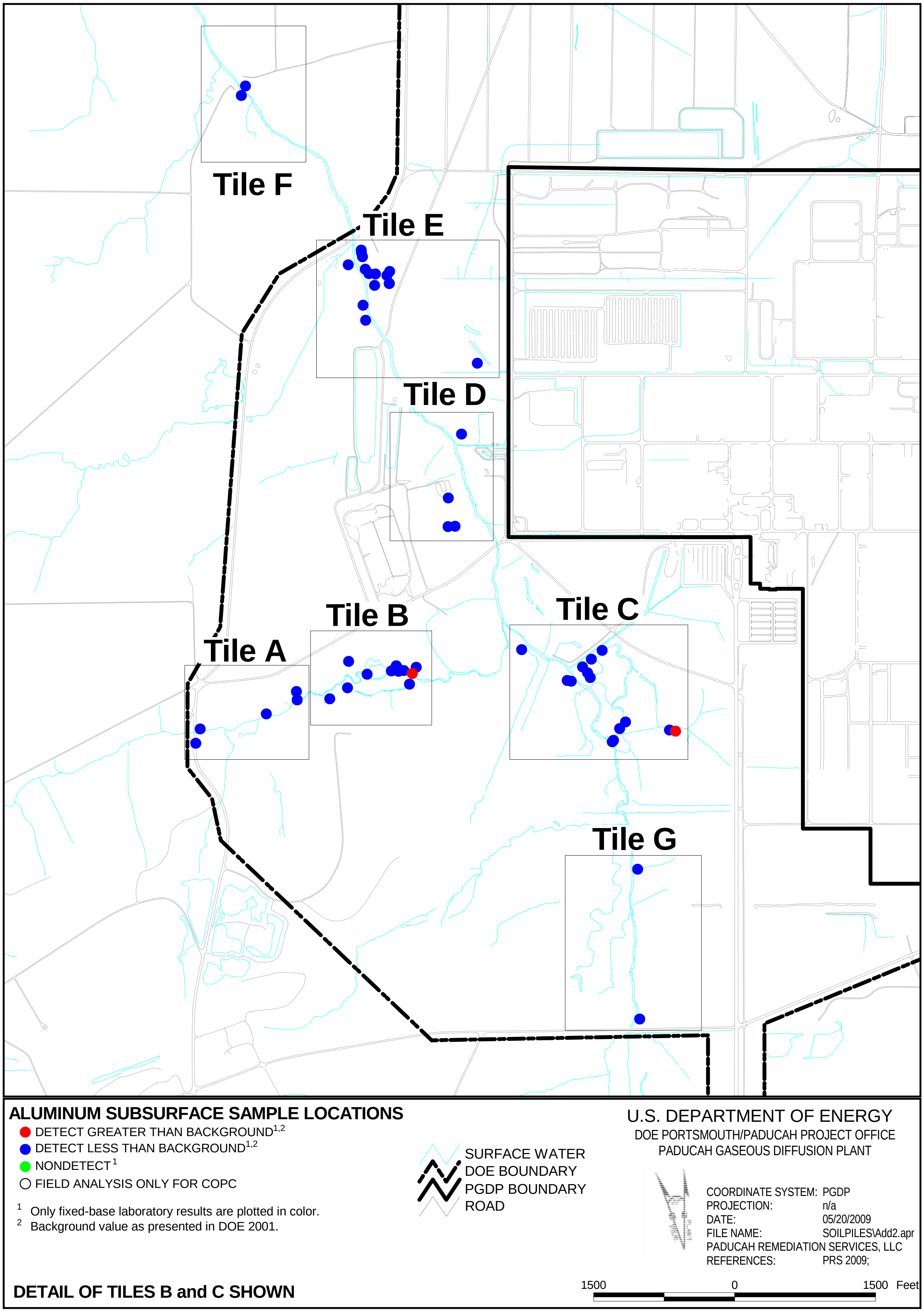
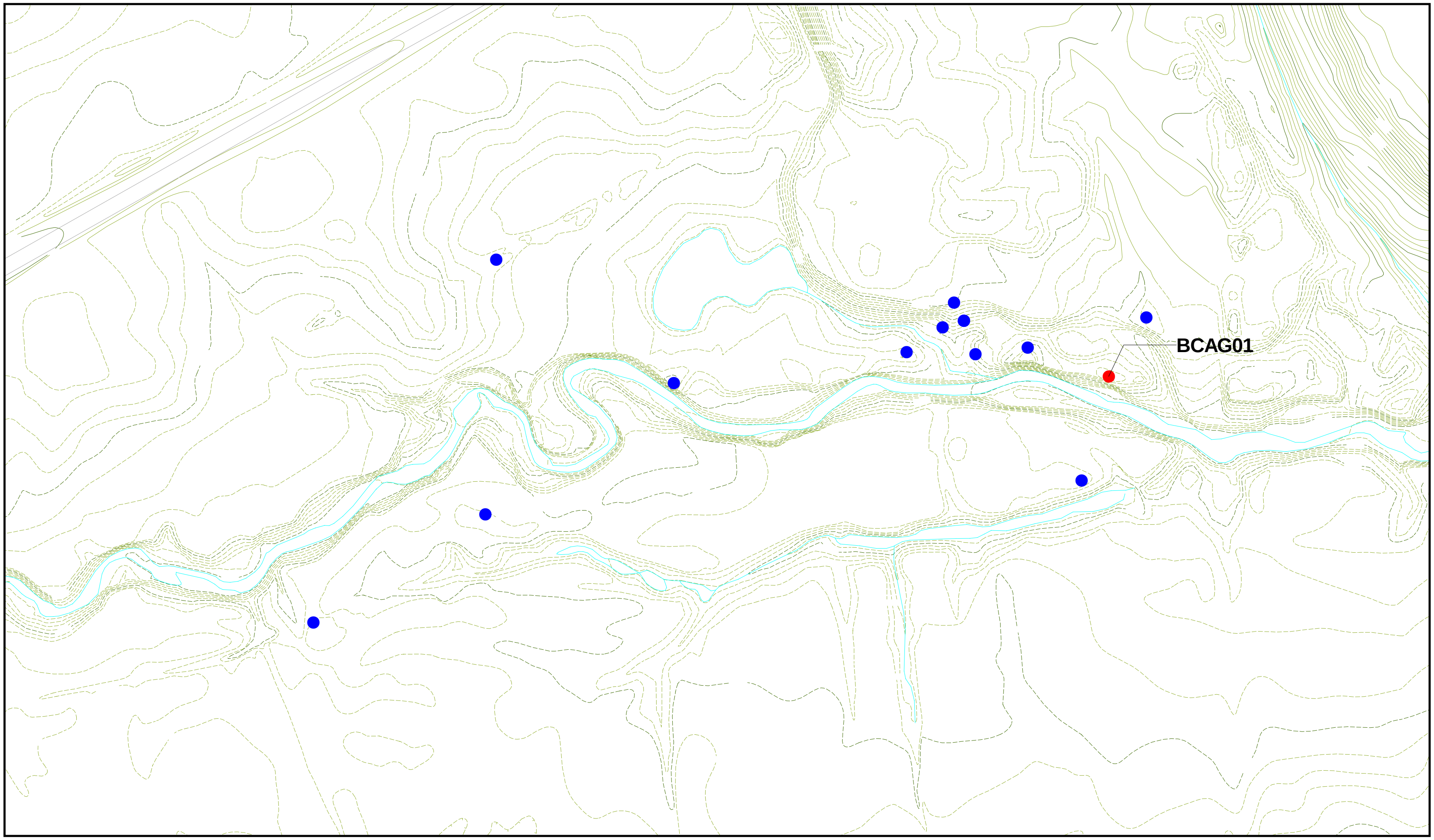
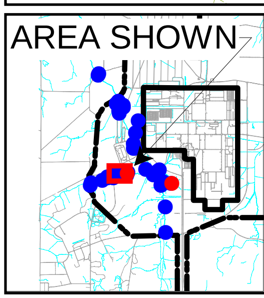


Figure B.2. Location of Sample Stations in Addendum 2 Soil Pile Sampling for Aluminum in the Subsurface





ALUMINUM SUBSURFACE SAMPLE LOCATIONS

- DETECT GREATER THAN BACKGROUND[1,2]
- DETECT LESS THAN BACKGROUND[1,2]
- NONDETECT[1]
- FIELD ANALYSIS ONLY FOR COPC

[1] Only fixed-base laboratory results are plotted in color.
[2] Background value as presented in DOE 2001.

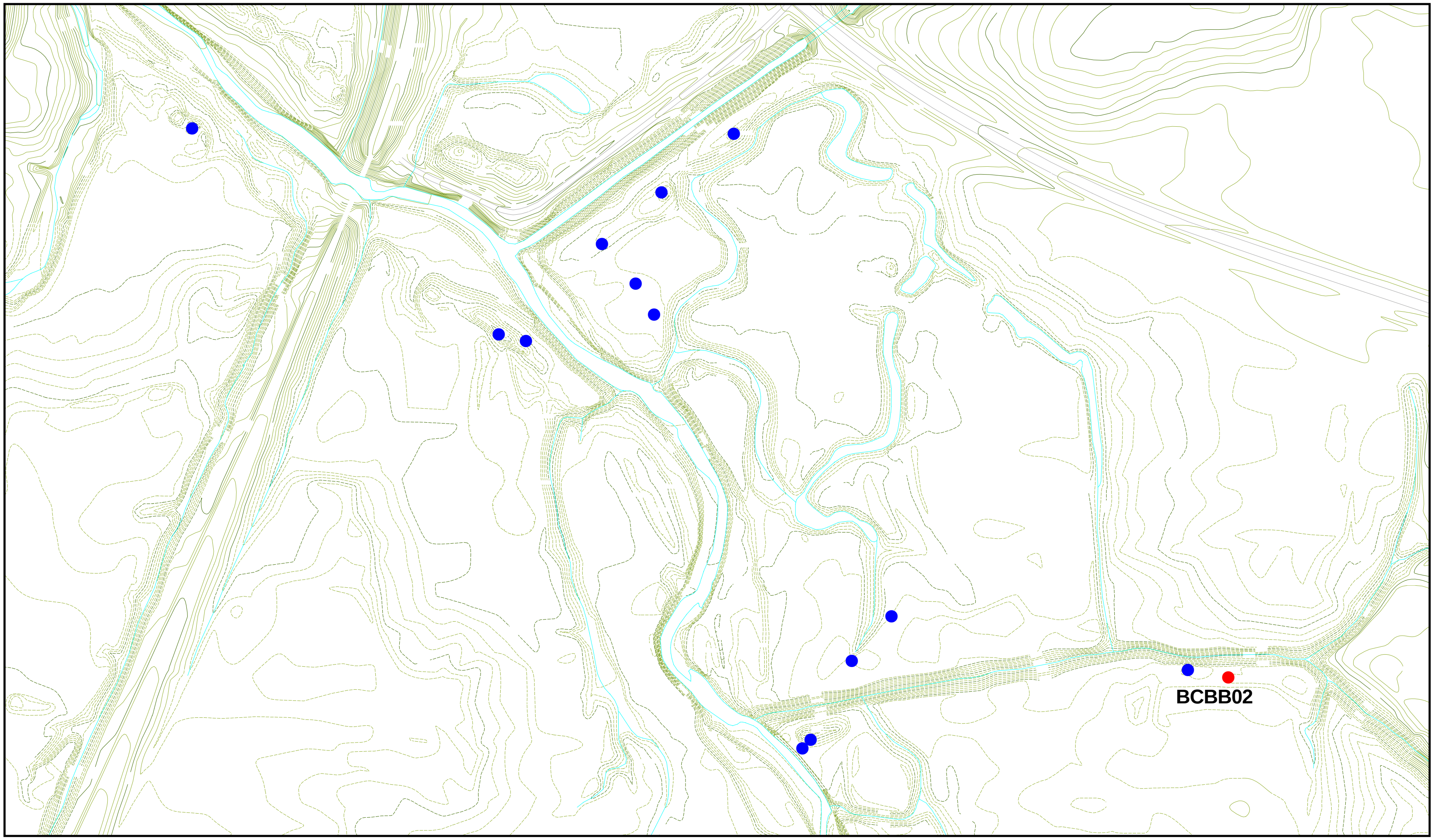
- SURFACE WATER
- DOE BOUNDARY
- PGDP BOUNDARY
- ROAD
- SURFACE CONTOUR (1 ft)
- SURFACE CONTOUR (5 ft)

TILE B

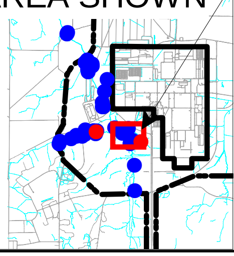
U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

COORDINATE SYSTEM:	PGDP
PROJECTION:	n/a
DATE:	05/20/2009
FILE NAME:	SOILPILES\Add2.apr
PADUCAH REMEDIATION SERVICES, LLC	
REFERENCES:	PRS 2009;

175 0 175 Feet



AREA SHOWN



ALUMINUM SUBSURFACE SAMPLE LOCATIONS

- DETECT GREATER THAN BACKGROUND[1,2]
- DETECT LESS THAN BACKGROUND[1,2]
- NONDETECT[1]
- FIELD ANALYSIS ONLY FOR COPC

[1] Only fixed-base laboratory results are plotted in color.
[2] Background value as presented in DOE 2001.

SURFACE WATER
DOE BOUNDARY
PGDP BOUNDARY
ROAD
SURFACE CONTOUR (1 ft)
SURFACE CONTOUR (5 ft)

TILE C

U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

COORDINATE SYSTEM: PGDP
PROJECTION: n/a
DATE: 05/20/2009
FILE NAME: SOILPILES\Add2.apr
PADUCAH REMEDIATION SERVICES, LLC
REFERENCES: PRS 2009;

250 0 250 Feet

Arsenic–Subsurface. Arsenic values in subsurface soil samples exceed the background value of 7.9 mg/kg in 4 of 56 samples. The four exceeding values are 7.94, 8.3, 8.85, and 9 mg/kg.

Figure B.3 graphically shows the results with the background value and other comparison values. Figure B.4 illustrates the spatial distribution of the sampling locations in which the background value was exceeded. As illustrated in Figure B.4, the arsenic results from piles BA and BB are the only piles in relative proximity to one another. These results are 8.85 and 8.3 mg/kg, respectively.

These 4 of 56 samples were evaluated more extensively by applying the criteria for ambient background values established by KEEC: (1) the mean site concentration (4.29 mg/kg) is below the 95% UCL of the mean concentrations of KEEC background (9.4 mg/kg); (2) at least half of the data points are less than the 60th percentile (8.3 mg/kg); and (3) no data points are above the upper bound value (21.2 mg/kg) (KEEC 2004). Therefore, although arsenic is detected in 4 samples at levels greater than the benchmark background value, arsenic is below the range of background presented and should not be considered present as a contaminant in the Addendum 2 soil piles.

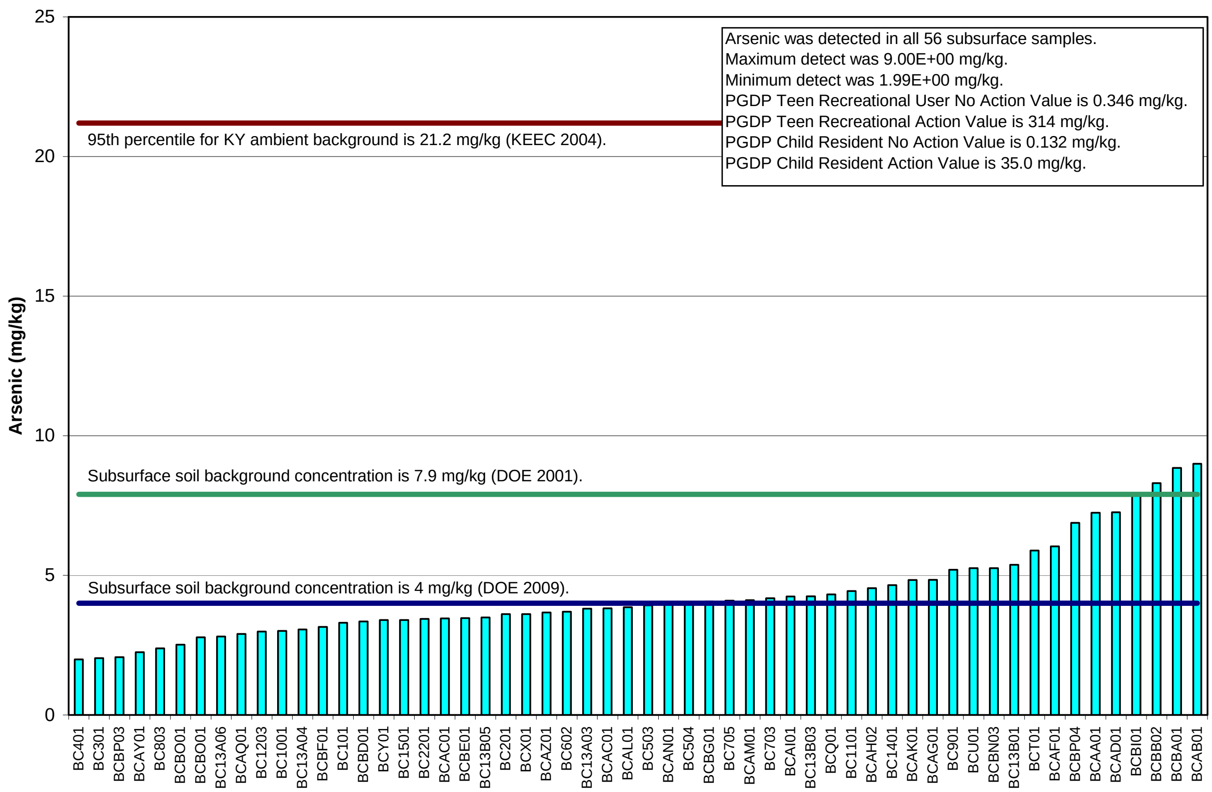


Figure B.3. Comparison between Arsenic Concentrations in Samples from Soil Piles Addendum 2 and Subsurface Soil Background Concentrations

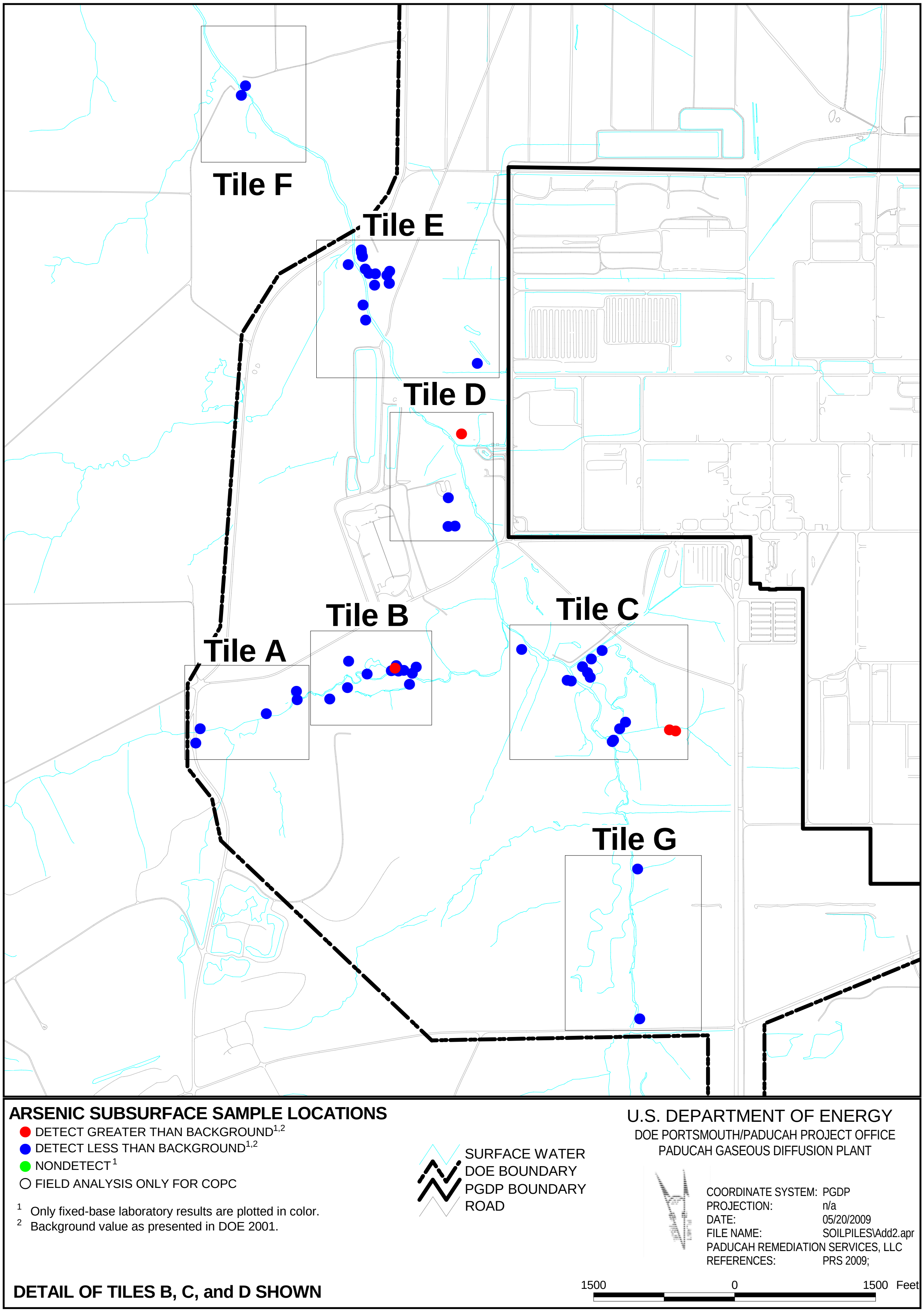


Figure B.4. Location of Sample Stations in Addendum 2 Soil Pile Sampling for Arsenic in the Subsurface

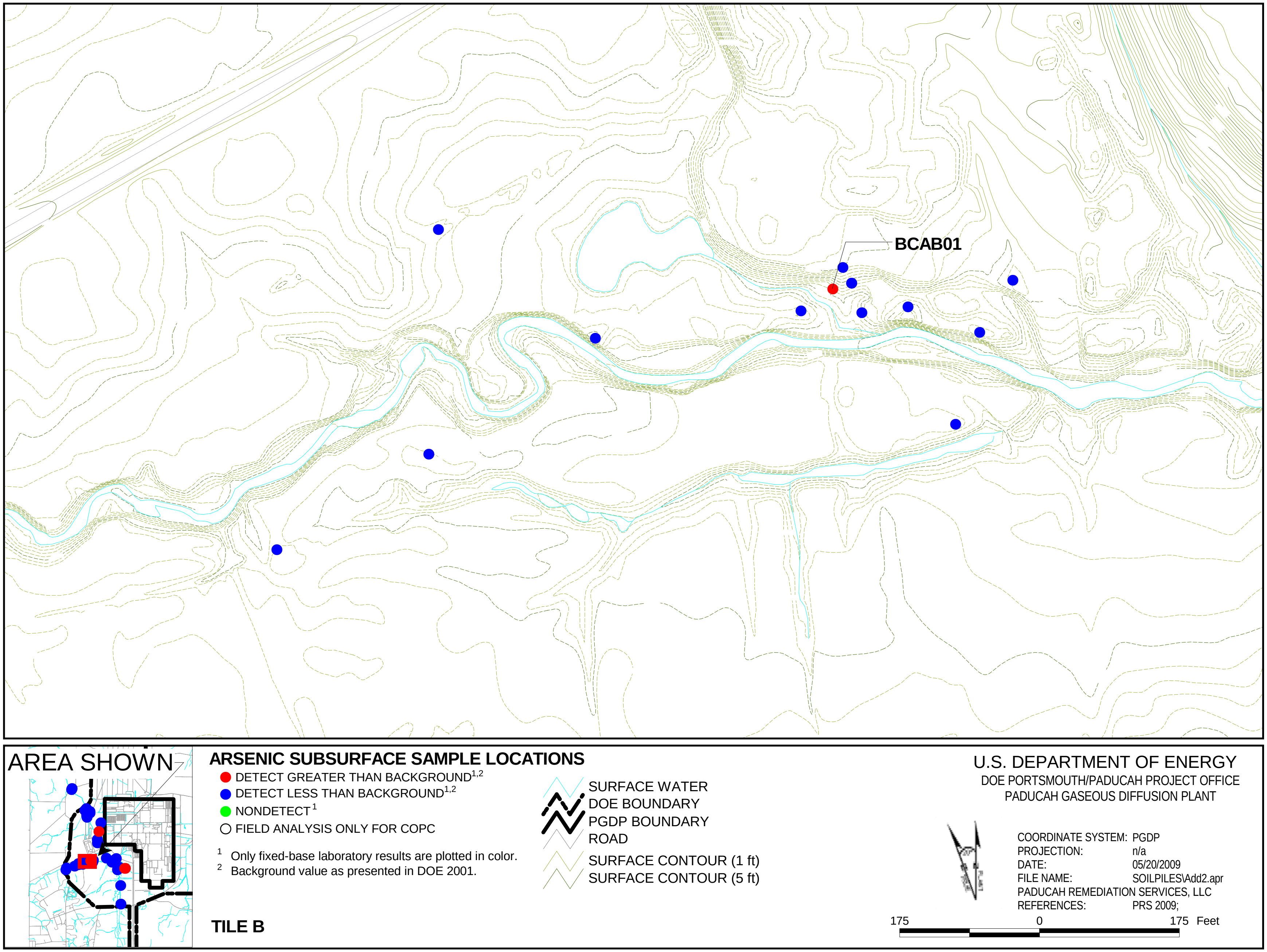


Figure B.4. (Continued)

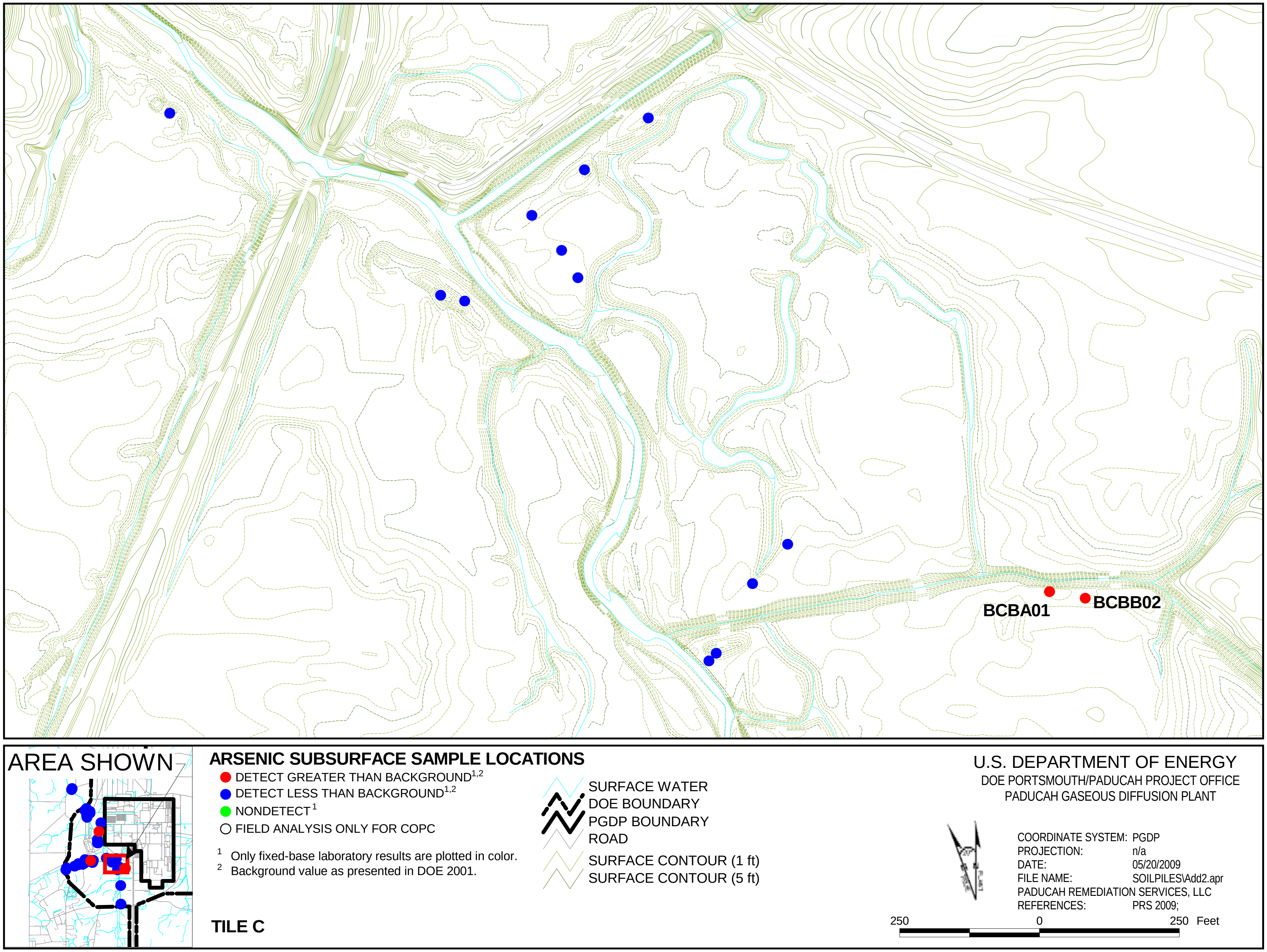


Figure B.4. (Continued)

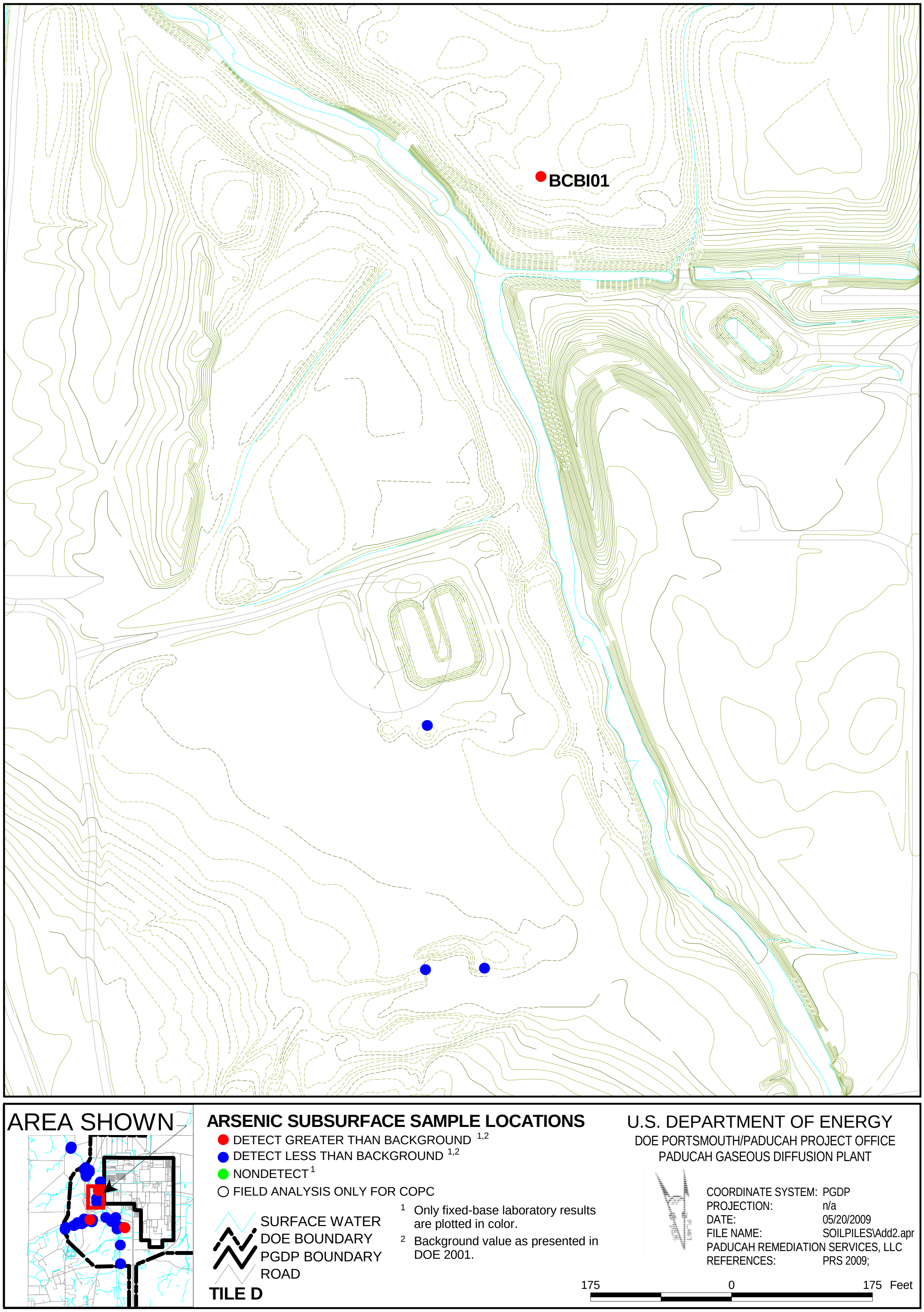


Figure B.4. (Continued)

Beryllium–Surface. Beryllium values in surface soil samples exceed the background value of 0.67 mg/kg in 3 of 54 samples. The three exceeding values are 0.676, 0.686, and 0.716 mg/kg. The criteria for applying ambient background values established by KEEC were met: (1) the mean site concentration (0.559 mg/kg) is below the 95% UCL of the mean concentrations of KEEC background (0.83 mg/kg); (2) at least half of the data points are less than the 60th percentile (0.75 mg/kg); and (3) no data points are above the upper bound value (1.8 mg/kg) (KEEC 2004). Figure B.5 graphically shows the results with the background value and other comparison values.

Figure B.6 illustrates the spatial distribution of the sampling locations in which the background value was exceeded. The soil piles from which the samples were collected are not related spatially.

Although beryllium is detected in 3 of 54 samples at levels greater than the benchmark background value, beryllium is below the range of background presented and should not be considered present in the Addendum 2 soil piles as a contaminant.

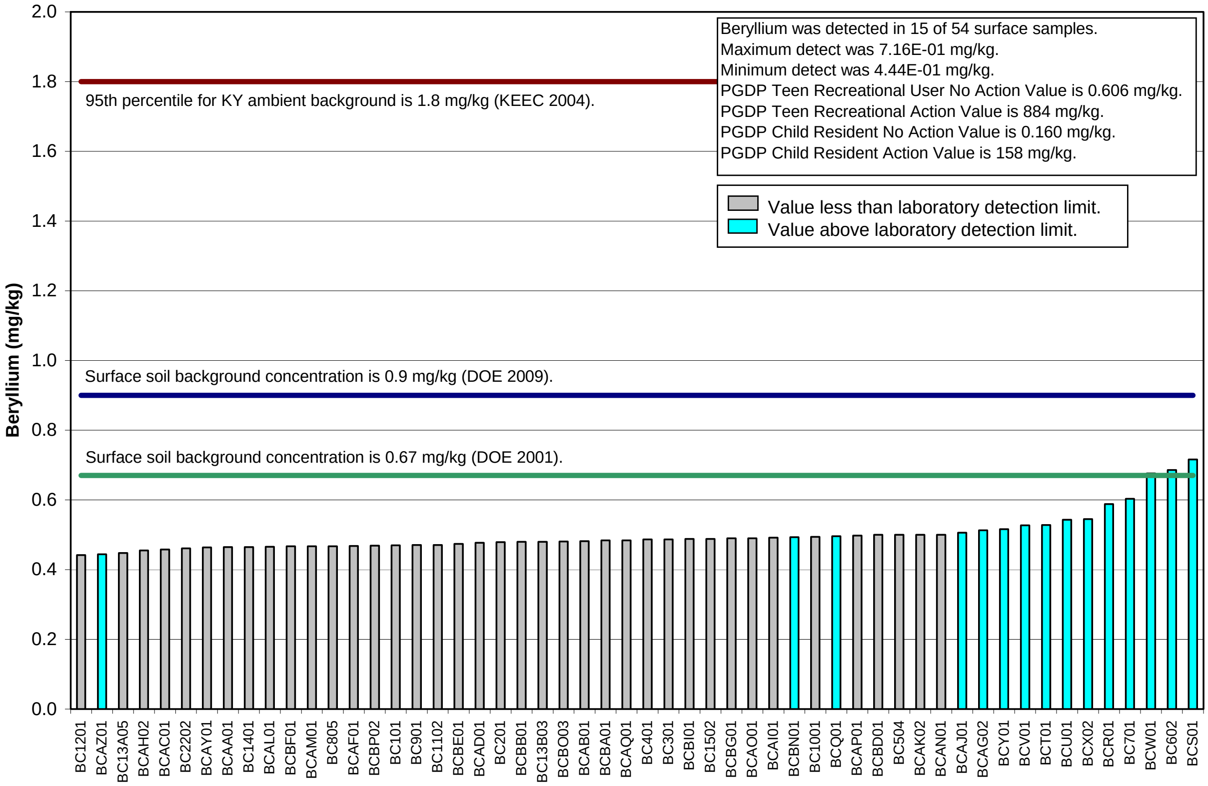


Figure B.5. Comparison between Beryllium Concentrations in Samples from Soil Piles Addendum 2 and Surface Soil Background Concentrations

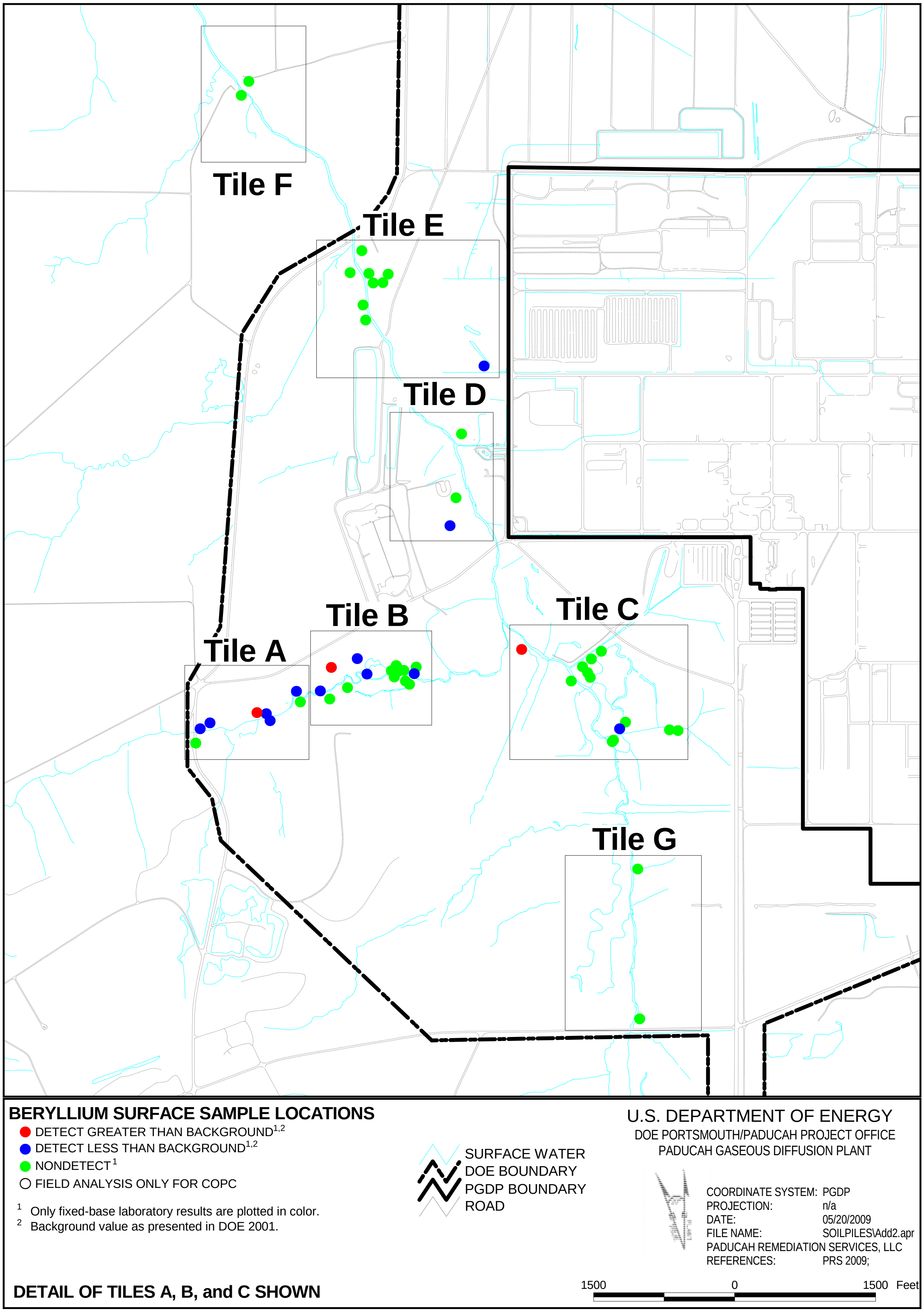
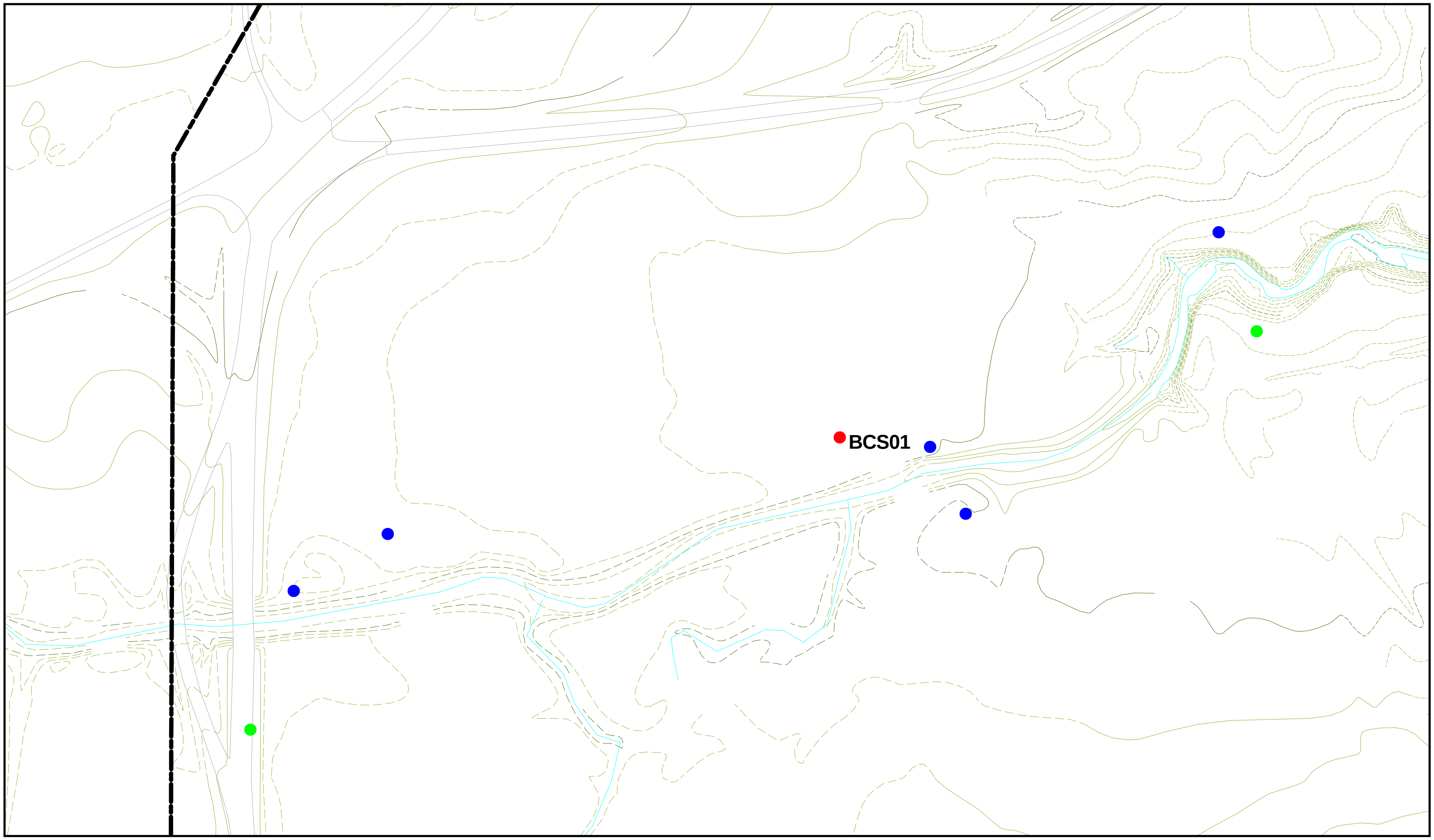
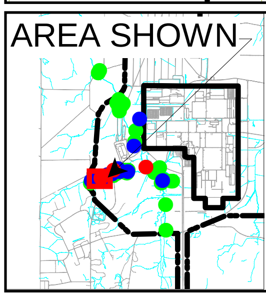


Figure B.6. Location of Sample Stations in Addendum 2 Soil Pile Sampling for Beryllium in the Surface





BERYLLIUM SURFACE SAMPLE LOCATIONS

- DETECT GREATER THAN BACKGROUND[1,2]
- DETECT LESS THAN BACKGROUND[1,2]
- NONDETECT[1]
- FIELD ANALYSIS ONLY FOR COPC

[1] Only fixed-base laboratory results are plotted in color.
[2] Background value as presented in DOE 2001.

SURFACE WATER
DOE BOUNDARY
PGDP BOUNDARY
ROAD
SURFACE CONTOUR (1 ft)
SURFACE CONTOUR (5 ft)

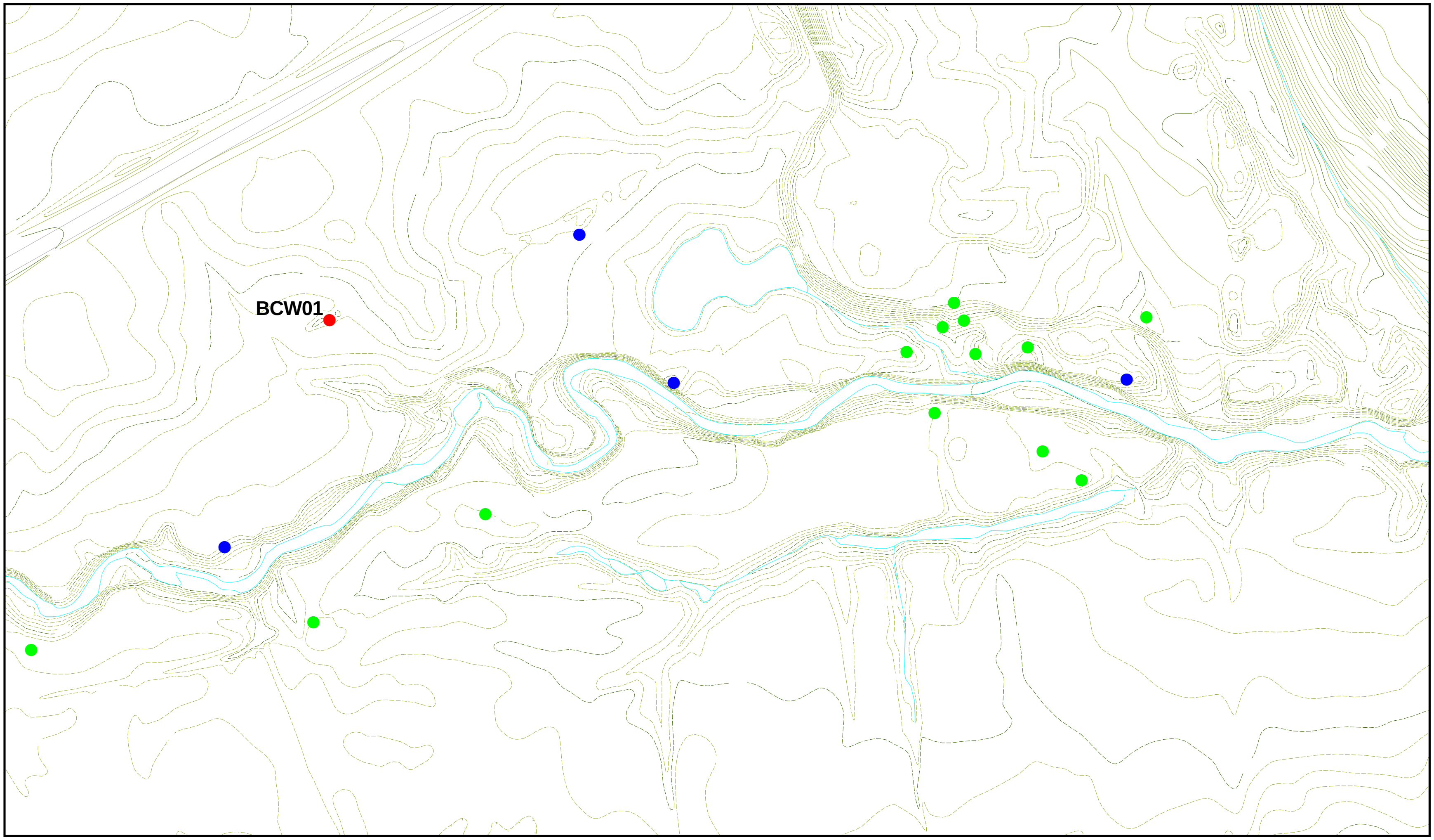
TILE A

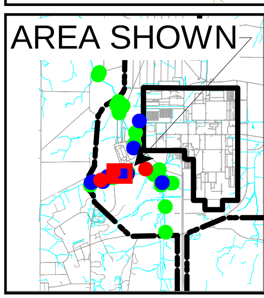
U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

COORDINATE SYSTEM:	PGDP
PROJECTION:	n/a
DATE:	05/20/2009
FILE NAME:	SOILPILES\Add2.apr
PADUCAH REMEDIATION SERVICES, LLC	
REFERENCES:	PRS 2009;

175 0 175 Feet

Figure B.6. (Continued)





BERYLLIUM SURFACE SAMPLE LOCATIONS

- DETECT GREATER THAN BACKGROUND[1,2]
- DETECT LESS THAN BACKGROUND[1,2]
- NONDETECT[1]
- FIELD ANALYSIS ONLY FOR COPC

[1] Only fixed-base laboratory results are plotted in color.
[2] Background value as presented in DOE 2001.

SURFACE WATER
DOE BOUNDARY
PGDP BOUNDARY
ROAD
SURFACE CONTOUR (1 ft)
SURFACE CONTOUR (5 ft)

TILE B

U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

COORDINATE SYSTEM:	PGDP
PROJECTION:	n/a
DATE:	05/20/2009
FILE NAME:	SOILPILES\Add2.apr
PADUCAH REMEDIATION SERVICES, LLC	
REFERENCES:	PRS 2009;

175 0 175 Feet

Figure B.6. (Continued)

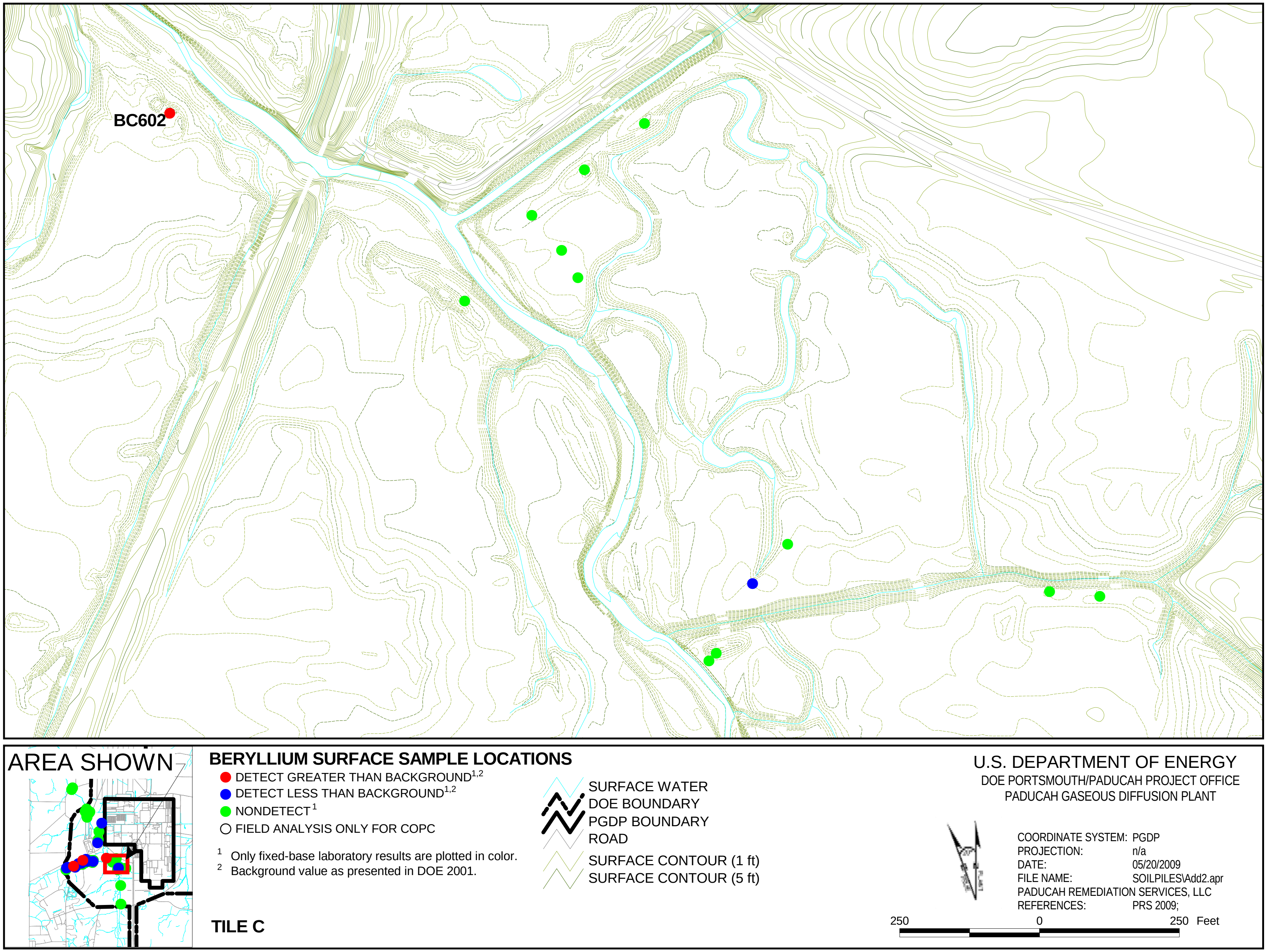


Figure B.6. (Continued)

Cadmium–Surface. Cadmium values in surface soil samples exceed the background value of 0.21 mg/kg in 6 of 54 samples. The exceeding values were the only detects of cadmium in surface samples because the background value is lower than the detection limit for cadmium. Detected values in the samples range from 0.477 to 0.674 mg/kg. The criteria for applying ambient background values established by KEEC were met: (1) the mean site concentration (for detects) (0.554 mg/kg) is below the 95% UCL of the mean concentrations of KEEC background (0.78 mg/kg); (2) at least half of the data points are not detected and therefore less than the 60th percentile (0.27 mg/kg); and (3) no data points are above the upper bound value (3.9 mg/kg) (KEEC 2004). Figure B.7 graphically shows the results with the background value and other comparison values.

Figure B.8 illustrates the spatial distribution of the sampling locations in which the background value was exceeded. Although 4 of the 6 detected values are primarily located within close proximity, their values (ranging 0.477 to 0.674 mg/kg) are close to the laboratory detection limits (ranging 0.455 to 0.468 mg/kg). These values all are well below the statewide ambient background values and, as such, are not of consequence; therefore, cadmium is not present in the Addendum 2 soil piles as a contaminant in the surface.

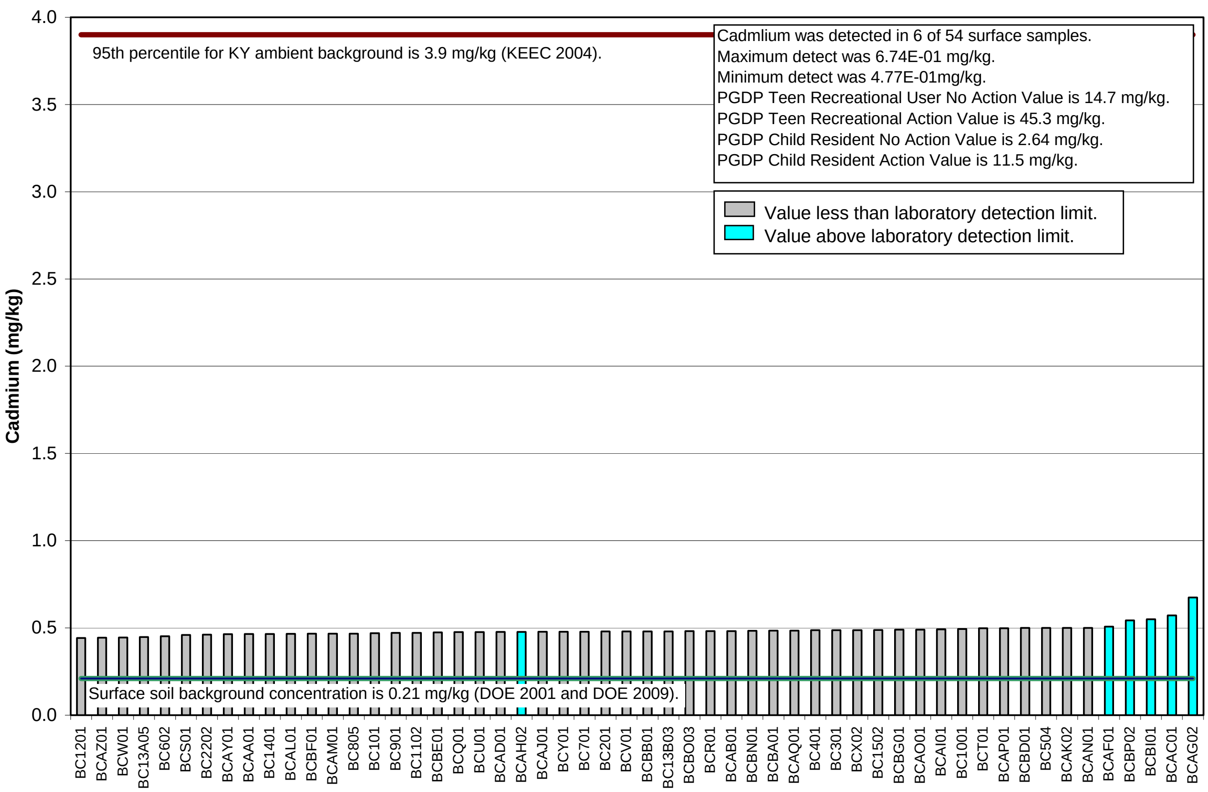


Figure B.7. Comparison between Cadmium Concentrations in Samples from Soil Piles Addendum 2 and Surface Soil Background Concentrations

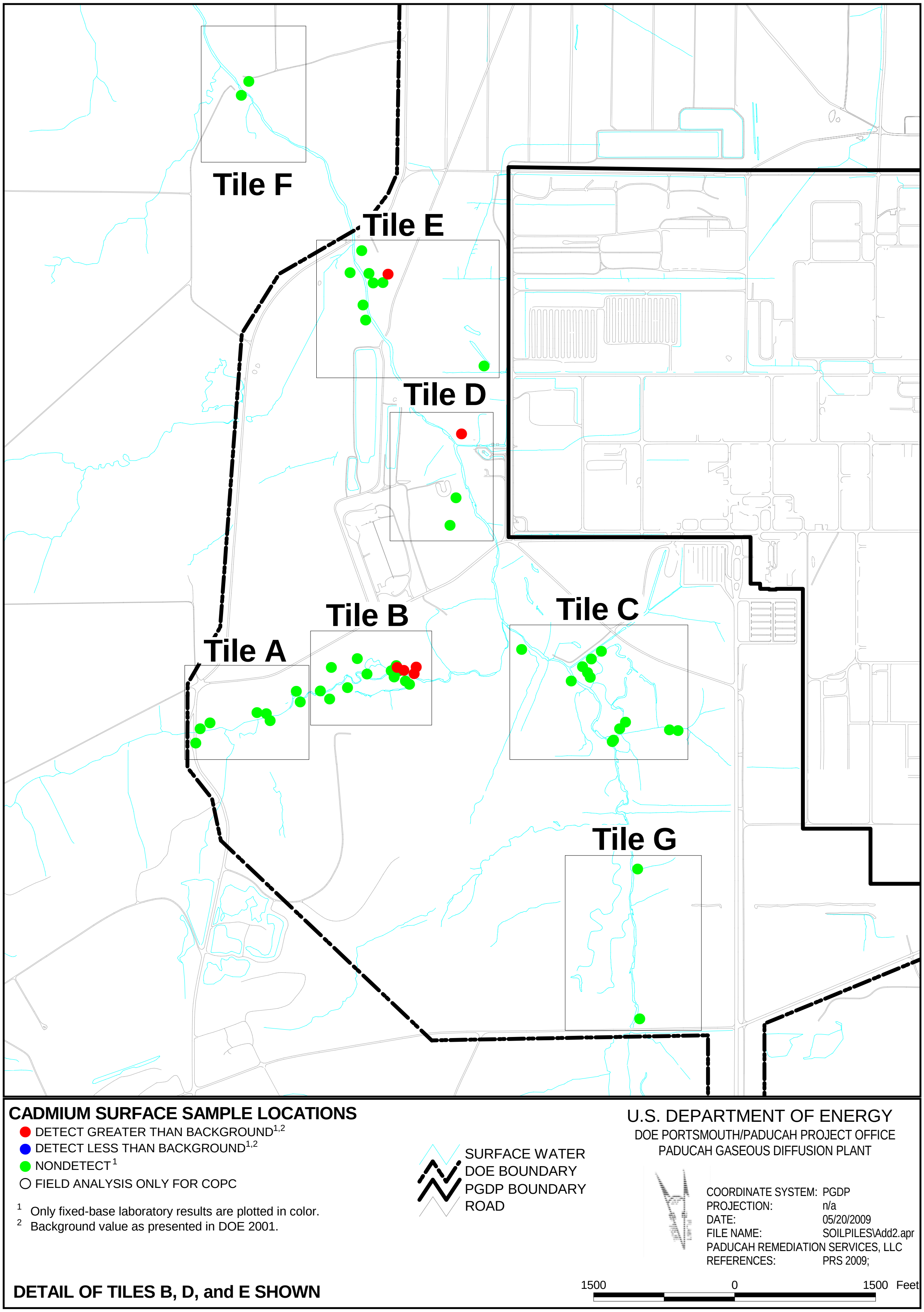
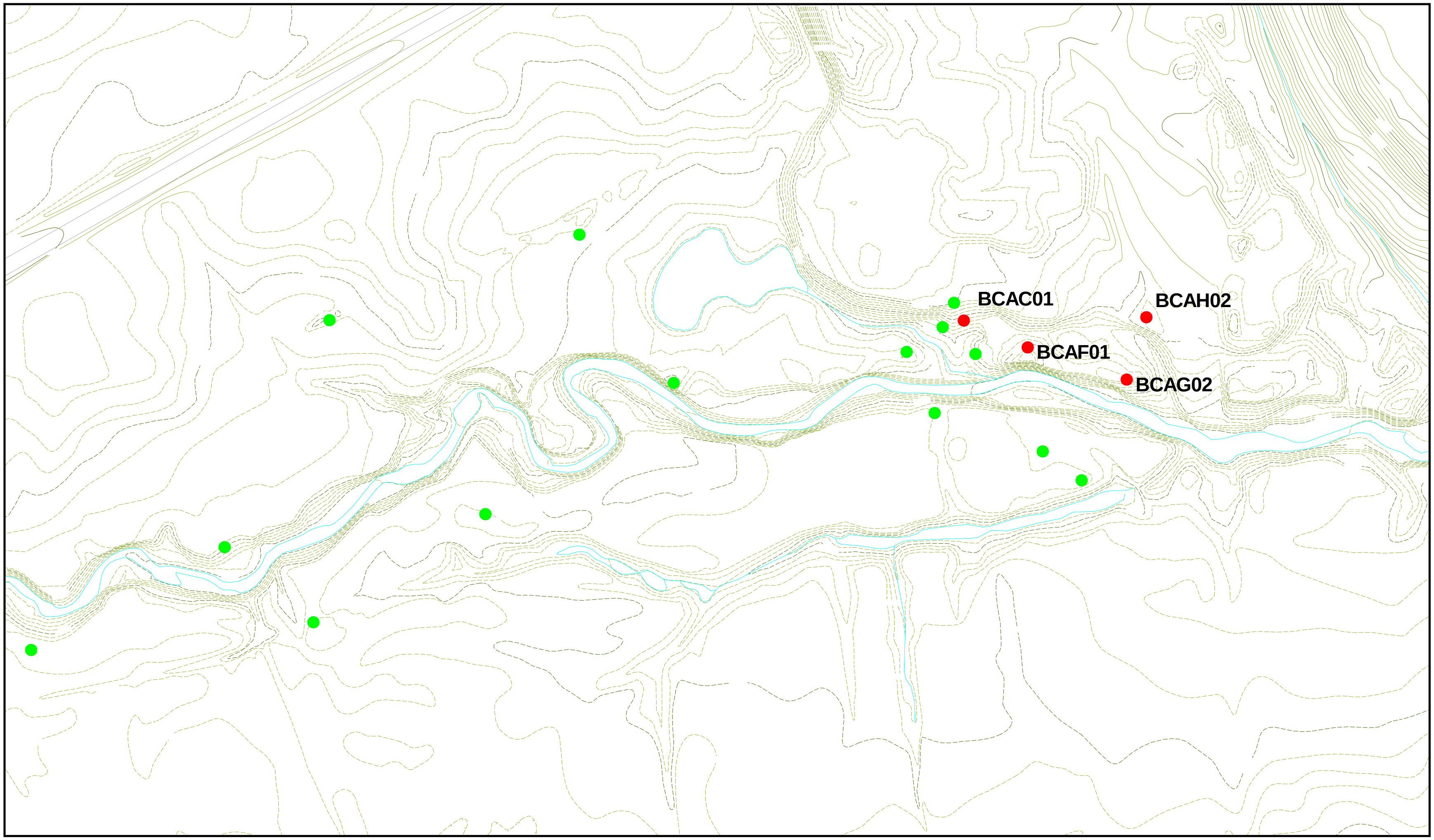


Figure B.8. Location of Sample Stations in Addendum 2 Soil Pile Sampling for Cadmium in the Surface

Figure B.8. (Continued)



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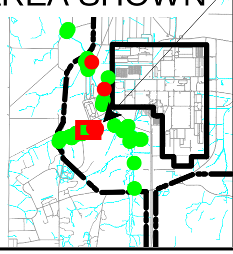


CADMIUM SURFACE SAMPLE LOCATIONS

- DETECT GREATER THAN BACKGROUND[1,2]
- DETECT LESS THAN BACKGROUND[1,2]
- NONDETECT[1]
- FIELD ANALYSIS ONLY FOR COPC

[1] Only fixed-base laboratory results are plotted in color.
[2] Background value as presented in DOE 2001.

SURFACE WATER
DOE BOUNDARY
PGDP BOUNDARY
ROAD
SURFACE CONTOUR (1 ft)
SURFACE CONTOUR (5 ft)

TILE B

U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

COORDINATE SYSTEM:	PGDP
PROJECTION:	n/a
DATE:	05/20/2009
FILE NAME:	SOILPILES\Add2.apr
PADUCAH REMEDIATION SERVICES, LLC	
REFERENCES:	PRS 2009;

175 0 175 Feet

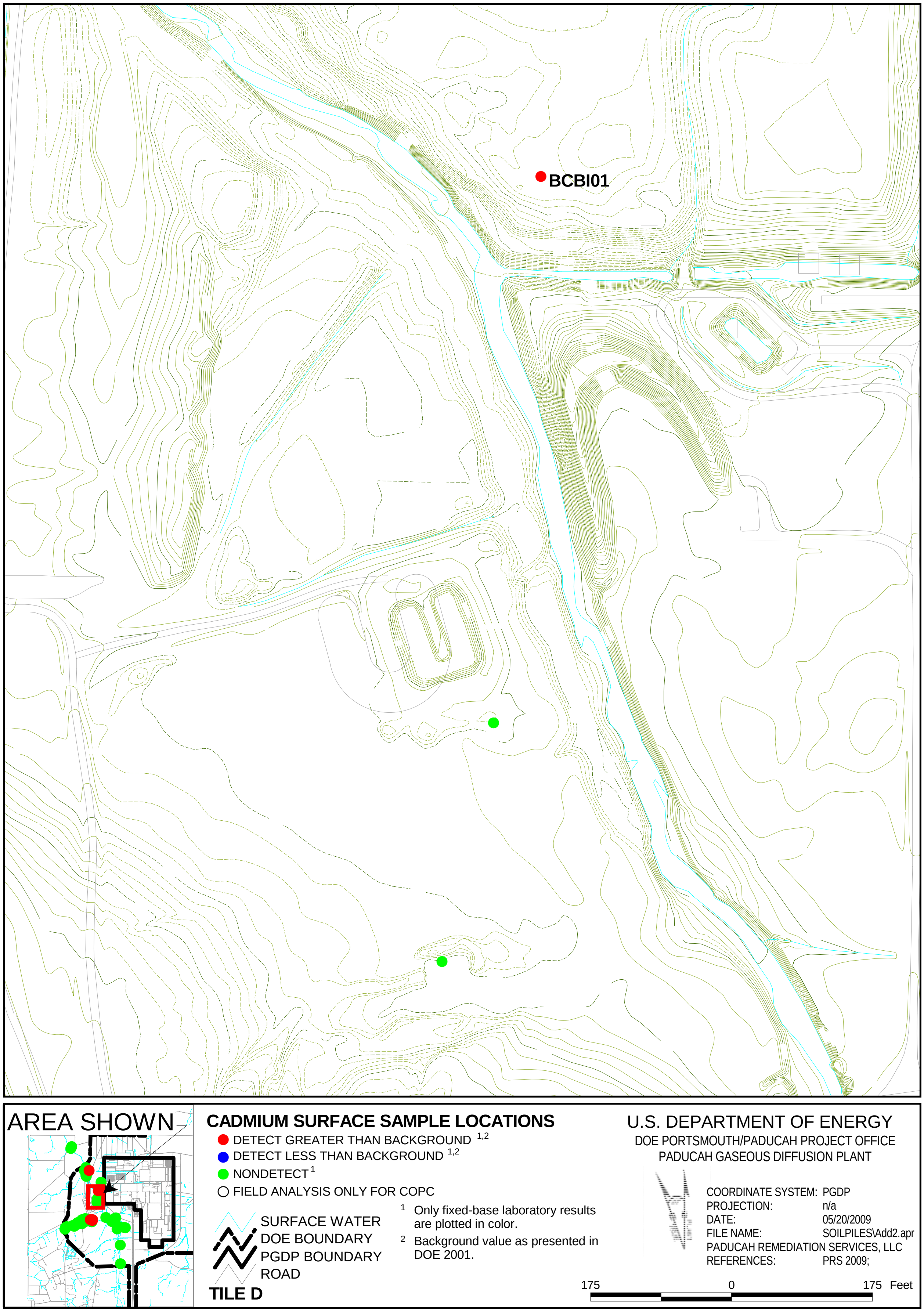


Figure B.8. (Continued)

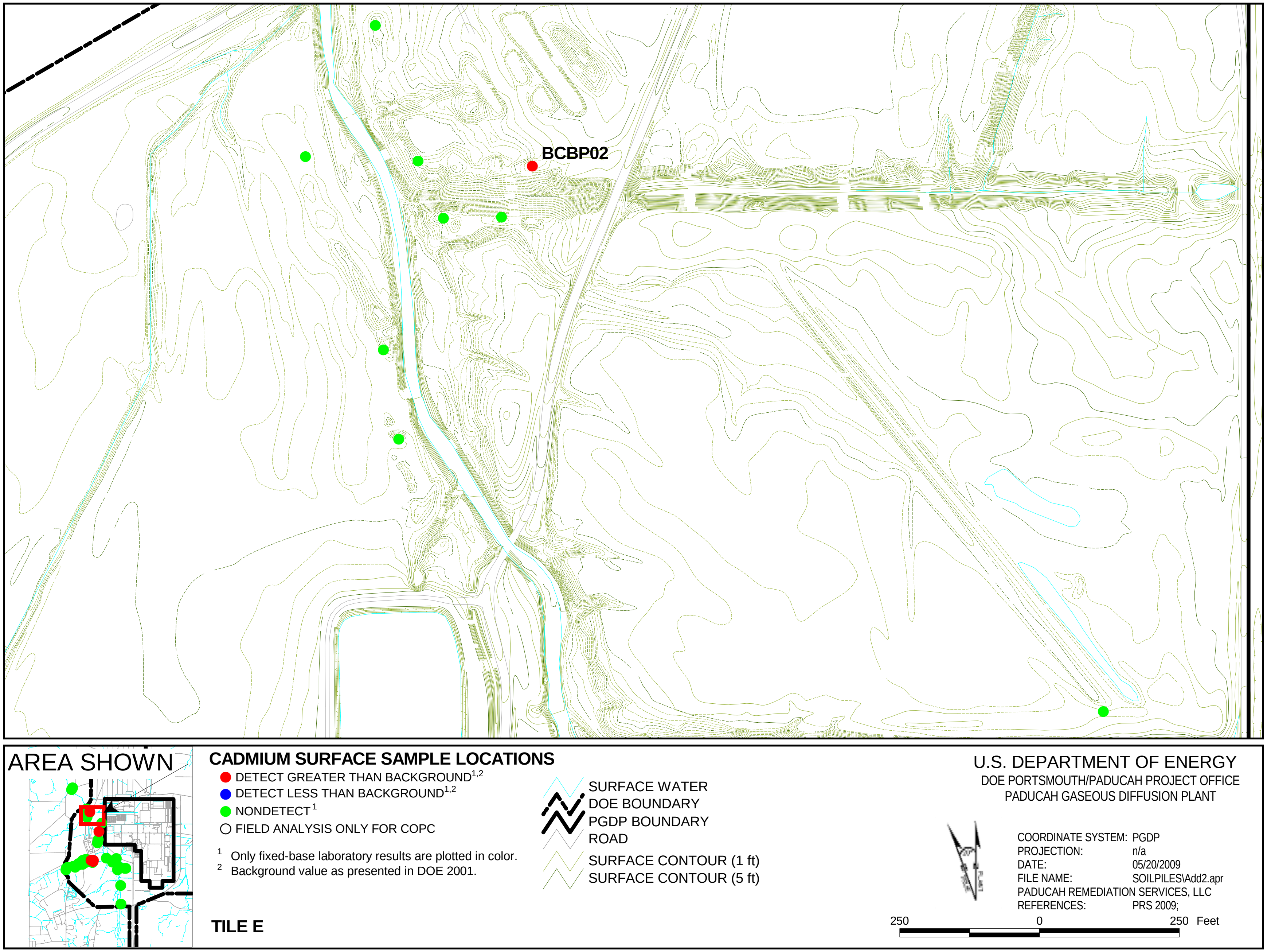


Figure B.8. (Continued)

Cadmium–Subsurface. Cadmium values in subsurface soil samples exceed the background value of 0.21 mg/kg in 8 of 56 samples. The exceeding values were the only detects of cadmium in the subsurface because the background value is lower than the detection limit for cadmium. Detected values in the samples range from 0.466 to 0.655 mg/kg. The criteria for applying ambient background values established by KEEC were met: (1) the mean site concentration (for detects) (0.543 mg/kg) is below the 95% UCL of the mean concentrations of KEEC background (0.78 mg/kg); (2) at least half of the data points are not detected and, therefore, less than the 60th percentile (0.27 mg/kg); and (3) no data points are above the upper bound value (3.9 mg/kg) (KEEC 2004). Figure B.9 graphically shows the results with the background value and other comparison values.

Figure B.10 illustrates the spatial distribution of the sampling locations in which the background value was exceeded. Although 6 of the 8 detected values are primarily located within close proximity, their values (ranging 0.466 to 0.609 mg/kg) are close to the laboratory detection limits (ranging 0.439 to 0.499 mg/kg). These values are all well below the statewide ambient background values and, as such, are not of consequence; therefore, cadmium is not present in the Addendum 2 soil piles as a contaminant in the subsurface.

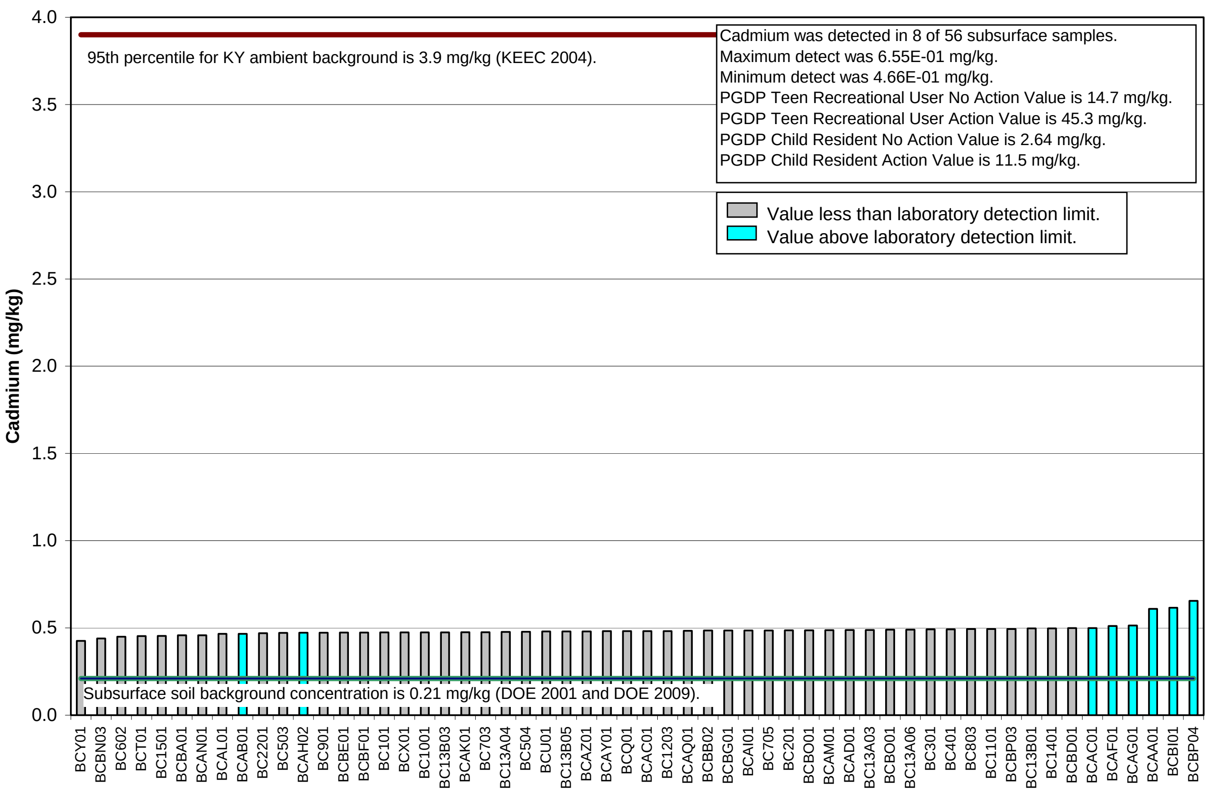


Figure B.9. Comparison between Cadmium Concentrations in Samples from Soil Piles Addendum 2 and Subsurface Soil Background Concentrations

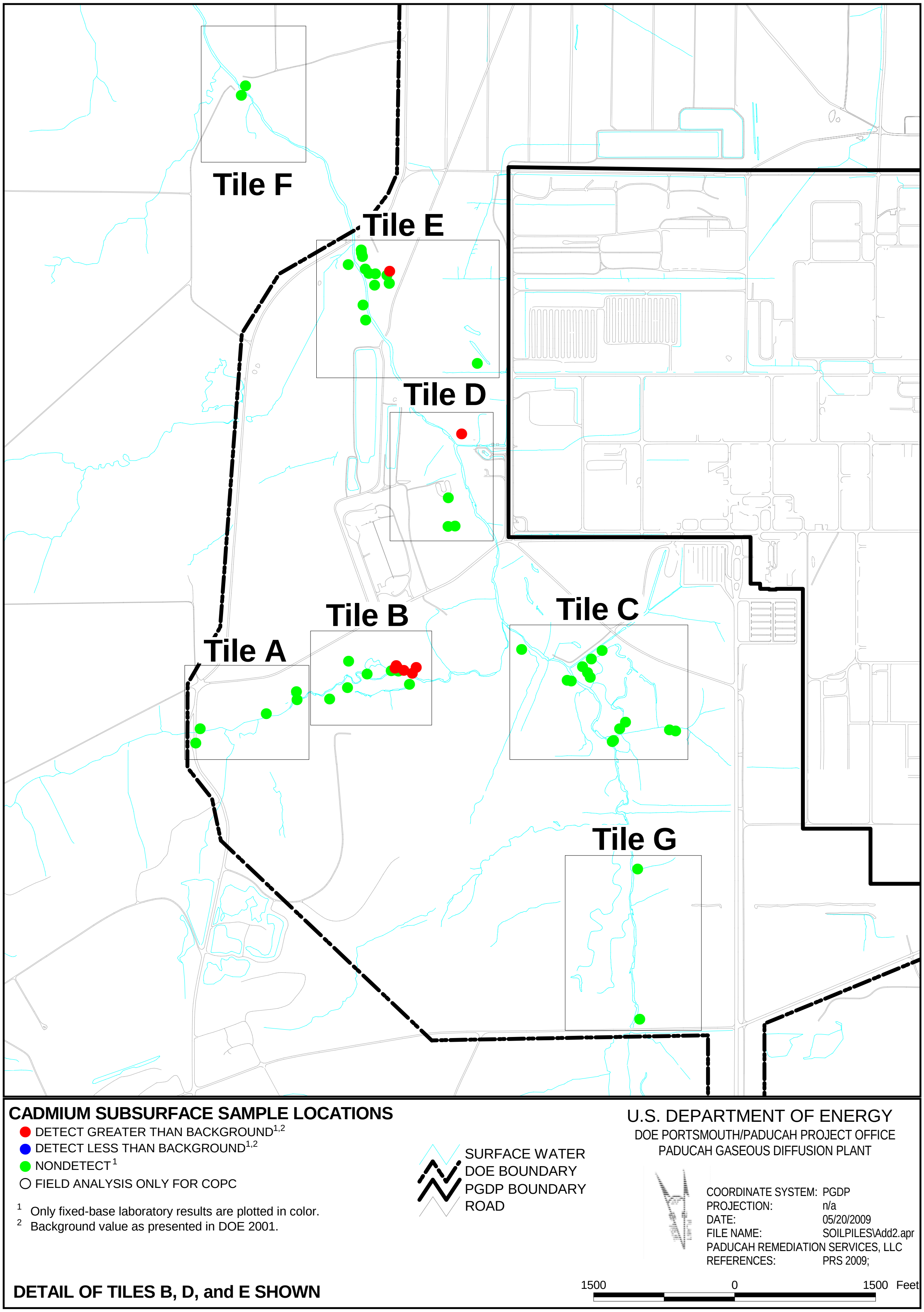
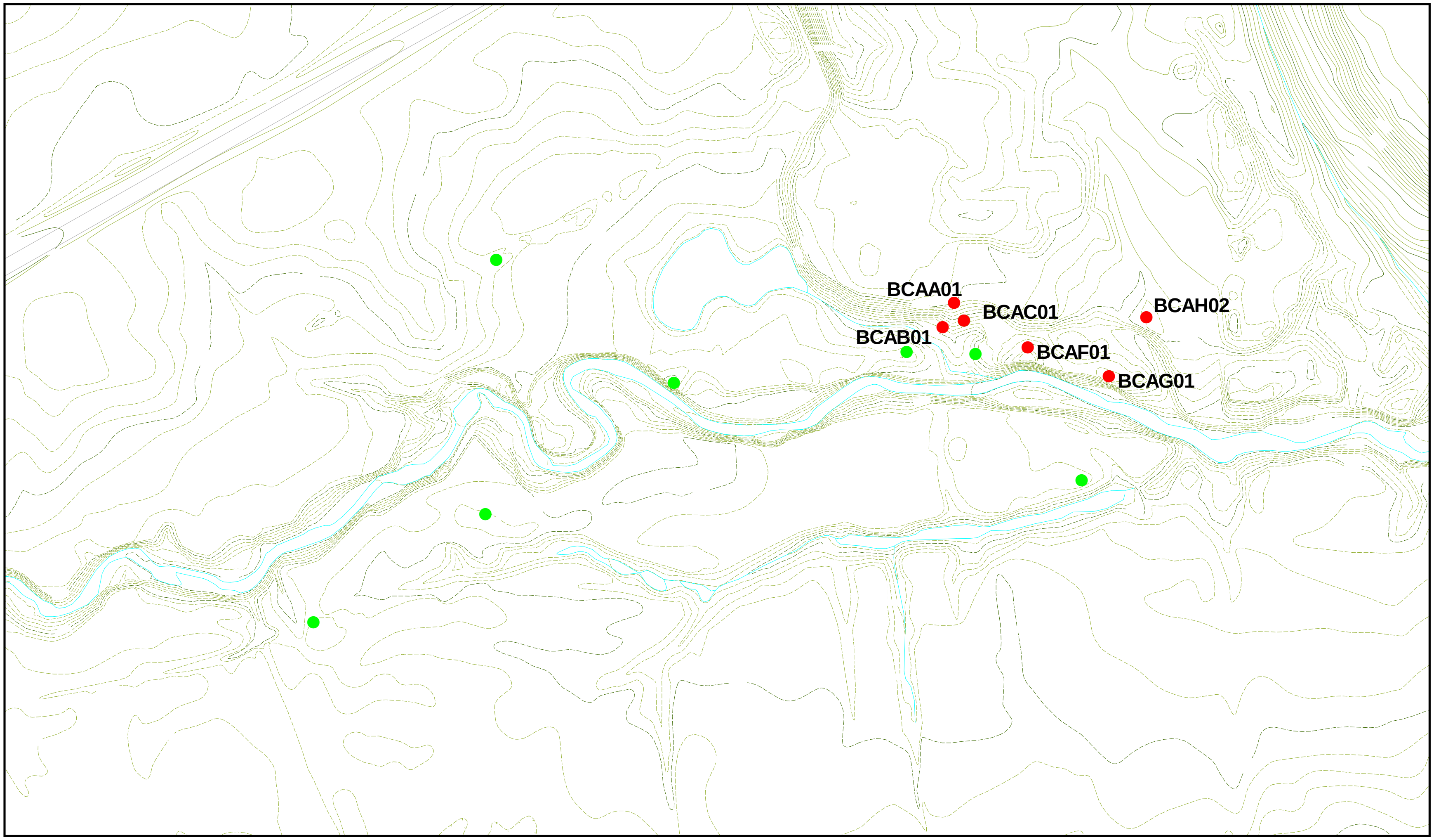
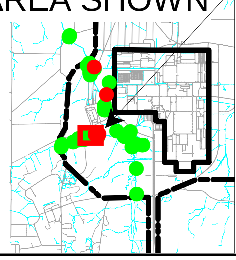


Figure B.10. Location of Sample Stations in Addendum 2 Soil Pile Sampling for Cadmium in the Subsurface

Figure B.10. (Continued)



AREA SHOWN



CADMIUM SUBSURFACE SAMPLE LOCATIONS

- DETECT GREATER THAN BACKGROUND[1,2]
- DETECT LESS THAN BACKGROUND[1,2]
- NONDETECT[1]
- FIELD ANALYSIS ONLY FOR COPC

[1] Only fixed-base laboratory results are plotted in color.
[2] Background value as presented in DOE 2001.

SURFACE WATER
DOE BOUNDARY
PGDP BOUNDARY
ROAD
SURFACE CONTOUR (1 ft)
SURFACE CONTOUR (5 ft)

TILE B

U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

COORDINATE SYSTEM:	PGDP
PROJECTION:	n/a
DATE:	05/20/2009
FILE NAME:	SOILPILES\Add2.apr
PADUCAH REMEDIATION SERVICES, LLC	
REFERENCES:	PRS 2009;

175 0 175 Feet

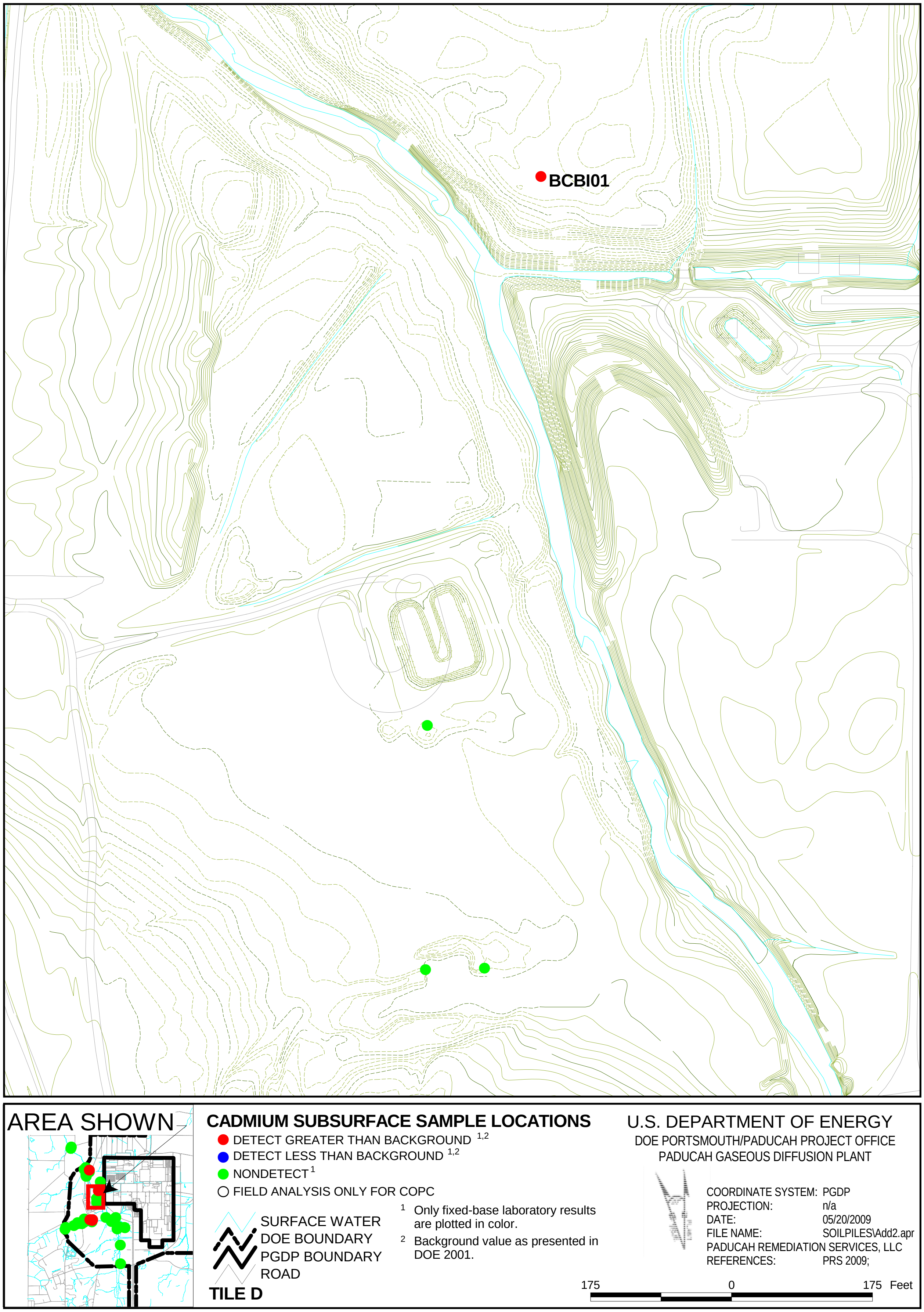


Figure B.10. (Continued)

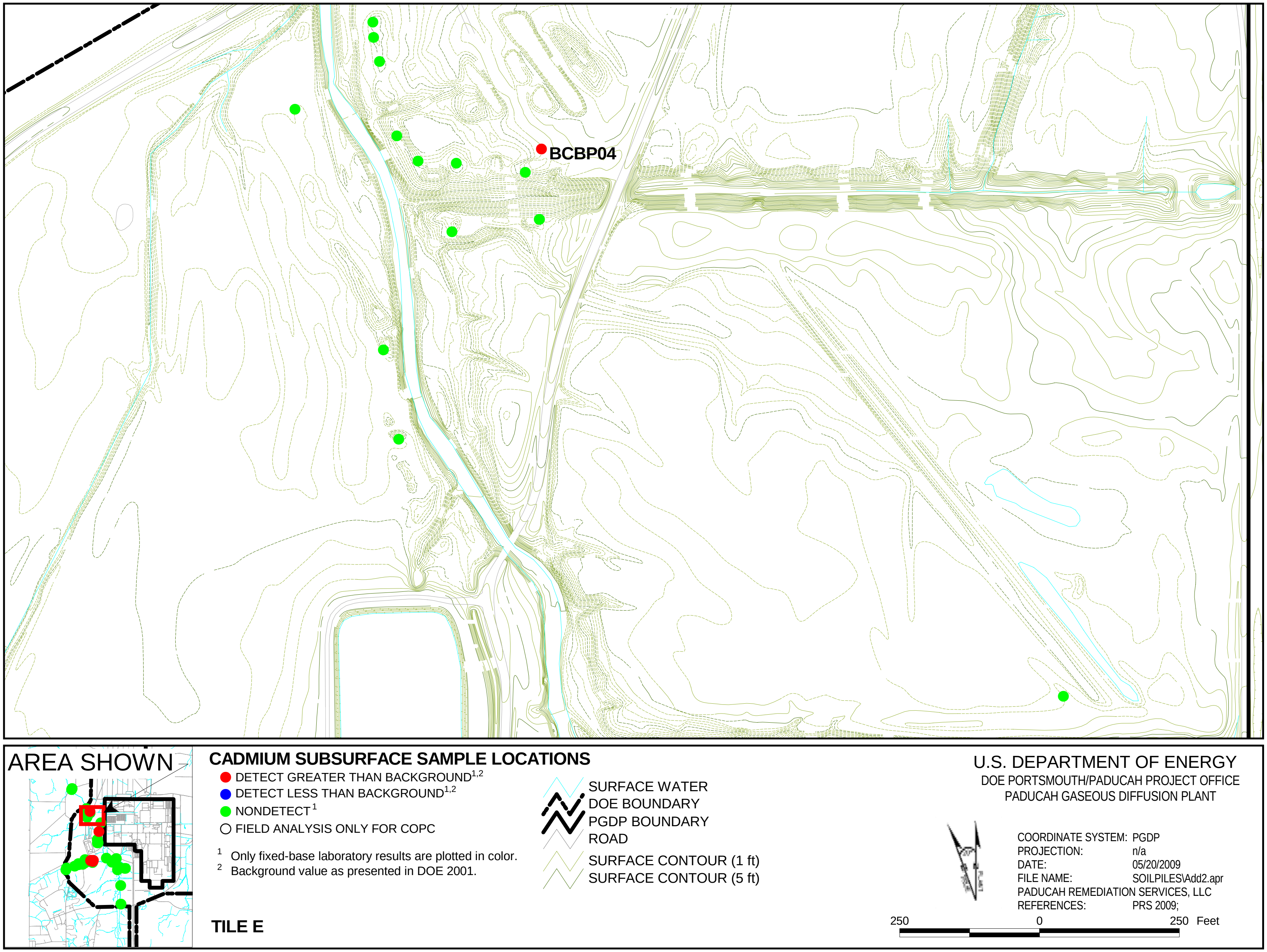


Figure B.10. (Continued)

Calcium–Subsurface. Calcium values in subsurface soil samples exceed the background value of 6,100 mg/kg in 3 of 56 samples. The three exceeding values are 9,750; 26,000; and 66,200 mg/kg. The locations from which the exceeding samples were collected are from the same area; however, several other samples were collected near these three locations that did not exceed background. Calcium is not listed with a generic statewide ambient background value, nor does the chemical have risk-based action and no-action levels because calcium is an essential element (DOE 2001); therefore, though calcium is present in the Addendum 2 soil piles above background, it is not considered a contaminant.

Figure B.11 graphically shows the results with the background value and other comparison values. Figure B.12 illustrates the spatial distribution of the sampling locations in which the background value was exceeded.

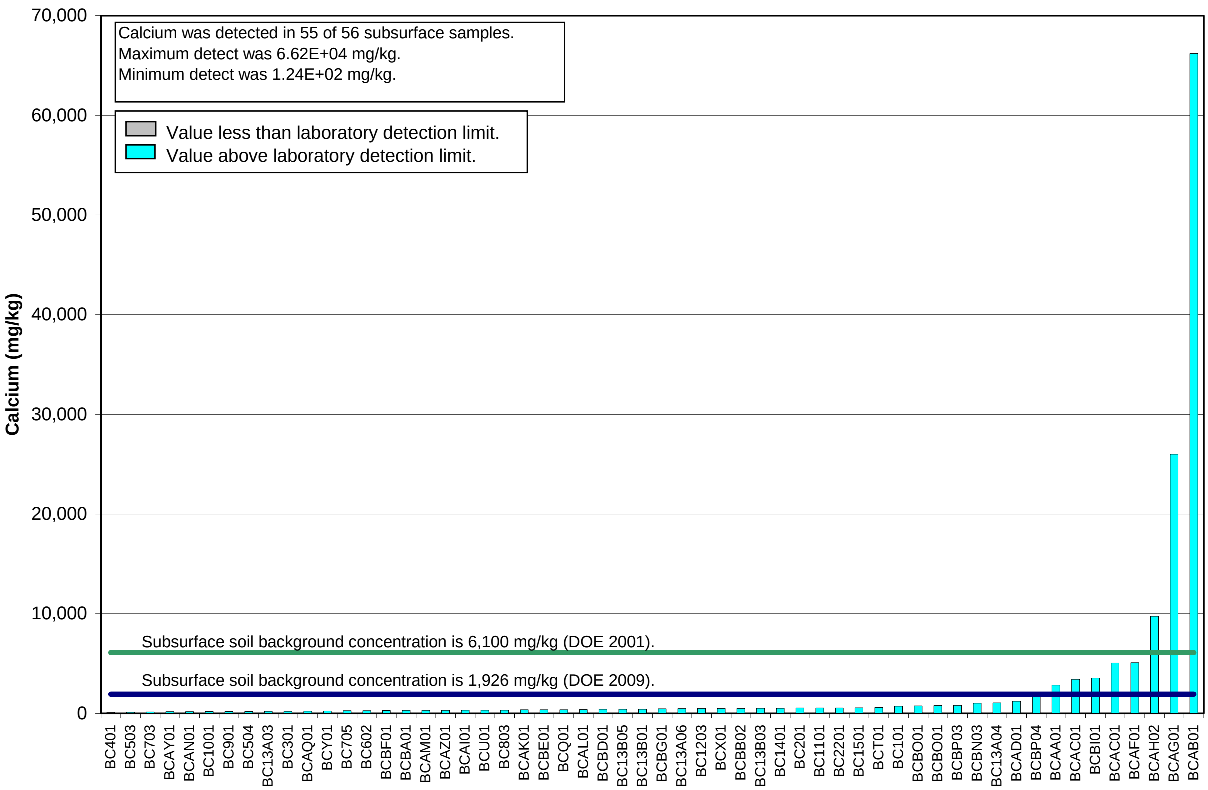


Figure B.11. Comparison between Calcium Concentrations in Samples from Soil Piles Addendum 2 and Subsurface Soil Background Concentrations

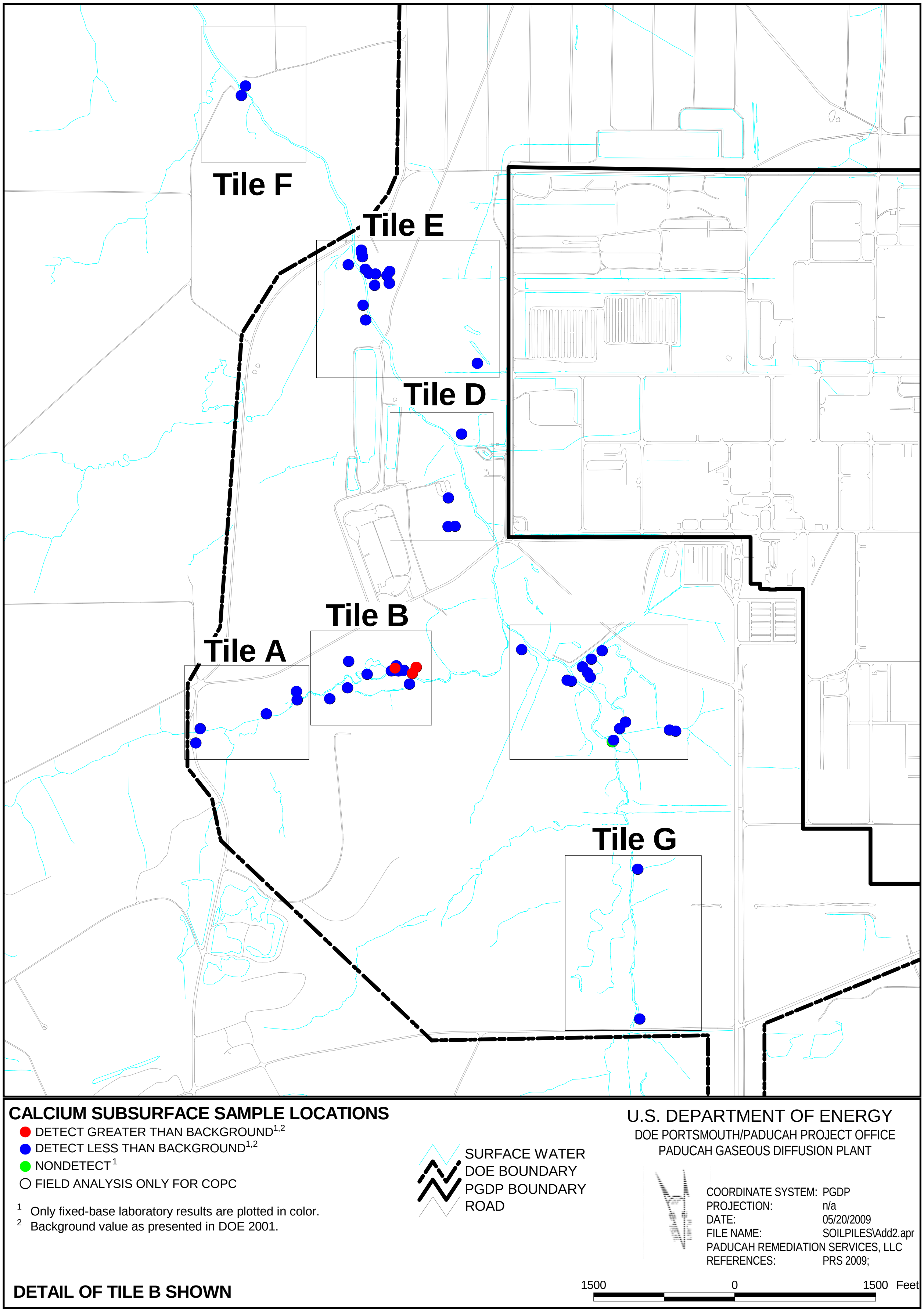


Figure B.12. Location of Sample Stations in Addendum 2 Soil Pile Sampling for Calcium in the Subsurface

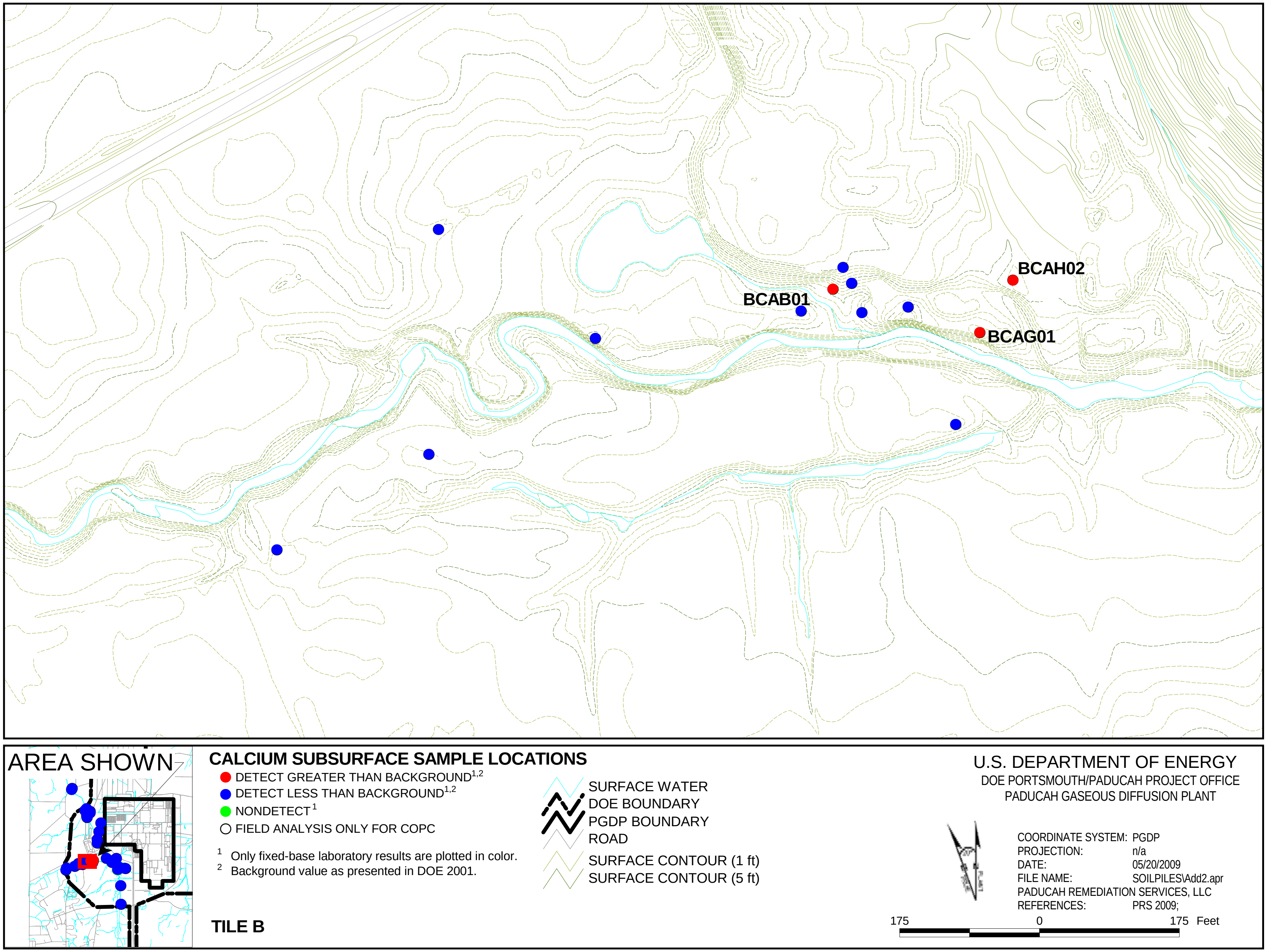


Figure B.12. (Continued)

Chromium–Surface. Chromium values in surface soil samples exceed the background value of 16 mg/kg in 5 of 54 samples. The samples exceeding background ranged from 16.7 to 29.7 mg/kg. Only 1 of the 54 samples exceeded the revised background value of 25 mg/kg established by the revised Risk Methods Document (DOE 2009). The criteria for applying ambient background values established by KEEC were met: (1) the mean site concentration (11.8 mg/kg) is below the 95% UCL of the mean concentrations of KEEC background (21.3 mg/kg); (2) at least half of the data points are less than the 60th percentile (19.3 mg/kg); and (3) no data points are above the upper bound value (40 mg/kg) (KEEC 2004); therefore, chromium is not present in the Addendum 2 soil piles as a contaminant in the surface. Figure B.13 graphically shows the results with the background value and other comparison values.

Figure B.14 illustrates the spatial distribution of the sampling locations in which the background value was exceeded.

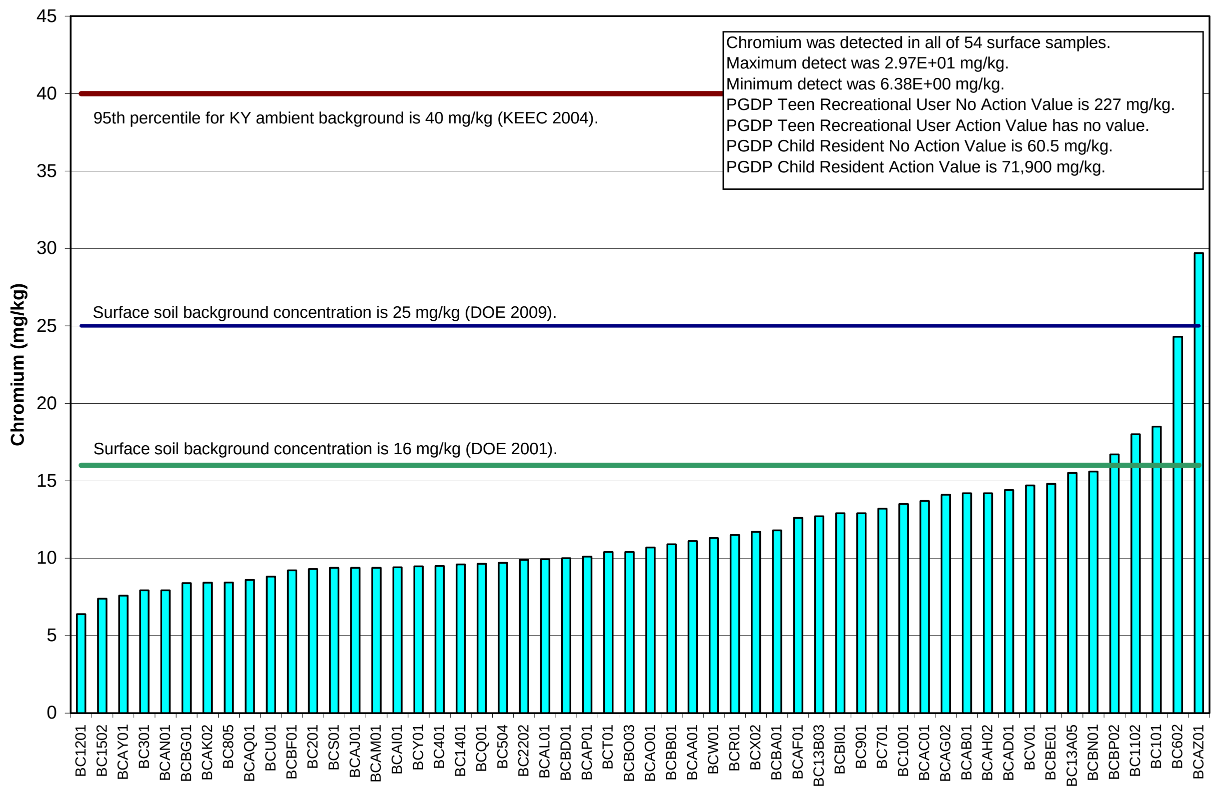


Figure B.13. Comparison between Chromium Concentrations in Samples from Soil Piles Addendum 2 and Surface Soil Background Concentrations

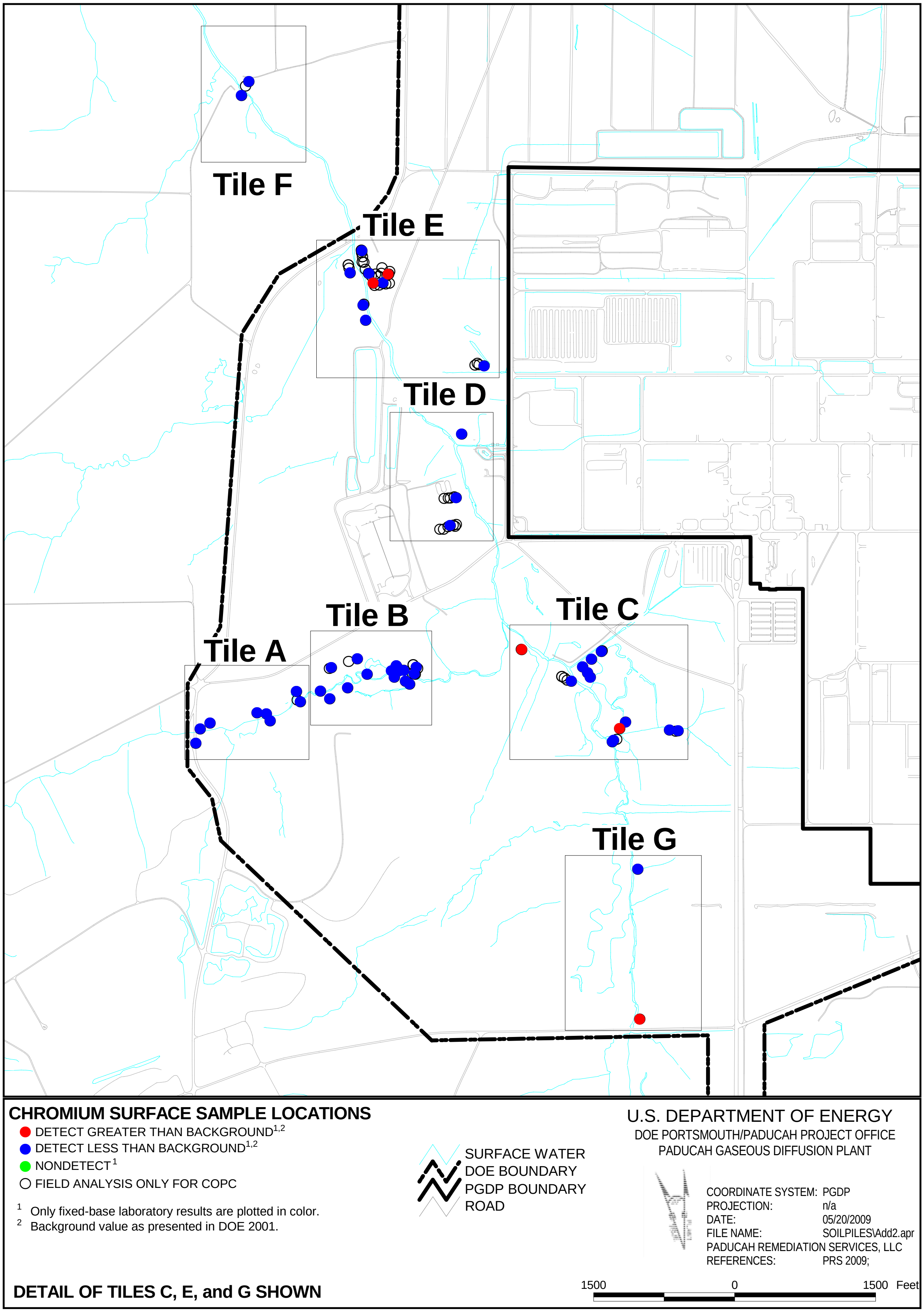
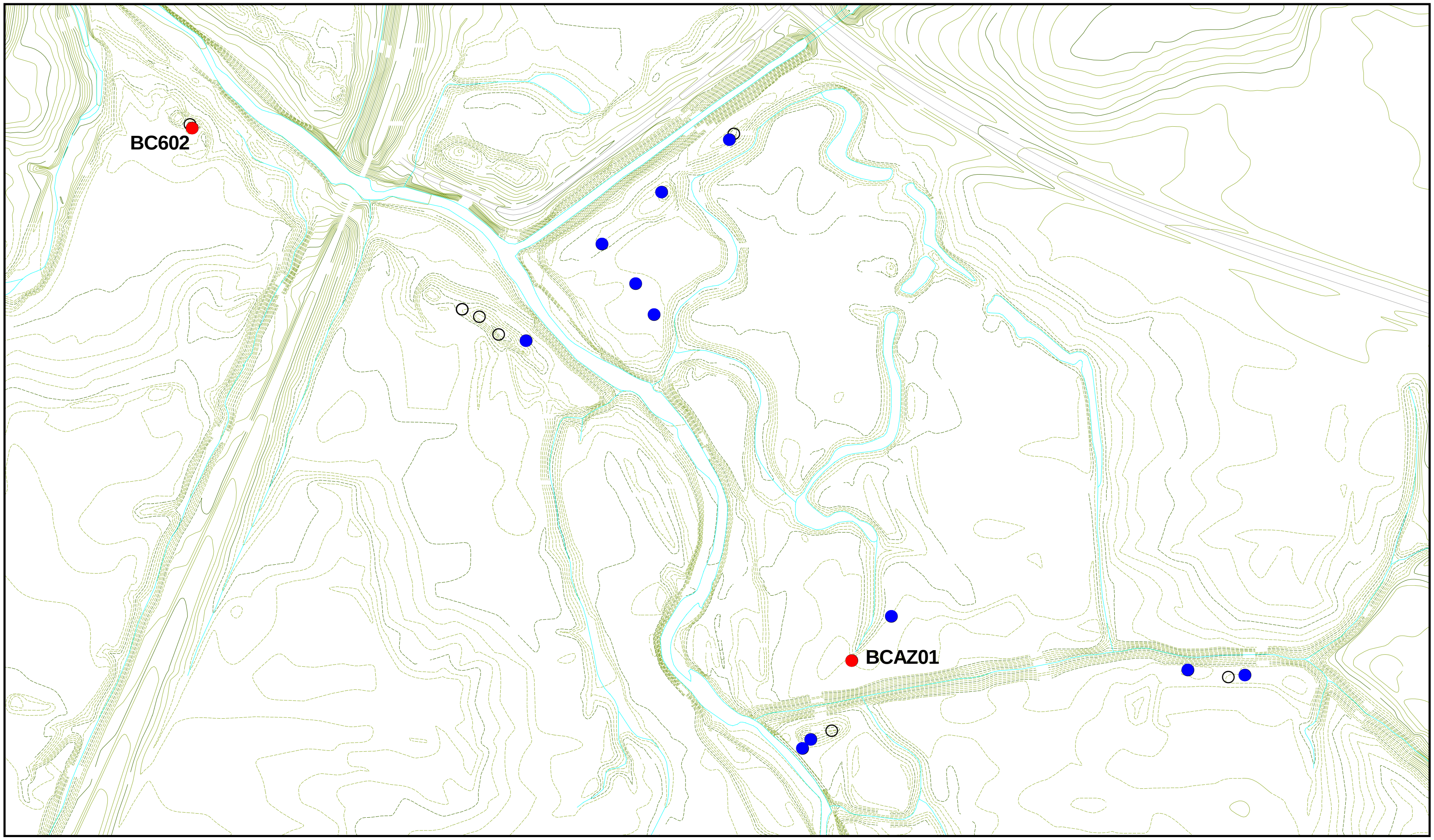
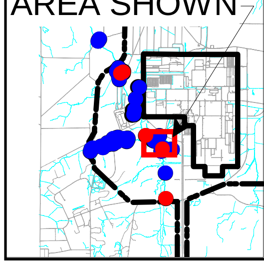


Figure B.14. Location of Sample Stations in Addendum 2 Soil Pile Sampling for Chromium in the Surface



AREA SHOWN



CHROMIUM SURFACE SAMPLE LOCATIONS

- DETECT GREATER THAN BACKGROUND[1,2]
- DETECT LESS THAN BACKGROUND[1,2]
- NONDETECT[1]
- FIELD ANALYSIS ONLY FOR COPC

[1] Only fixed-base laboratory results are plotted in color.
[2] Background value as presented in DOE 2001.

SURFACE WATER
DOE BOUNDARY
PGDP BOUNDARY
ROAD
SURFACE CONTOUR (1 ft)
SURFACE CONTOUR (5 ft)

TILE C

U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

COORDINATE SYSTEM:	PGDP
PROJECTION:	n/a
DATE:	05/20/2009
FILE NAME:	SOILPILES\Add2.apr
PADUCAH REMEDIATION SERVICES, LLC	
REFERENCES:	PRS 2009;

250 0 250 Feet

Figure B.14. (Continued)

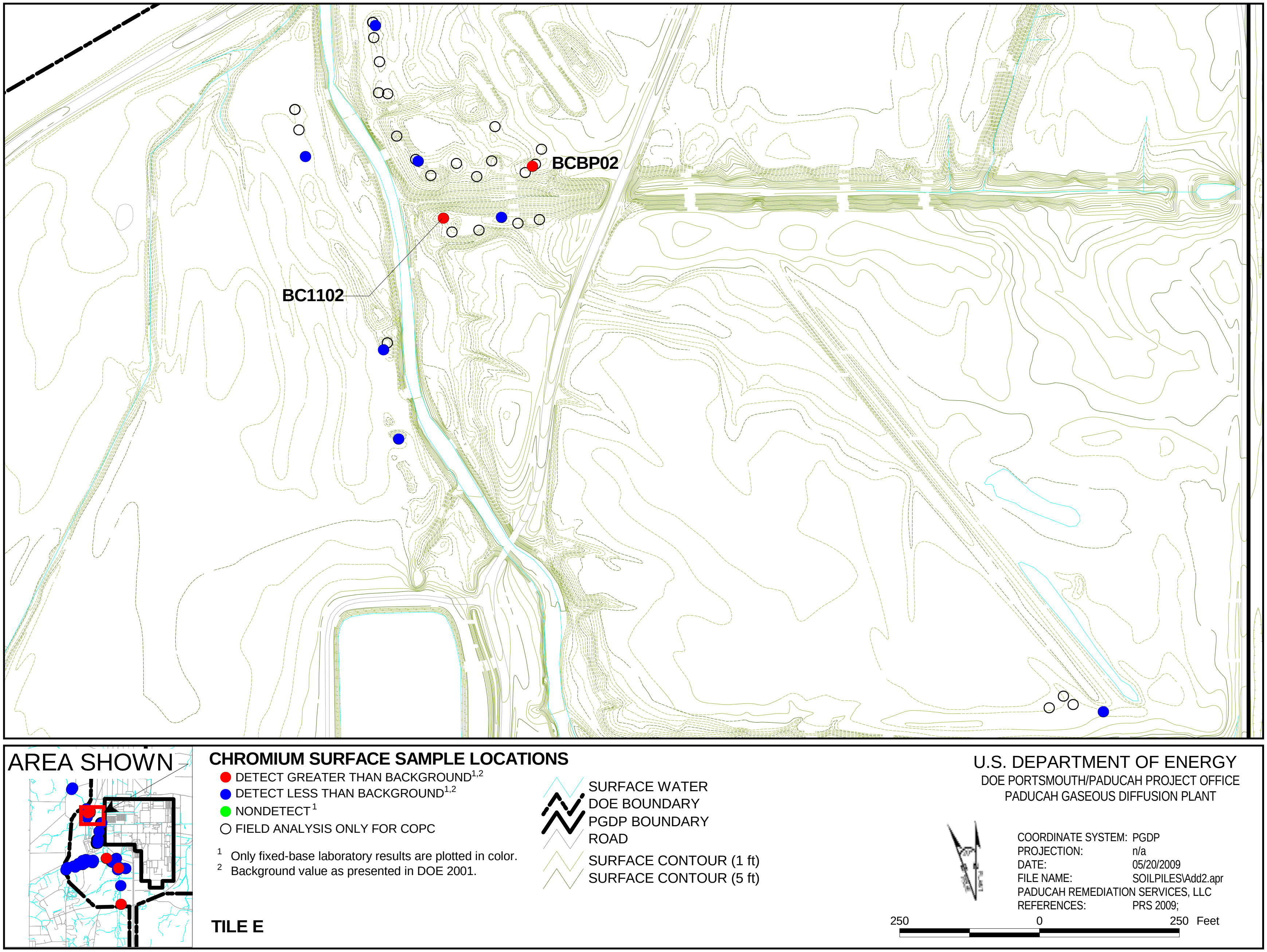


Figure B.14. (Continued)

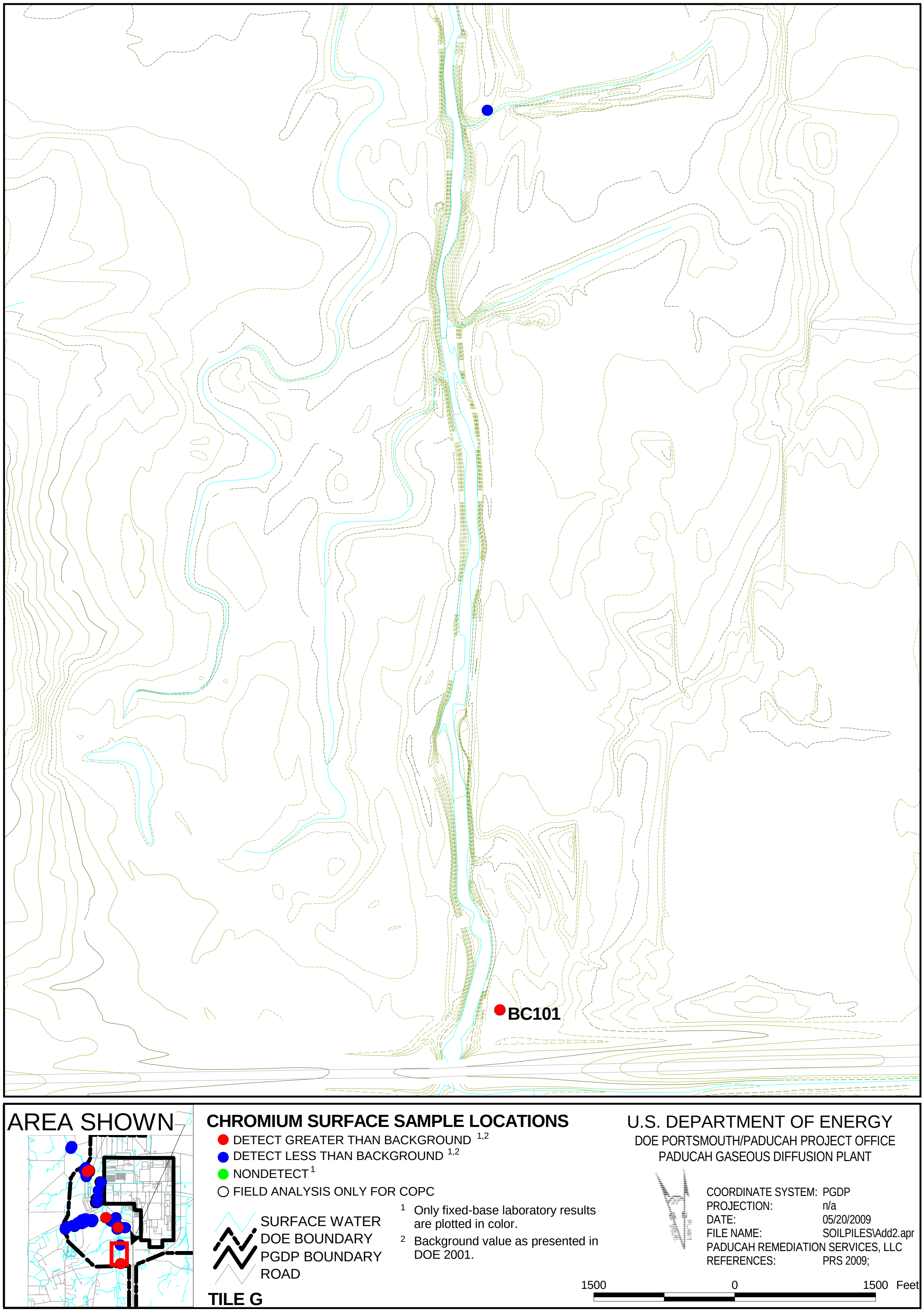


Figure B.14. (Continued)

Chromium–Subsurface. Chromium values in subsurface soil samples exceed the background value of 43 mg/kg in only 1 of 56 samples (54.6 mg/kg). This value is near other subsurface samples that are below the background value. Additionally, though this sample exceeds background, it is well below the screening criteria established for the soil piles. The teen recreational user no-action level for chromium is 227 mg/kg, and the child resident no-action level for chromium is 60.5. Although chromium is present in the Addendum 2 soil piles above background, it should not be considered a contaminant since it is well below the screening criteria.

Figure B.15 graphically shows the results with the background value and other comparison values. Figure B.16 illustrates the spatial distribution of the sampling locations in which the background value was exceeded.

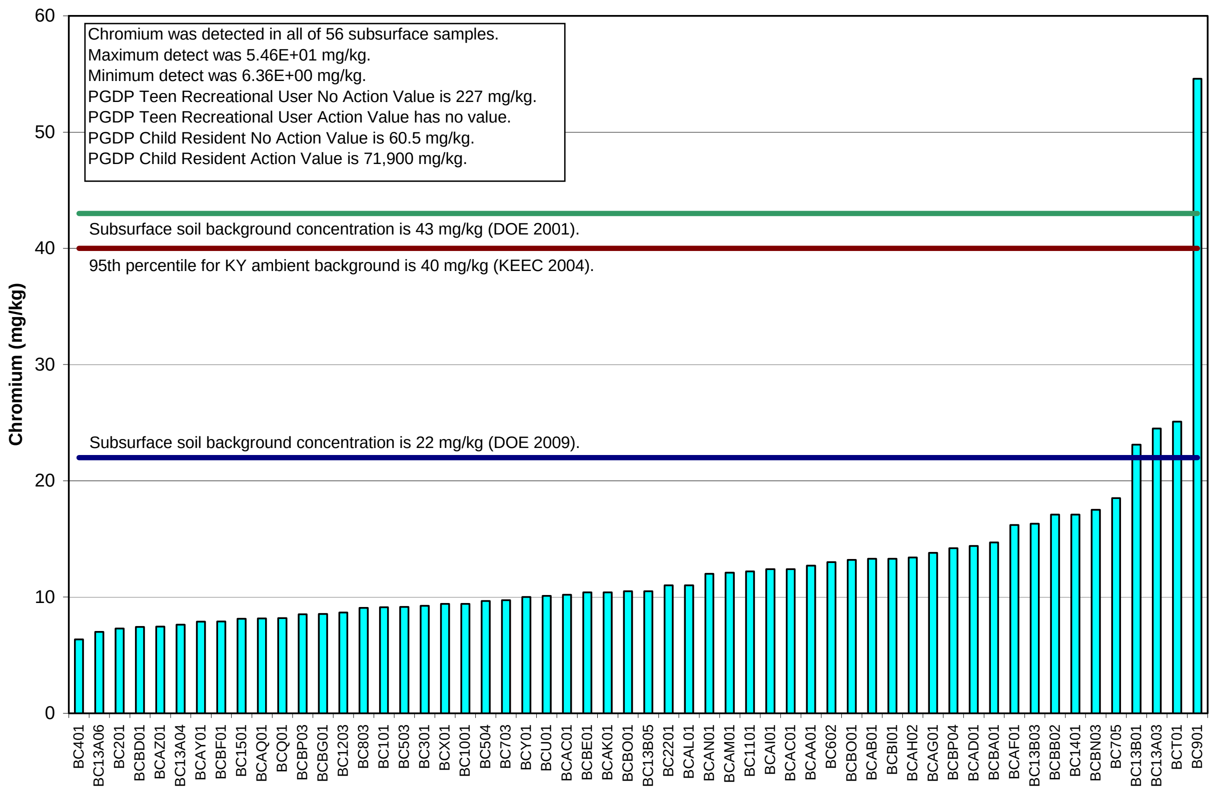


Figure B.15. Comparison between Chromium Concentrations in Samples from Soil Piles Addendum 2 and Subsurface Soil Background Concentrations

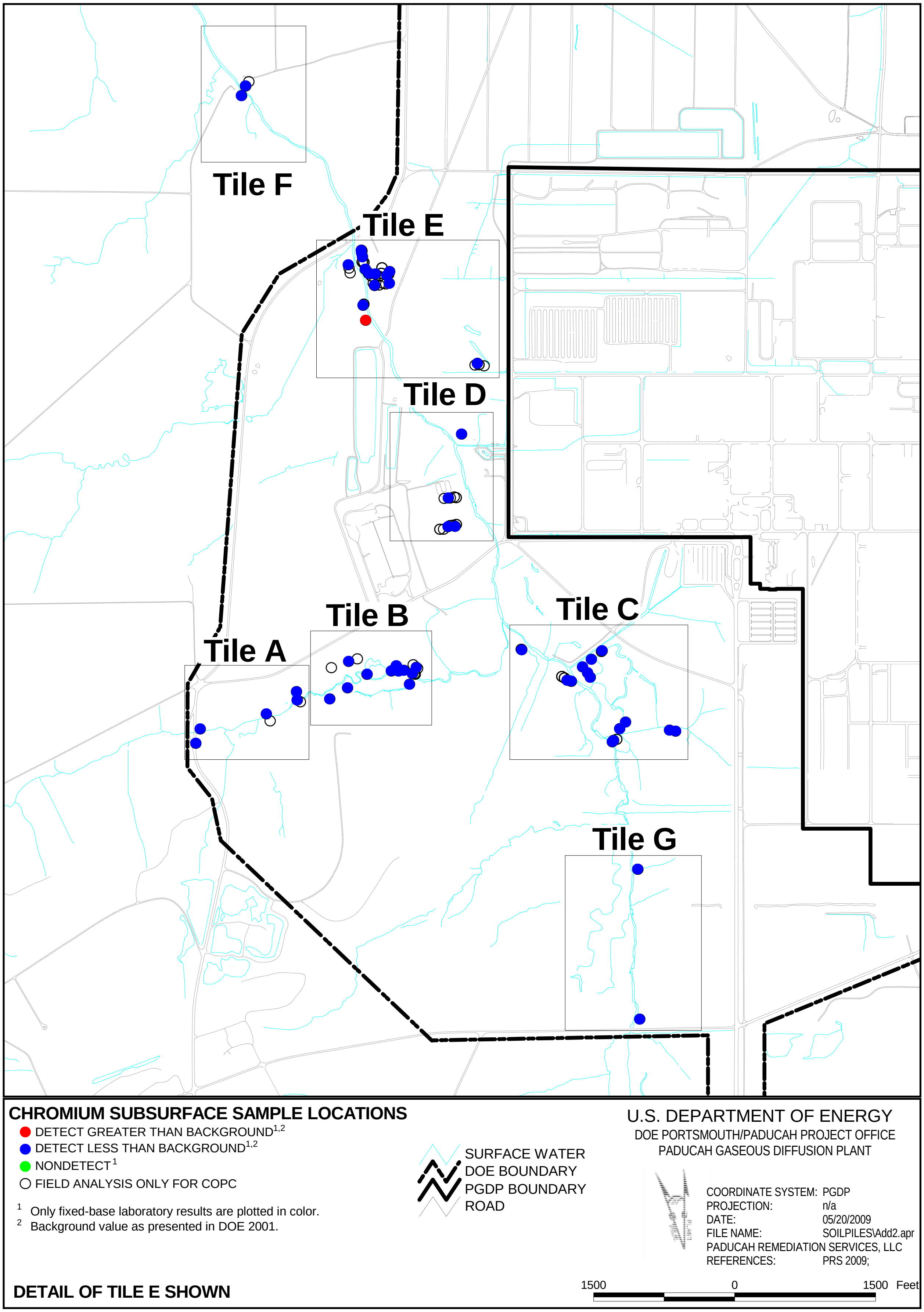


Figure B.16. Location of Sample Stations in Addendum 2 Soil Pile Sampling for Chromium in the Subsurface

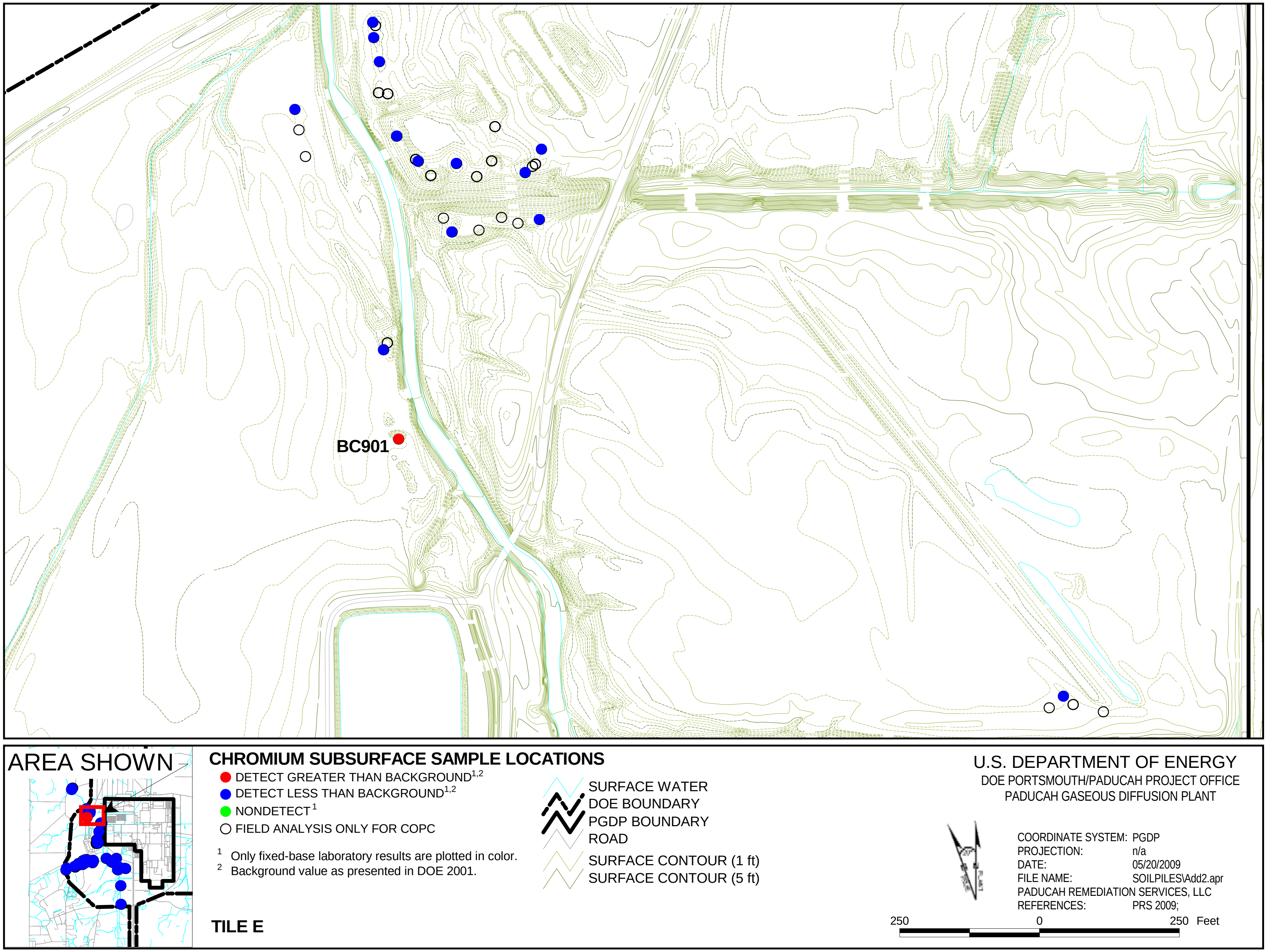


Figure B.16. (Continued)

Lead–Subsurface. Lead values in subsurface soil samples exceed the background value of 23 mg/kg in 1 of 56 samples (28.8 mg/kg). The criteria for applying ambient background values established by KEEC were met: (1) the mean site concentration (9.89 mg/kg) is below the 95% UCL of the mean concentrations of KEEC background (33 mg/kg); (2) at least half of the data points are less than the 60th percentile (20.9 mg/kg); and (3) no data points are above the upper bound value (84.6 mg/kg) (KEEC 2004); therefore, lead is not present in the Addendum 2 soil piles as a contaminant.

Figure B.17 graphically shows the results with the background value and other comparison values. Figure B.18 illustrates the spatial distribution of the sampling locations in which the background value was exceeded.

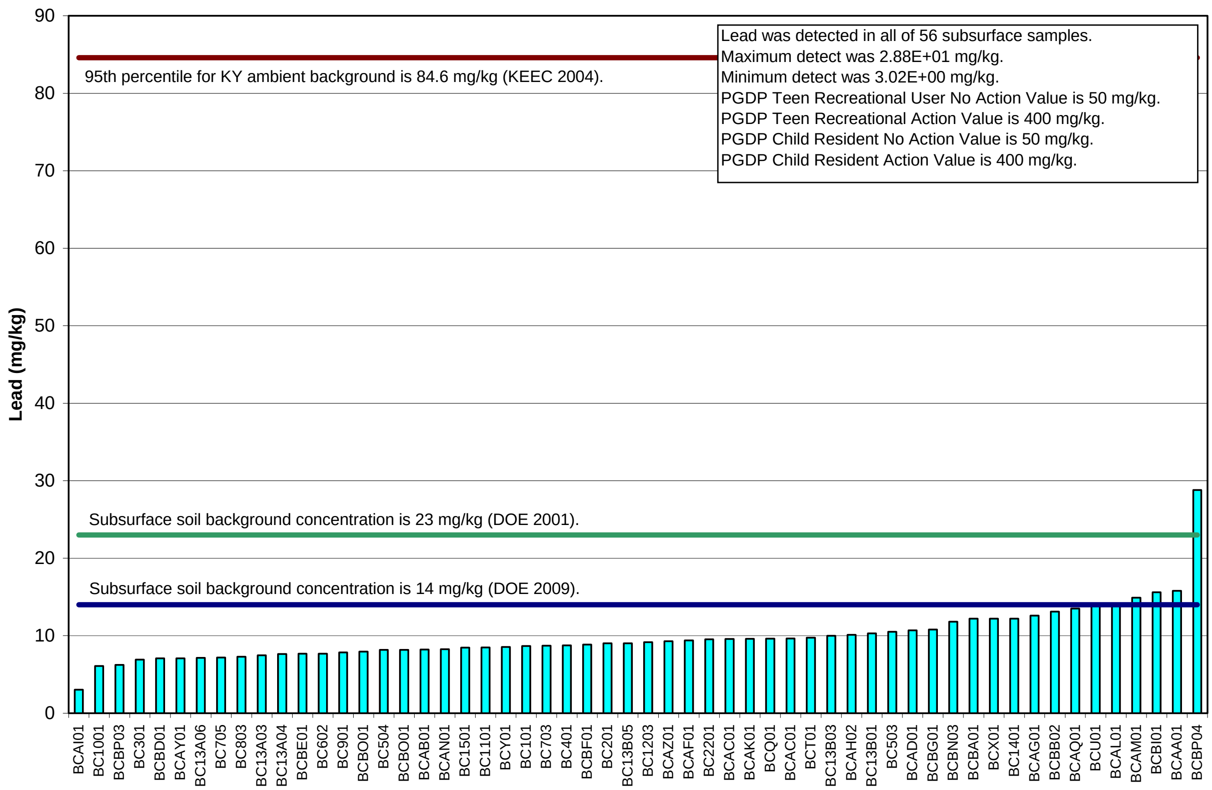


Figure B.17. Comparison between Lead Concentrations in Samples from Soil Piles Addendum 2 and Subsurface Soil Background Concentrations

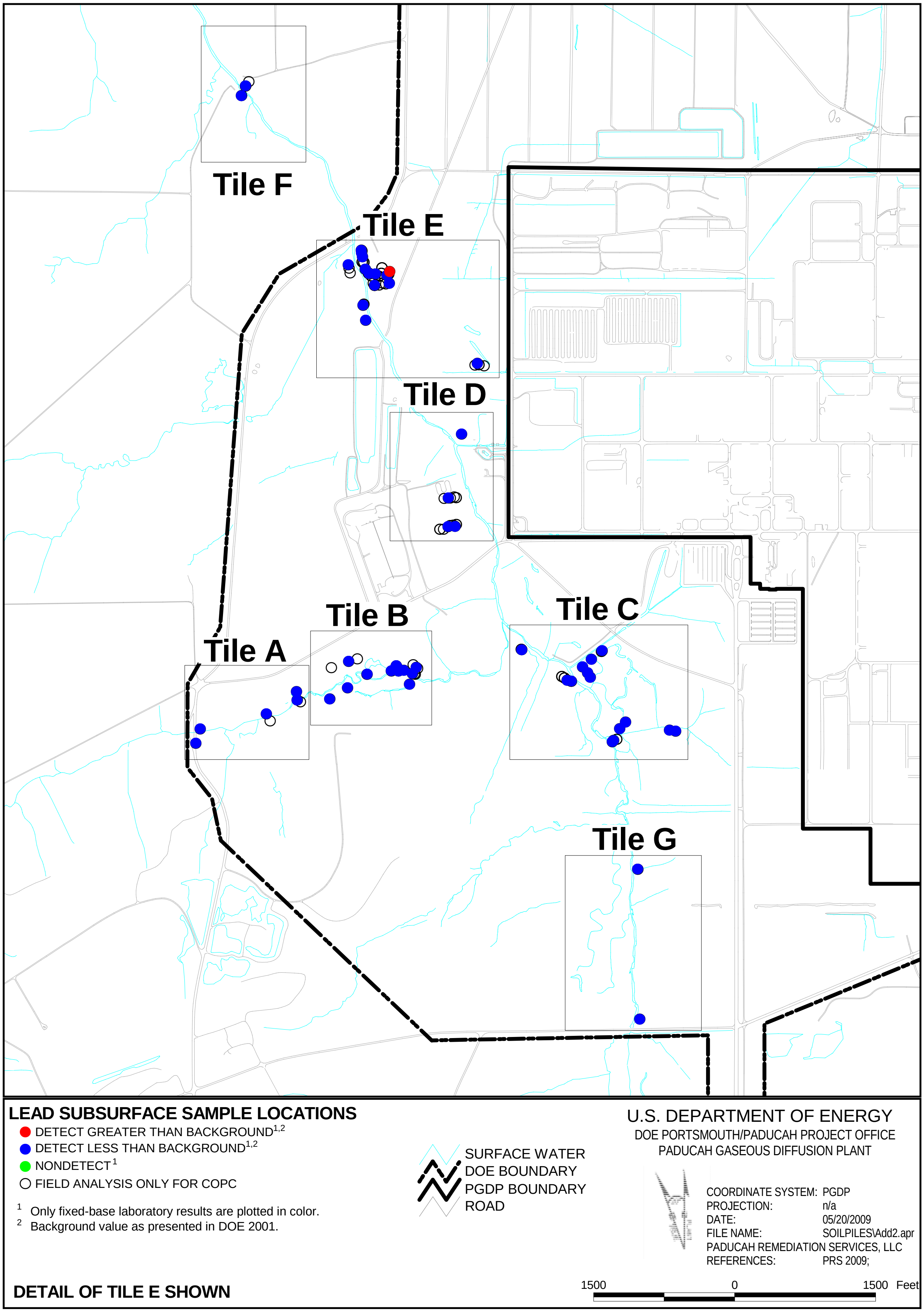
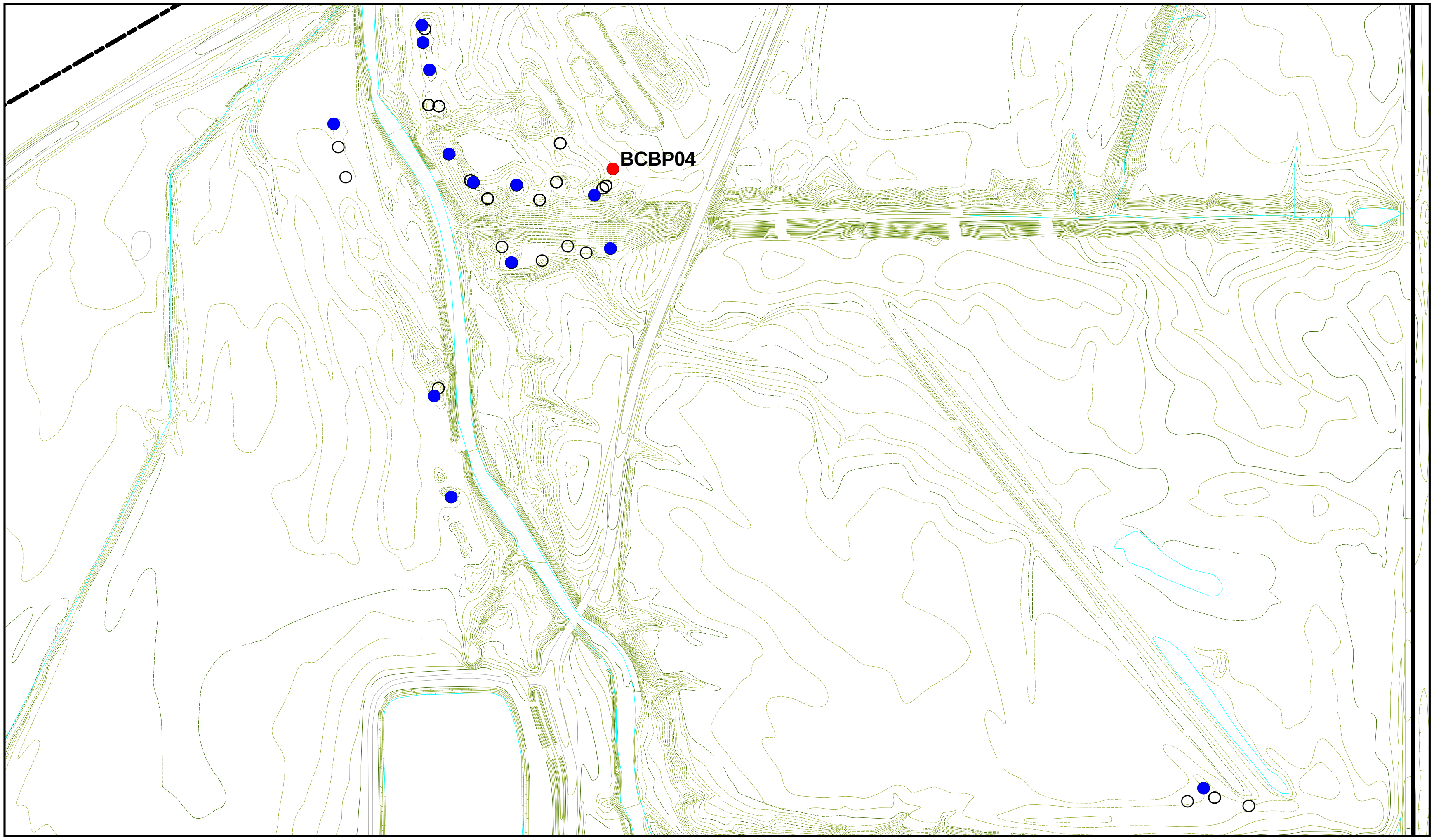
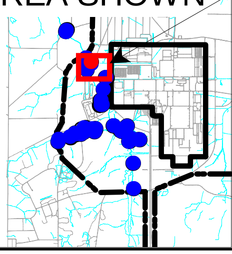


Figure B.18. Location of Sample Stations in Addendum 2 Soil Pile Sampling for Lead in the Subsurface



AREA SHOWN



LEAD SUBSURFACE SAMPLE LOCATIONS

- DETECT GREATER THAN BACKGROUND[1,2]
- DETECT LESS THAN BACKGROUND[1,2]
- NONDETECT[1]
- FIELD ANALYSIS ONLY FOR COPC

[1] Only fixed-base laboratory results are plotted in color.
[2] Background value as presented in DOE 2001.

SURFACE WATER
DOE BOUNDARY
PGDP BOUNDARY
ROAD
SURFACE CONTOUR (1 ft)
SURFACE CONTOUR (5 ft)

TILE E

U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

COORDINATE SYSTEM:	PGDP
PROJECTION:	n/a
DATE:	05/20/2009
FILE NAME:	SOILPILES\Add2.apr
PADUCAH REMEDIATION SERVICES, LLC	
REFERENCES:	PRS 2009;

250 0 250 Feet

Figure B.18. (Continued)

Manganese–Surface. Manganese values in surface soil samples exceed the background value of 1,500 mg/kg in only 1 of 54 samples (1,580 mg/kg). The criteria for applying ambient background values established by KEEC were met: (1) the mean site concentration (532 mg/kg) is below the 95% UCL of the mean concentrations of KEEC background (1,071 mg/kg); (2) at least half of the data points are less than the 60th percentile (948 mg/kg); and (3) no data points are above the upper bound value (2,620 mg/kg) (KEEC 2004); therefore, manganese is not present in the Addendum 2 soil piles as a contaminant.

Figure B.19 graphically shows the results with the background value and other comparison values. Figure B.20 illustrates the spatial distribution of the sampling locations in which the background value was exceeded.

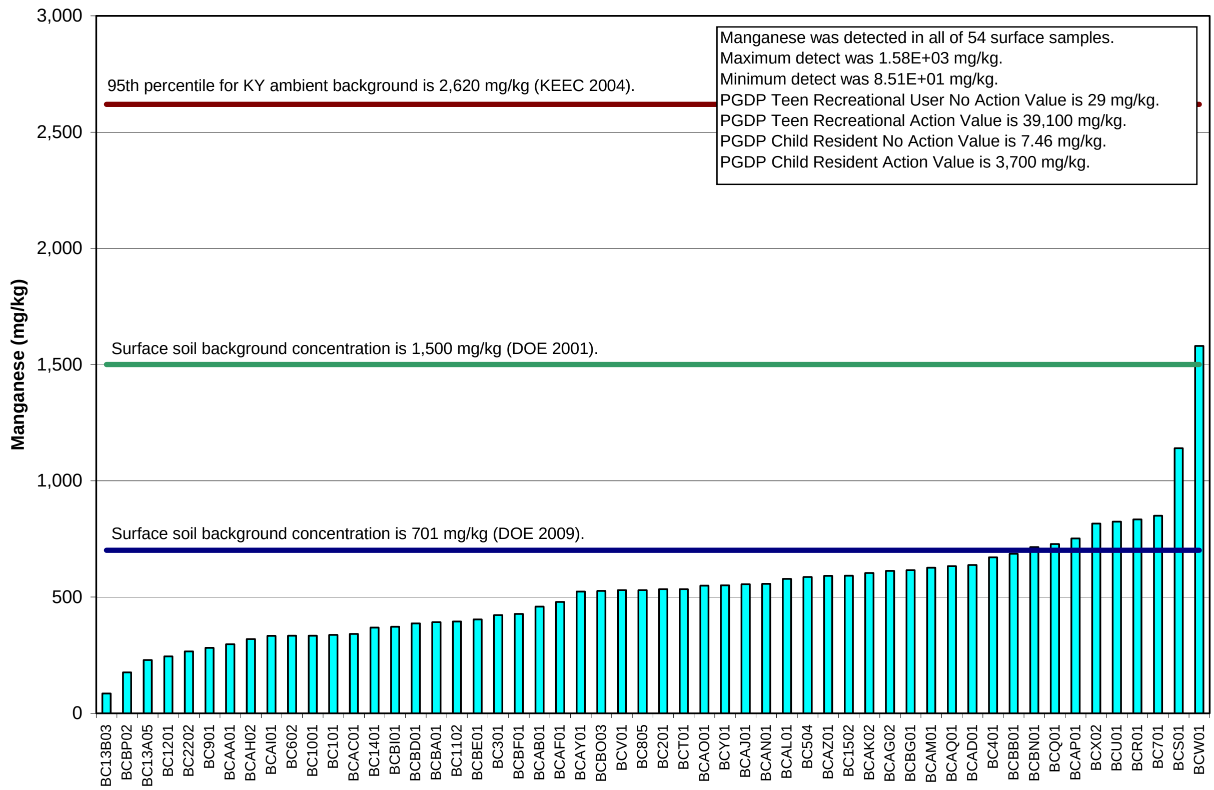


Figure B.19. Comparison between Manganese Concentrations in Samples from Soil Piles Addendum 2 and Surface Soil Background Concentrations

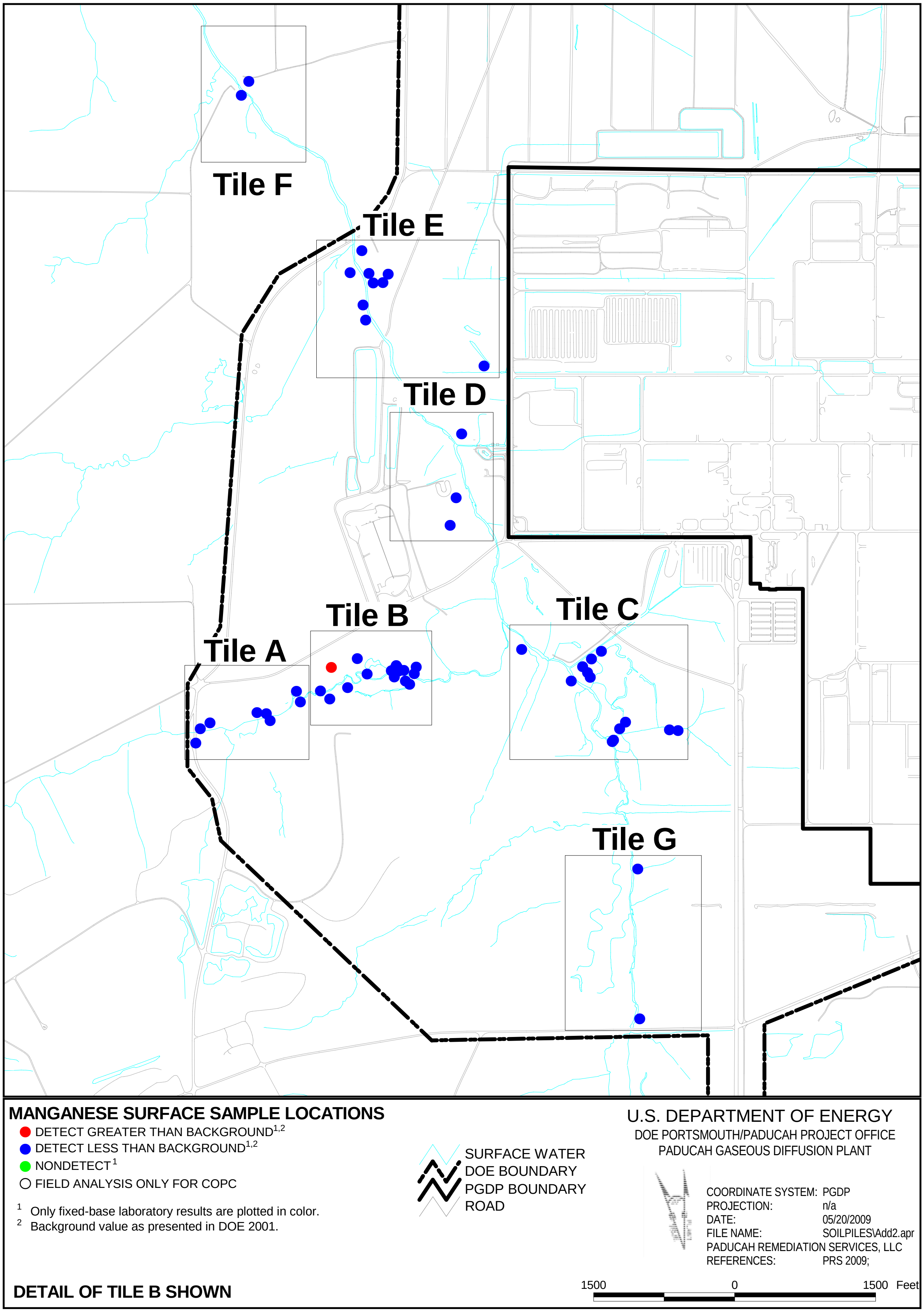
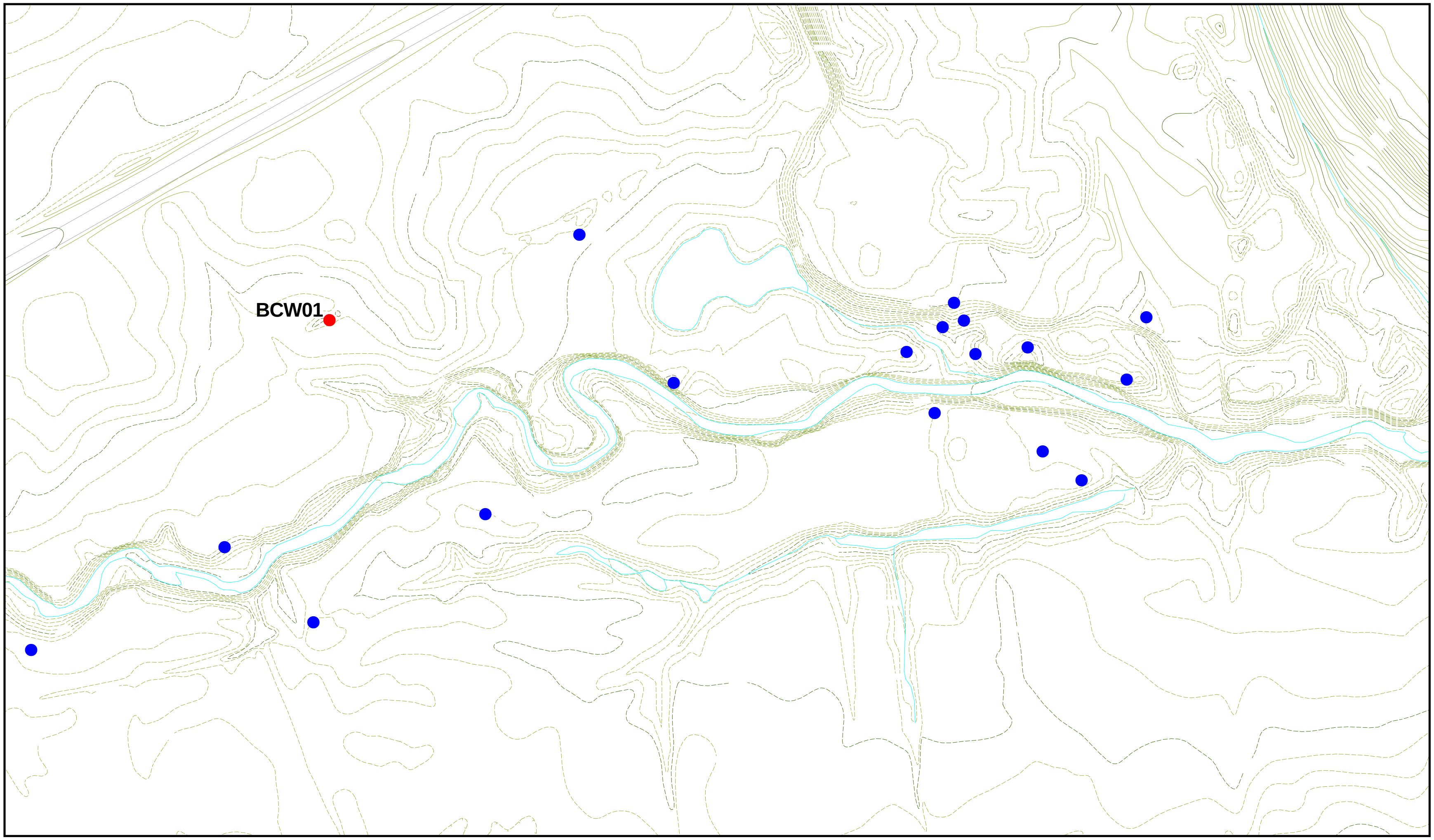
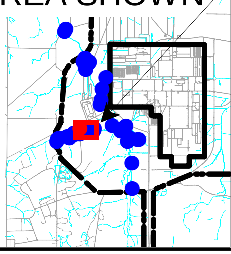


Figure B.20. Location of Sample Stations in Addendum 2 Soil Pile Sampling for Manganese in the Surface



AREA SHOWN



MANGANESE SURFACE SAMPLE LOCATIONS

- DETECT GREATER THAN BACKGROUND[1,2]
- DETECT LESS THAN BACKGROUND[1,2]
- NONDETECT[1]
- FIELD ANALYSIS ONLY FOR COPC

[1] Only fixed-base laboratory results are plotted in color.
[2] Background value as presented in DOE 2001.

SURFACE WATER
DOE BOUNDARY
PGDP BOUNDARY
ROAD
SURFACE CONTOUR (1 ft)
SURFACE CONTOUR (5 ft)

TILE B

U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

COORDINATE SYSTEM: PGDP
PROJECTION: n/a
DATE: 05/20/2009
FILE NAME: SOILPILES\Add2.apr
PADUCAH REMEDIATION SERVICES, LLC
REFERENCES: PRS 2009;

175 0 175 Feet

Figure B.20. (Continued)

Vanadium–Subsurface. Vanadium values in subsurface soil samples exceed the background value of 37 mg/kg in 1 of 56 samples (37.7 mg/kg). The criteria for applying ambient background values established by KEEC were met: (1) the mean site concentration (17.8 mg/kg) is below the 95% UCL of the mean concentrations of KEEC background (27.7 mg/kg); (2) at least half of the data points are less than the 60th percentile (27.3 mg/kg); and (3) no data points are above the upper bound value (48.6 mg/kg) (KEEC 2004); therefore, vanadium is not present in the Addendum 2 soil piles as a contaminant.

Figure B.21 graphically shows the results with the background value and other comparison values. Figure B.22 illustrates the spatial distribution of the sampling locations in which the background value was exceeded.

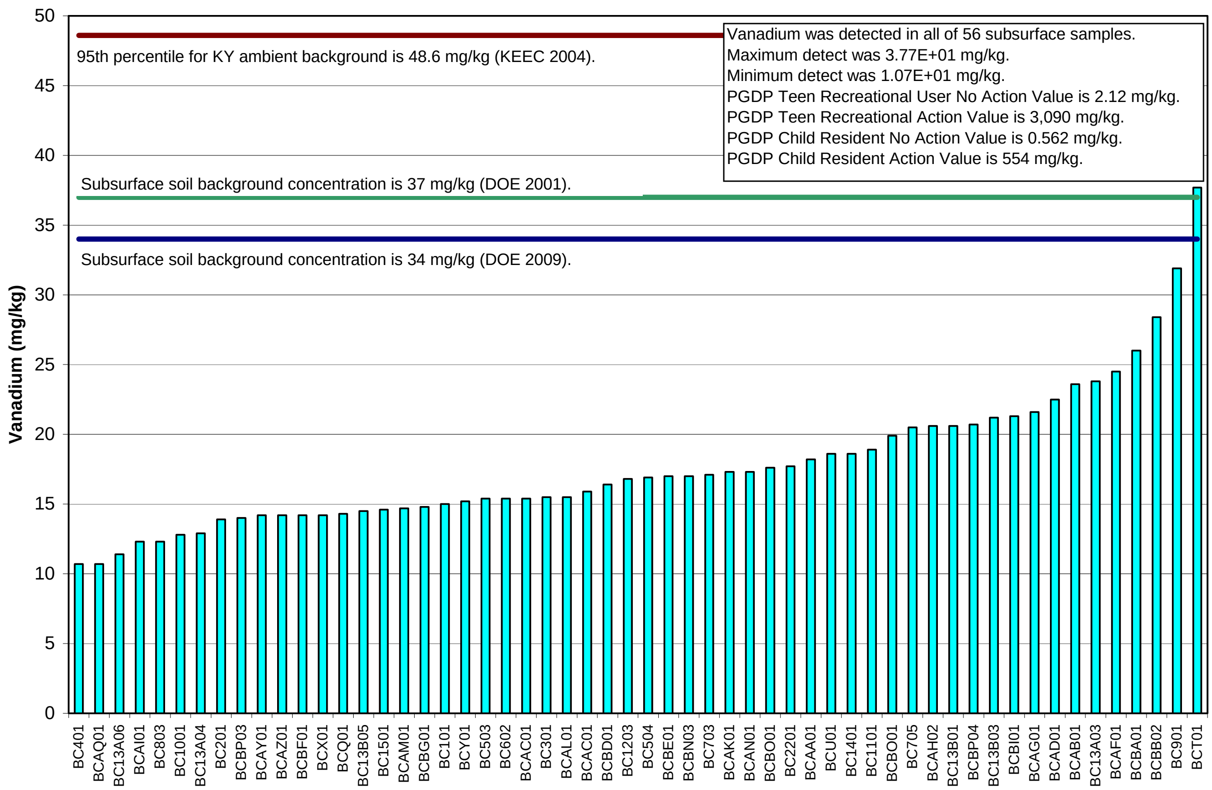


Figure B.21. Comparison between Vanadium Concentrations in Samples from Soil Piles Addendum 2 and Subsurface Soil Background Concentrations

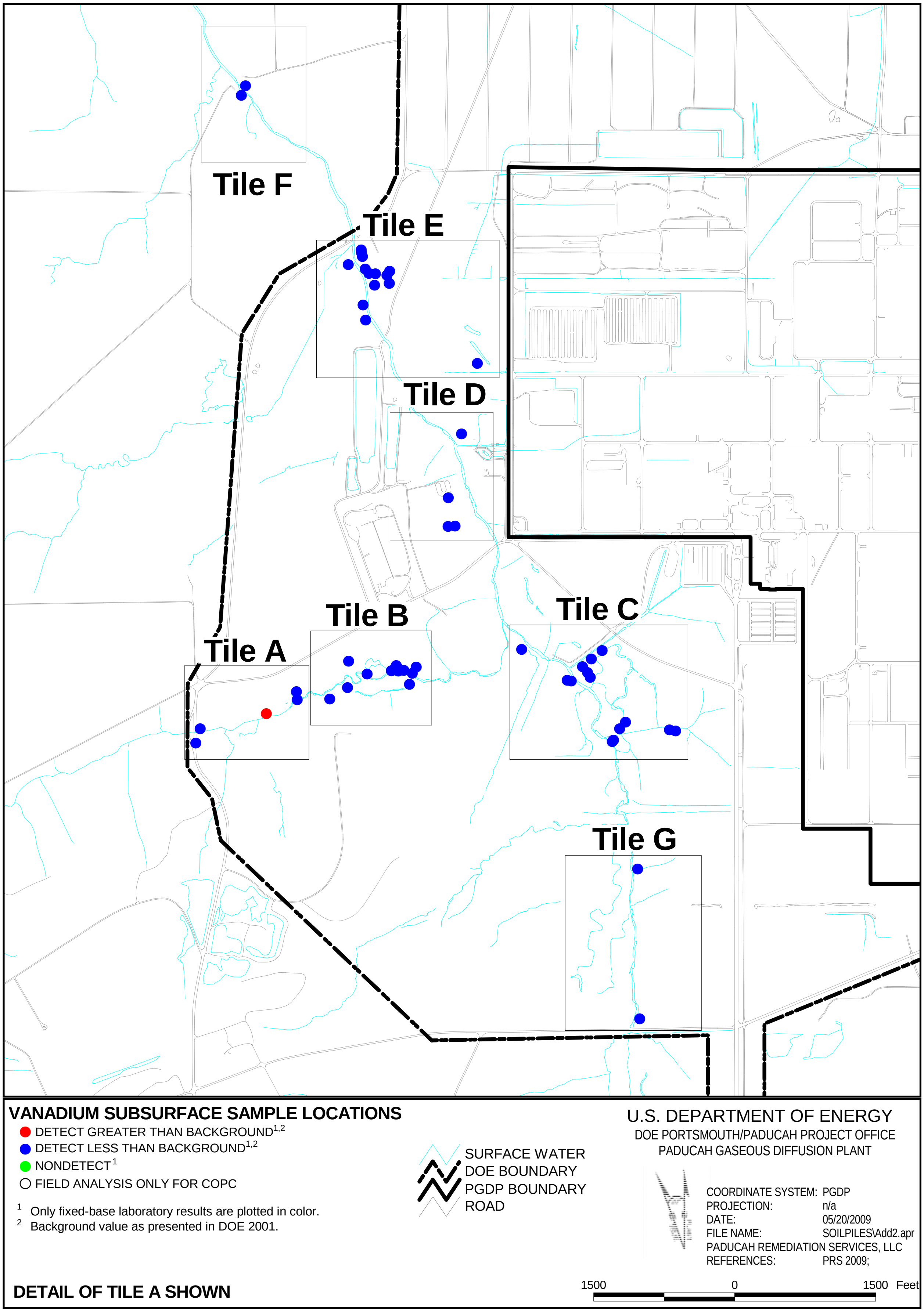


Figure B.22. Location of Sample Stations in Addendum 2 Soil Pile Sampling for Vanadium in the Subsurface

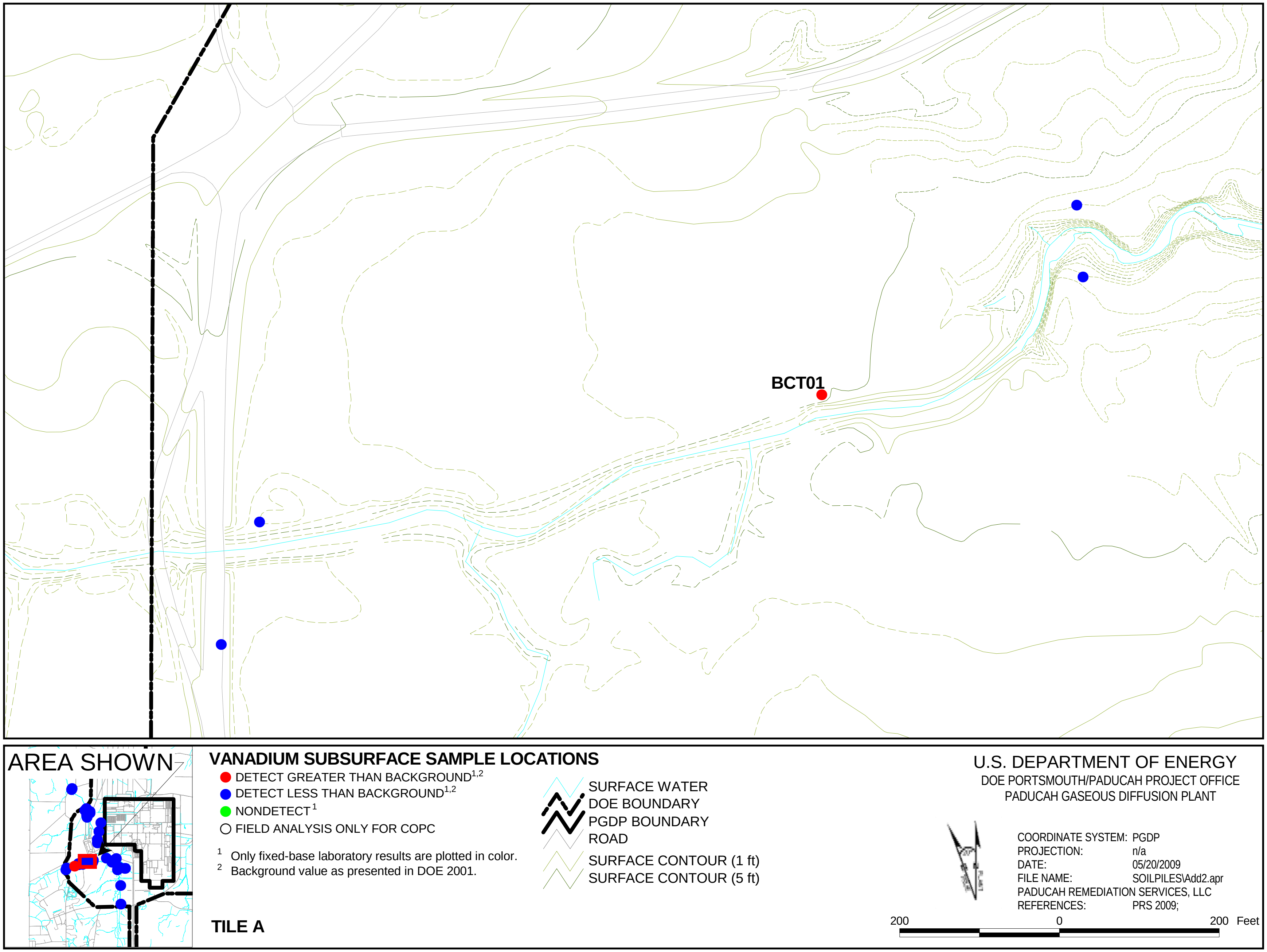


Figure B.22. (Continued)

Cesium-137–Surface. Cesium-137 values in surface soil samples exceed the background value of 0.49 pCi/g in 6 of 54 samples. The samples exceeding background ranged from 0.724 to 0.883 pCi/g. Figure B.23 graphically shows the results with the background value and other comparison values. Although the cesium-137 concentration exceeds the site-specific background for PGDP, the concentration of cesium-137 in samples exceeding background is below levels seen in 1988 to 1993 monitoring studies at PGDP. Cesium-137 levels in these studies ranged from 0.11 to 4.0 pCi/g (DOE 1997). The highest result is reported in the 1990 Annual Site Environmental Report from a location 13 kilometers south of PGDP (MMES 1991).

In all cases from Addendum 2 soil piles, the locations from which surface samples exceed site-specific PGDP background are from soil piles along the banks of the Unnamed Tributary, which is upstream of PGDP operations. Specifically, these Soil Piles are W, X, AL, AO, AP, and AQ. Figure B.24 illustrates the direction of surface water flow and the spatial distribution of the sampling locations in which the background value was exceeded.

Cesium-137 is a major contributor to global fall-out due to atmospheric testing of nuclear weapons in the 1950s to the early 1960s. A summary from Argonne National Lab (ANL 2007) states that concentrations up to 1 pCi/g are expected from fall-out.

Although cesium-137 is detected in 6 of 54 samples at levels greater than the benchmark background value, cesium-137 is below the range of background and global fallout presented and should not be considered in the Addendum 2 soil piles as a contaminant.

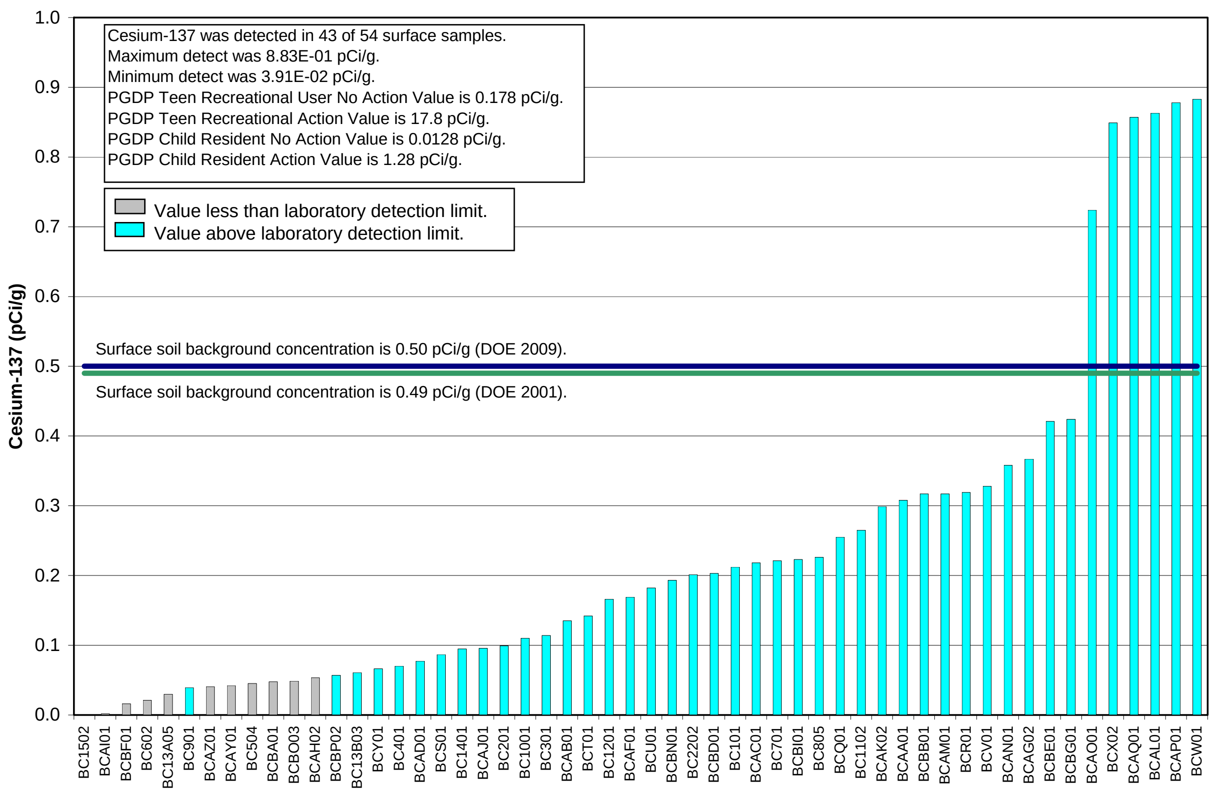


Figure B.23. Comparison between Cesium-137 Concentrations in Samples from Soil Piles Addendum 2 and Surface Soil Background Concentrations

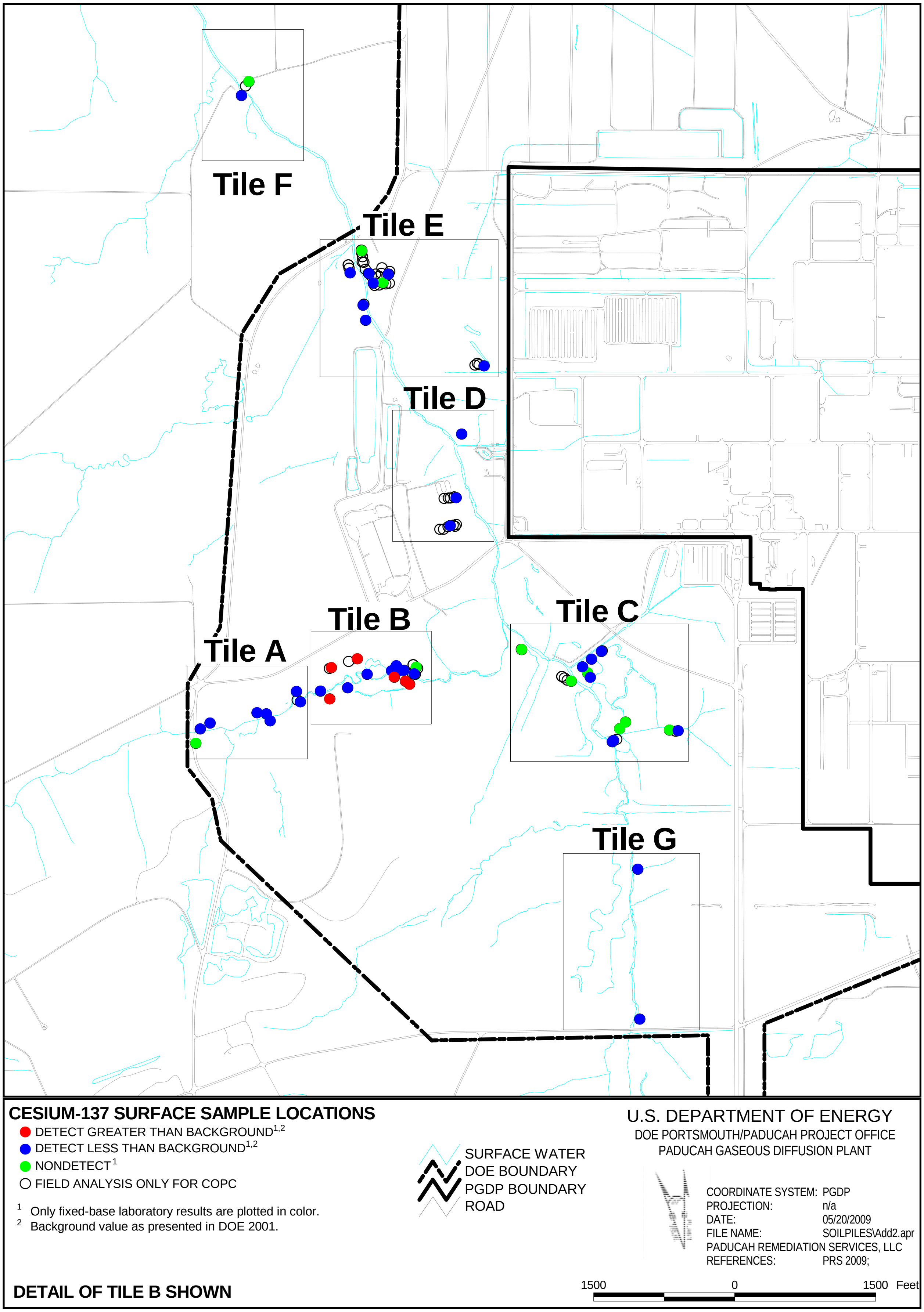


Figure B.24. Location of Sample Stations in Addendum 2 Soil Pile Sampling for Cesium-137 in the Surface

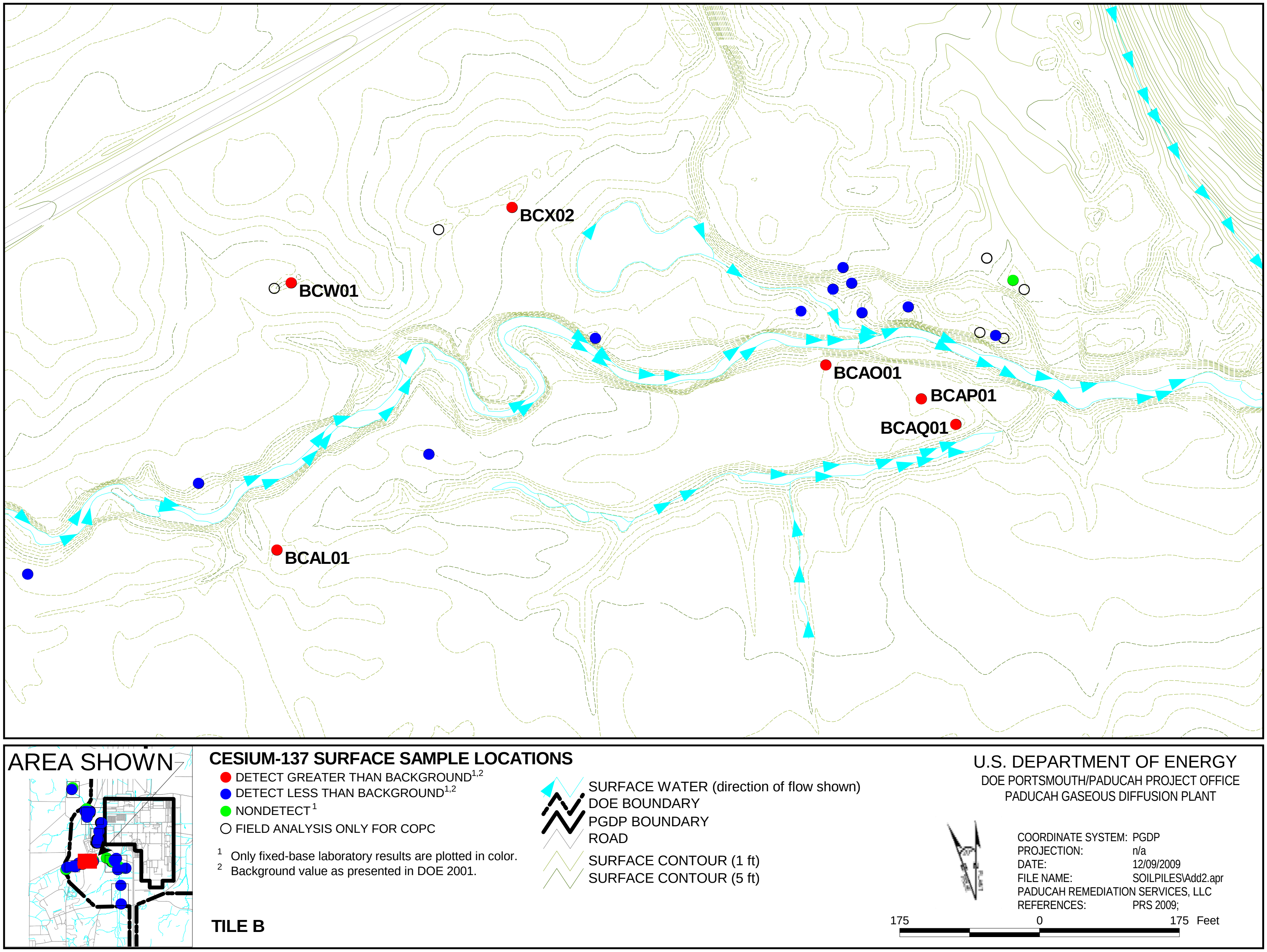


Figure B.24. (Continued)

Cesium-137–Subsurface. Cesium-137 values in subsurface soil samples exceed the background value of 0.28 pCi/g in 9 of 56 samples (ranging 0.342 to 0.979 pCi/g). In many of the cases, the locations from which subsurface samples exceed site-specific PGDP background are from soil piles along the banks upstream of PGDP operations. Specifically, these soil piles are X, AL, AM, and AQ along the Unnamed Tributary. Of these piles, three (Soil Piles X, AL, and AQ) had results above the background value in surface soil samples as well. Figure B.25 depicts the distribution of detected cesium-137 activities within these soil piles. Other soil piles exceeding the site-specific PGDP background in subsurface samples are 22, BE, and BG near Outfall K009; BI near Outfall K008; BP near Outfall K001.

Although the cesium-137 concentration exceeds the site-specific background for PGDP, the concentration of cesium-137 in samples exceeding background is below levels seen in 1988 to 1993 monitoring studies at PGDP. Cesium-137 levels in these studies ranged from 0.11 to 4.0 pCi/g (DOE 1997). The highest result is reported in the 1990 Annual Site Environmental Report from a location 13 kilometers south of PGDP (MMES 1991).

Cesium-137 is a major contributor to global fall-out due to atmospheric testing of nuclear weapons in the 1950s to the early 1960s. A summary from Argonne National Lab (ANL 2007) states that concentrations up to 1 pCi/g are expected from fall-out. Although cesium-137 as a result of fall-out would not be expected to be found at depth, the material from the soil piles is thought once to have been surface soil or sediment and could have been subject to the results of global fall-out at that time.

Figure B.26 graphically shows the results with the background value and other comparison values. Figure B.27 illustrates the spatial distribution of the sampling locations in which the background value was exceeded. Although cesium-137 is detected in 9 of 56 samples at levels greater than the benchmark background value, cesium-137 is below the range of background and global fallout presented and should not be considered in the Addendum 2 soil piles as a contaminant.

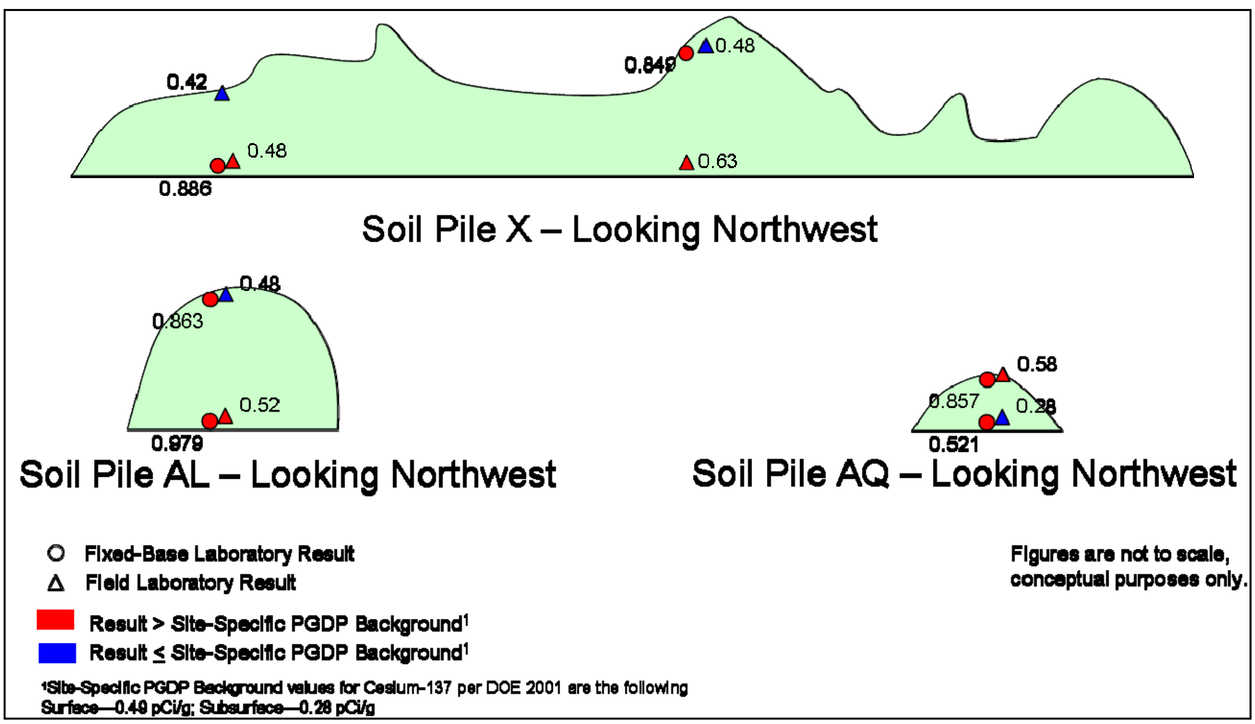


Figure B.25 Detected Cesium-137 within Soil Piles X, AL, and AQ

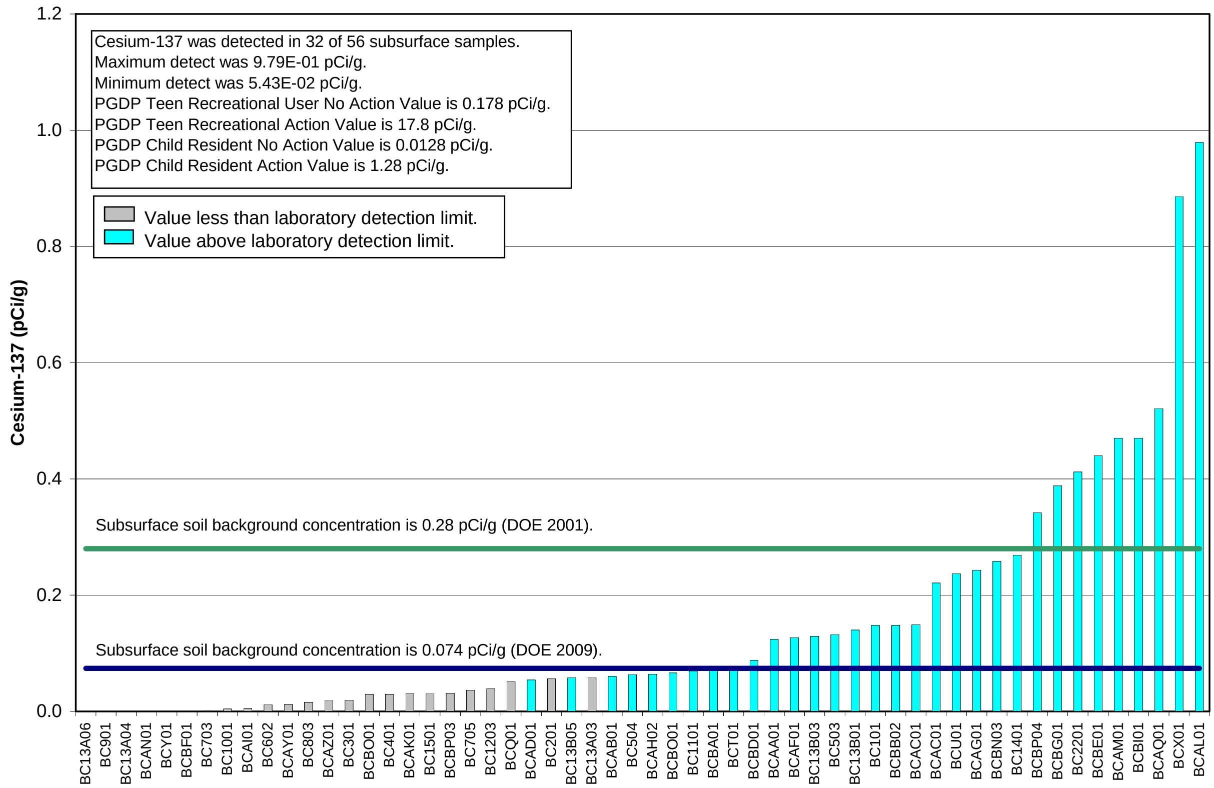


Figure B.26. Comparison between Cesium-137 Concentrations in Samples from Soil Piles Addendum 2 and Subsurface Soil Background Concentrations

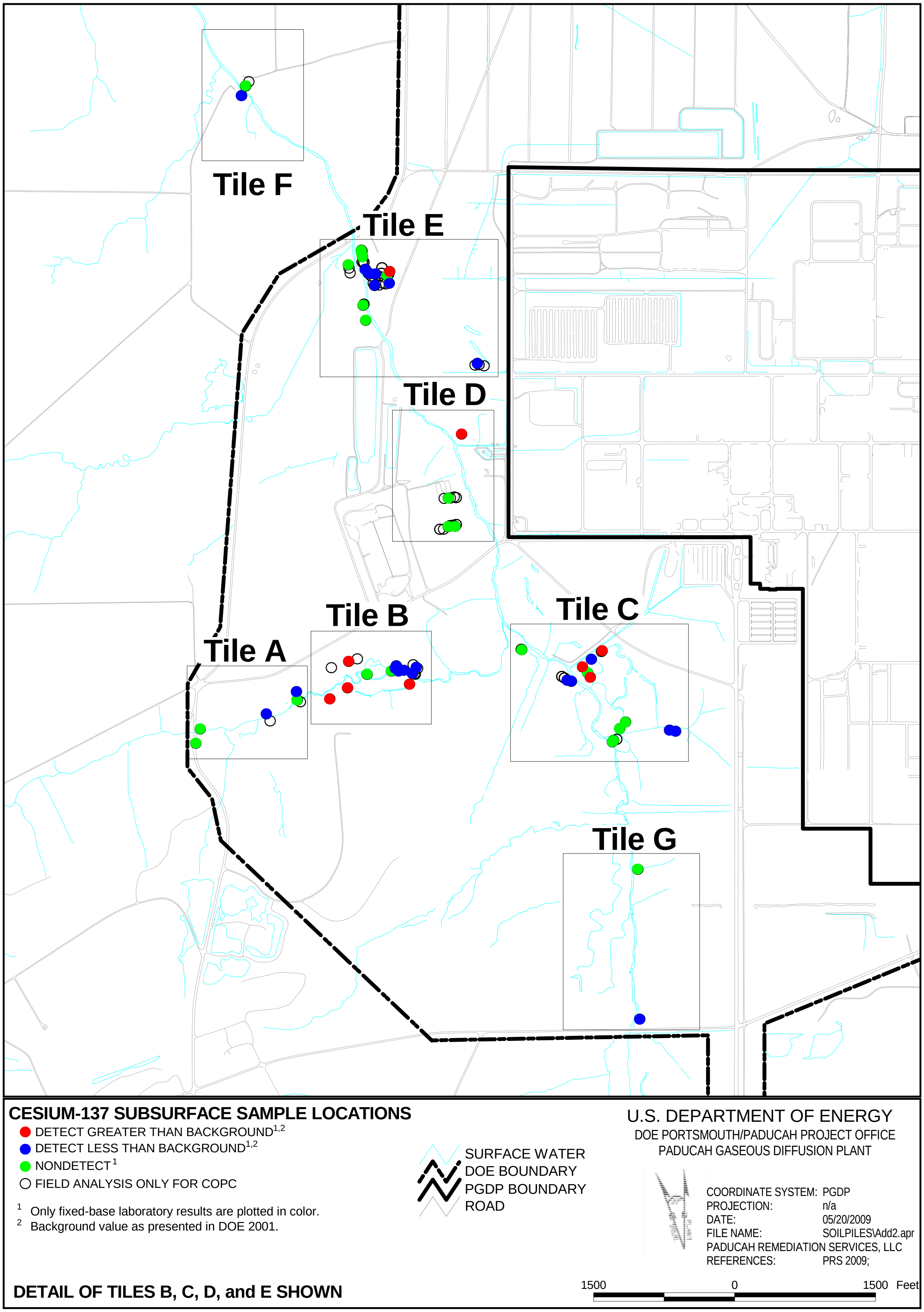


Figure B.27. Location of Sample Stations in Addendum 2 Soil Pile Sampling for Cesium-137 in the Subsurface

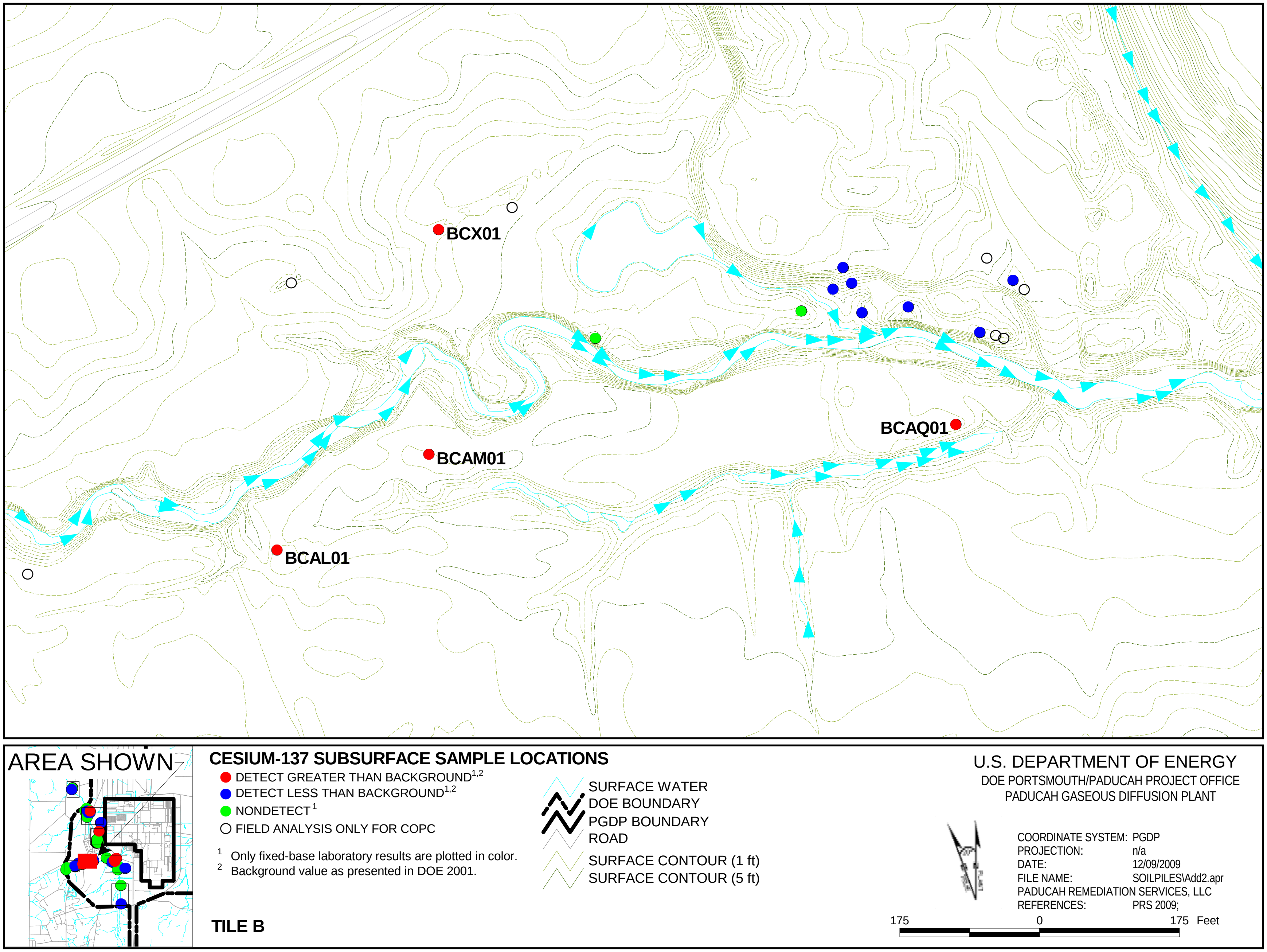
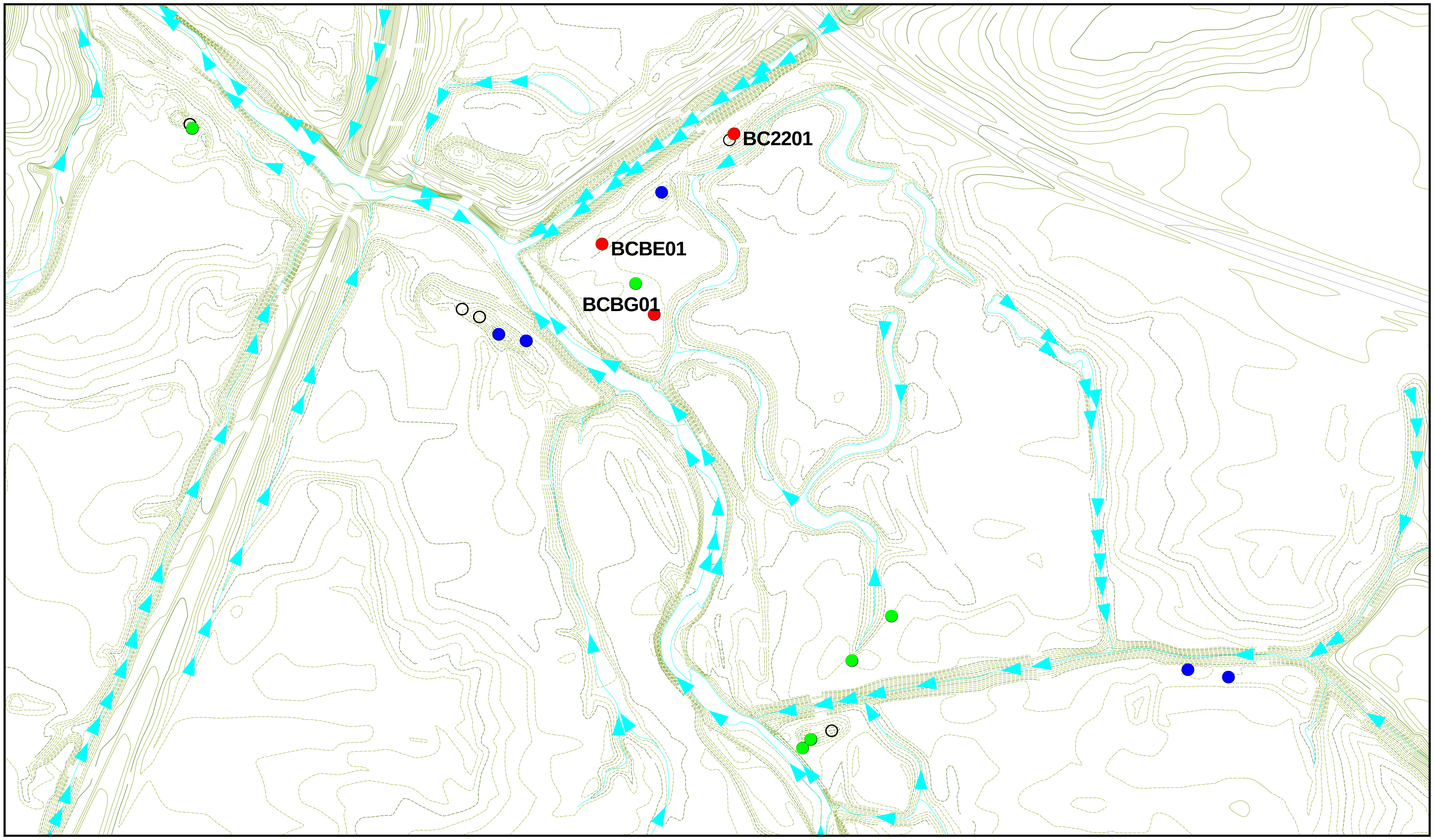
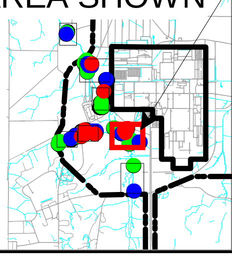


Figure B.27. (Continued)



AREA SHOWN



CESIUM-137 SUBSURFACE SAMPLE LOCATIONS

- DETECT GREATER THAN BACKGROUND[1,2]
- DETECT LESS THAN BACKGROUND[1,2]
- NONDETECT[1]
- FIELD ANALYSIS ONLY FOR COPC

[1] Only fixed-base laboratory results are plotted in color.
[2] Background value as presented in DOE 2001.

SURFACE WATER (direction of flow shown)
DOE BOUNDARY
PGDP BOUNDARY
ROAD
SURFACE CONTOUR (1 ft)
SURFACE CONTOUR (5 ft)

TILE C

U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

COORDINATE SYSTEM:	PGDP
PROJECTION:	n/a
DATE:	12/09/2009
FILE NAME:	SOILPILES\Add2.apr
PADUCAH REMEDIATION SERVICES, LLC	
REFERENCES:	PRS 2009;

250 0 250 Feet

Figure B.27. (Continued)

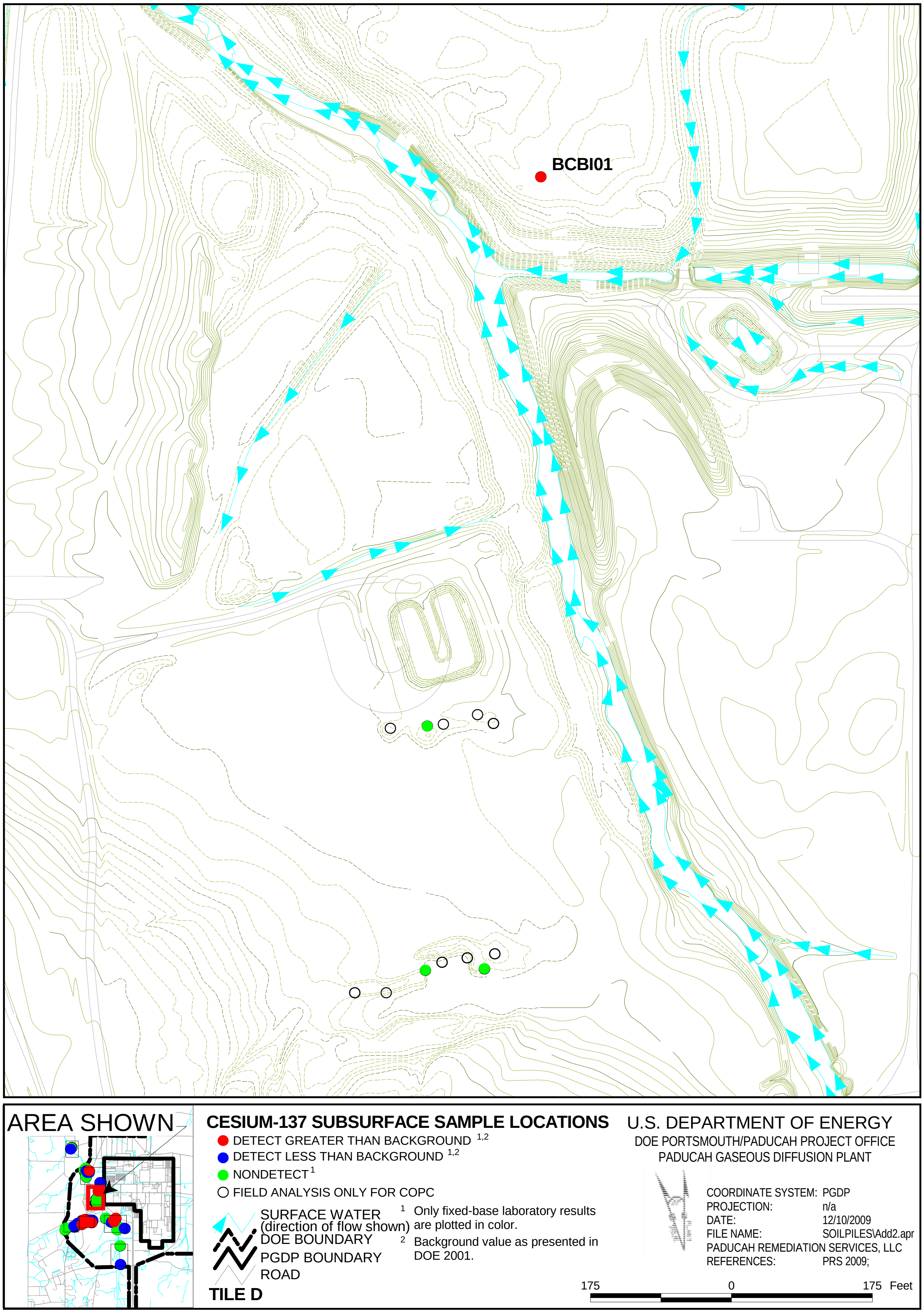


Figure B.27. (Continued)

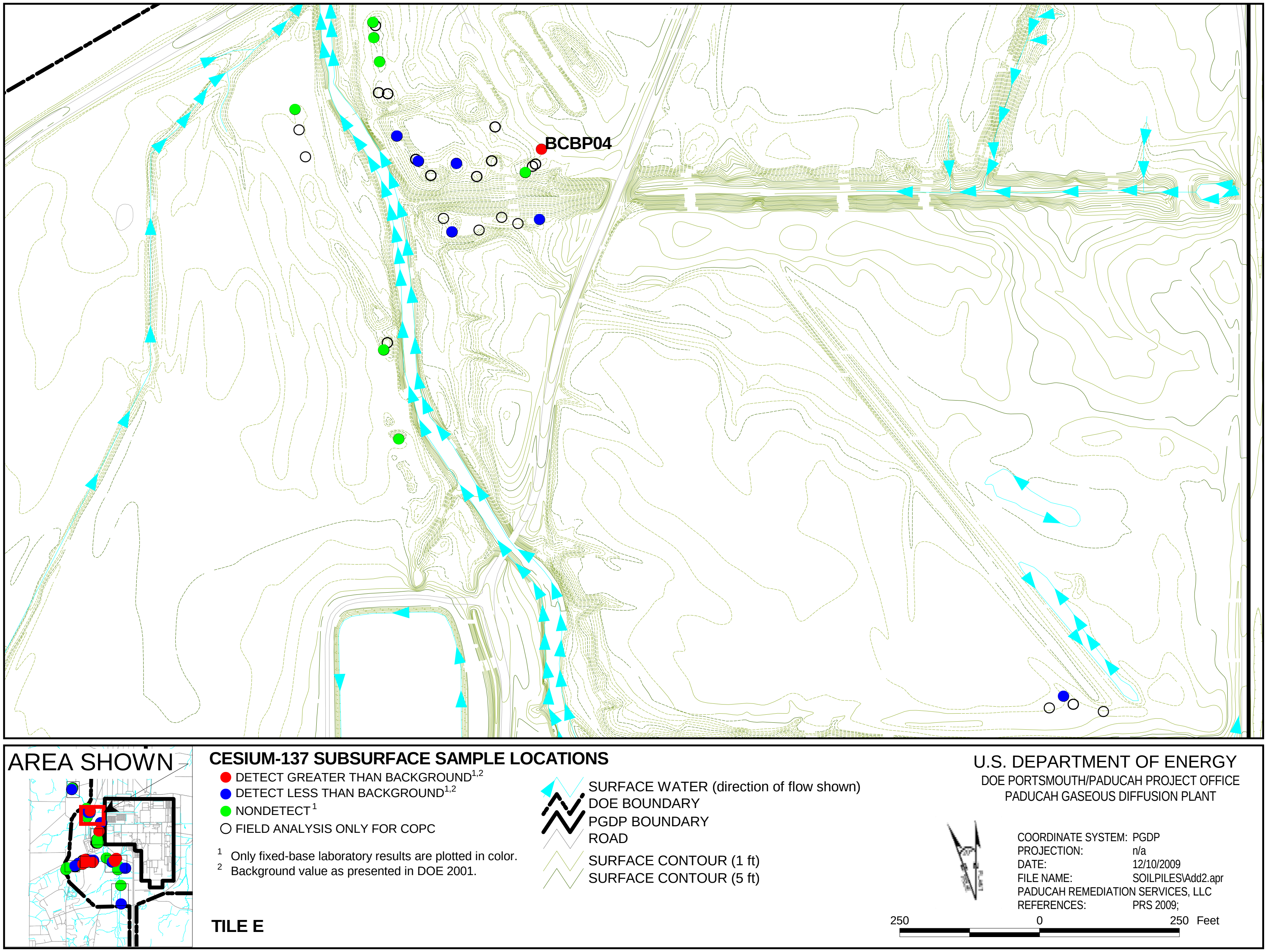


Figure B.27. (Continued)

Plutonium-239/240–Surface. Plutonium-239/240 values in surface soil samples exceed the background value of 0.025 pCi/g in 3 of 54 samples. The three exceeding values are 0.0264, 0.028, and 0.0353 pCi/g. Although the plutonium-239/240 concentration exceeds the site-specific background for PGDP, the concentration of plutonium-239/240 in samples exceeding background are below the concentrations associated with fall-out. Plutonium-239/240 is a major contributor to global fall-out due to atmospheric testing of nuclear weapons in the 1950s to the early 1960s. A summary from Argonne National Lab (ANL 2007) states that concentrations up to 0.1 pCi/g are expected from fall-out; therefore, plutonium-239/240 should not be considered in the Addendum 2 soil piles as a contaminant.

Figure B.28 graphically shows the results with the background value and other comparison values. Figure B.29 illustrates the spatial distribution of the sampling locations in which the background value was exceeded.

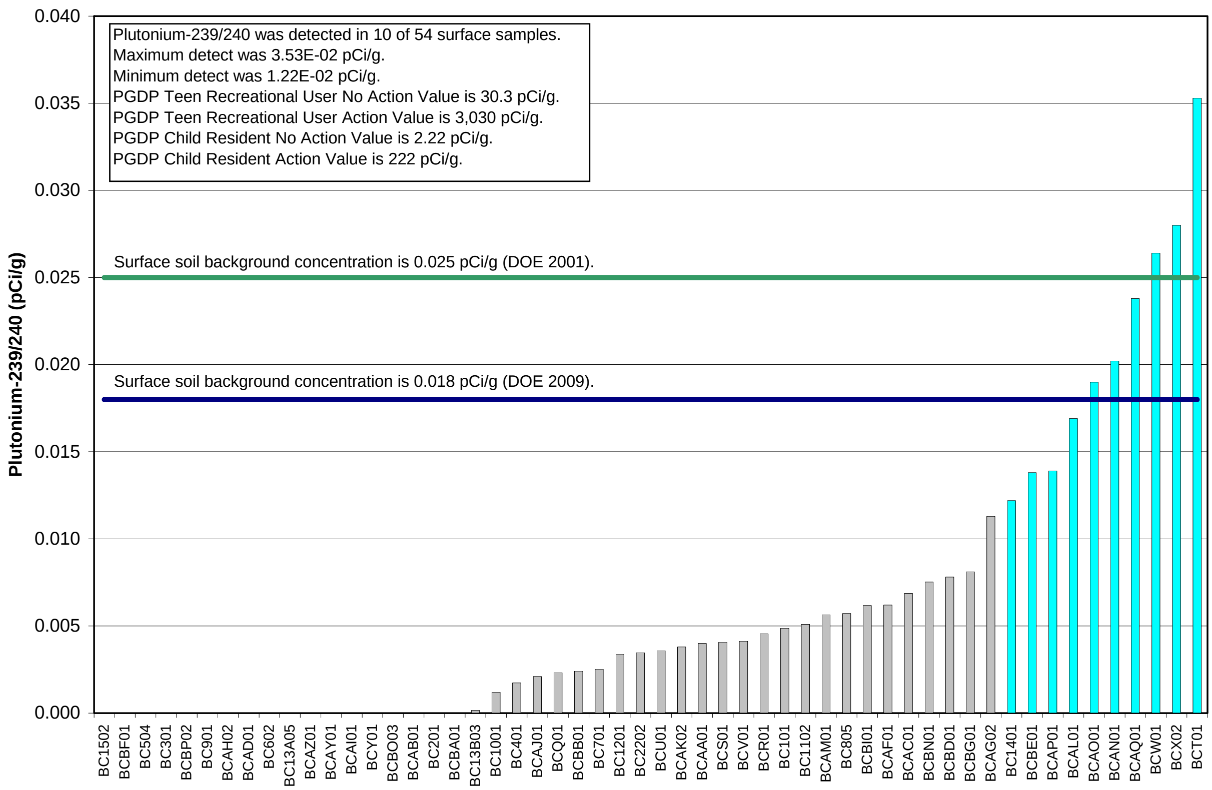


Figure B.28. Comparison between Plutonium-239/240 Concentrations in Samples from Soil Piles Addendum 2 and Surface Soil Background Concentrations

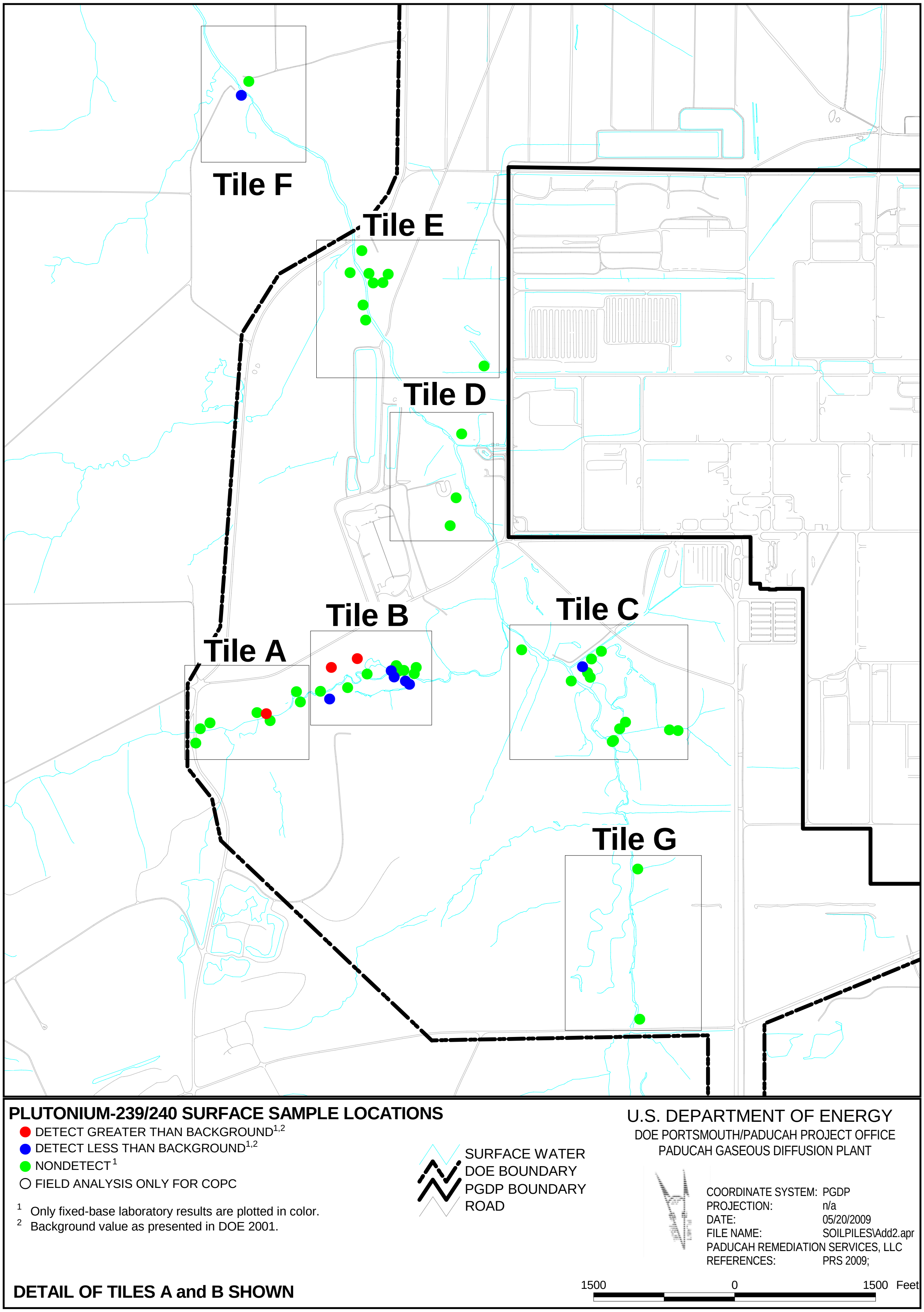
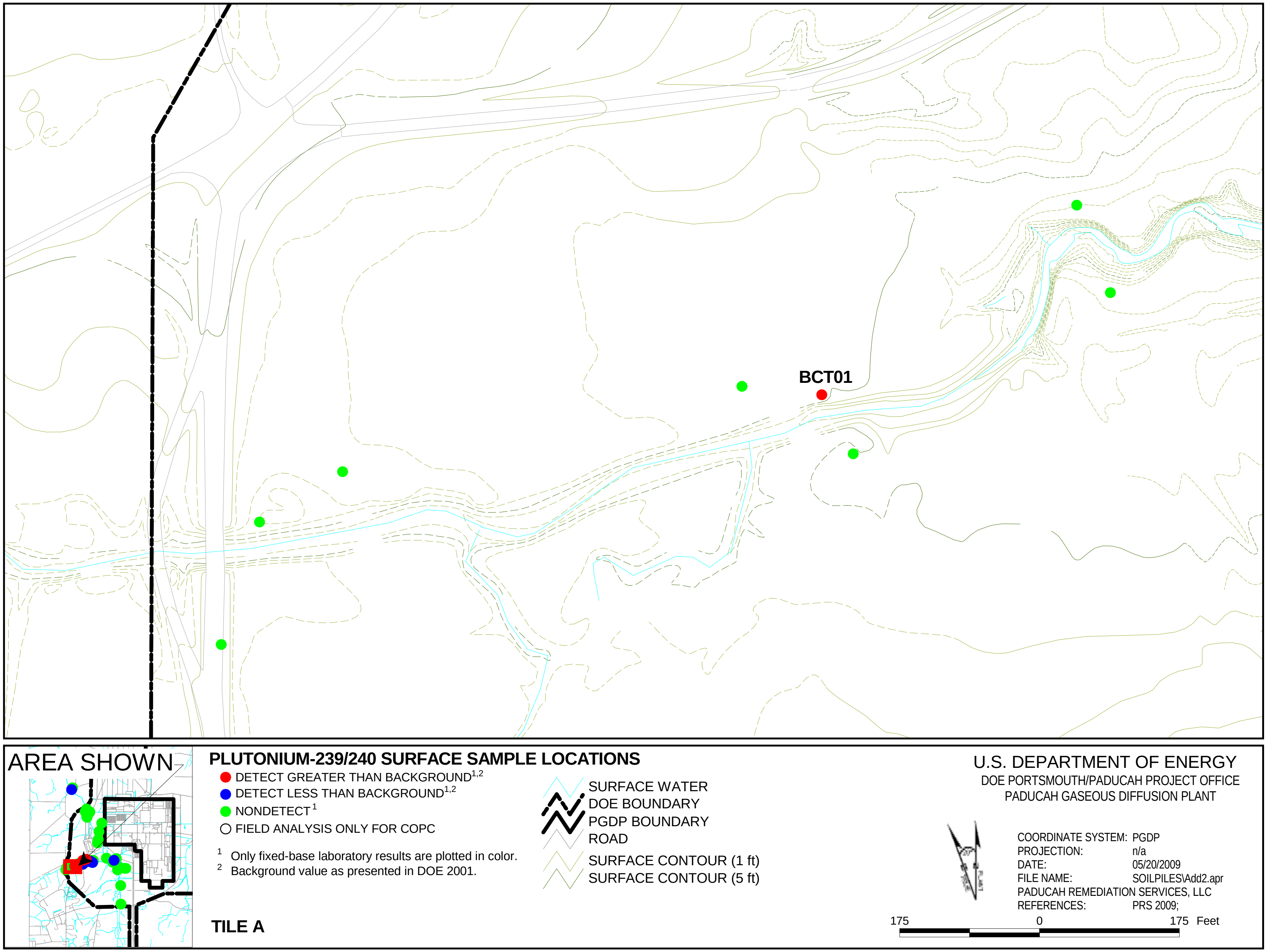


Figure B.29. Location of Sample Stations in Addendum 2 Soil Pile Sampling for Plutonium-239/240 on the Surface



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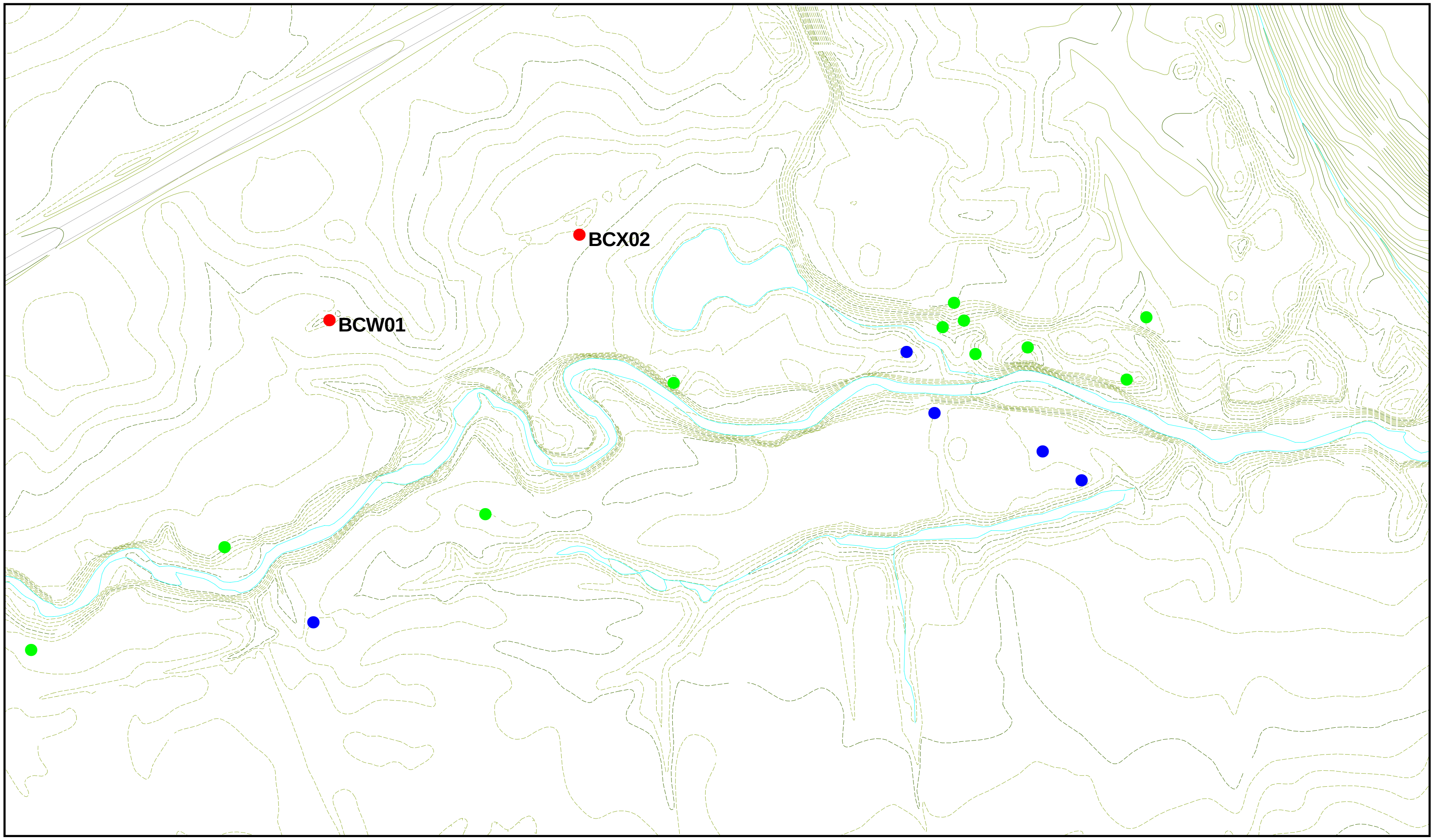
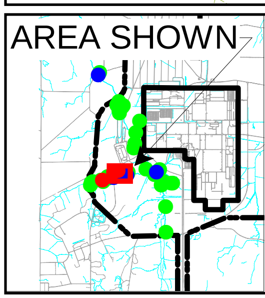




PLUTONIUM-239/240 SURFACE SAMPLE LOCATIONS

- DETECT GREATER THAN BACKGROUND[1,2]
- DETECT LESS THAN BACKGROUND[1,2]
- NONDETECT[1]
- FIELD ANALYSIS ONLY FOR COPC

[1] Only fixed-base laboratory results are plotted in color.
[2] Background value as presented in DOE 2001.

SURFACE WATER
DOE BOUNDARY
PGDP BOUNDARY
ROAD
SURFACE CONTOUR (1 ft)
SURFACE CONTOUR (5 ft)

TILE B

U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

COORDINATE SYSTEM:	PGDP
PROJECTION:	n/a
DATE:	05/20/2009
FILE NAME:	SOILPILES\Add2.apr
PADUCAH REMEDIATION SERVICES, LLC	
REFERENCES:	PRS 2009;

175 0 175 Feet

Figure B.29. (Continued)

Uranium-238–Surface. Due to the method by which uranium isotopes were analyzed by the laboratory, an incremental adjustment was applied in order to compare these results with screening values.[2] Incrementally adjusted uranium-238 values in surface soil samples exceed the background value of 1.2 pCi/g (1.205, 1.282, and 1.493) in three of the 54 samples. The exceeding values are the following: 0.405, 0.482, and 0.693 pCi/g. Prior to the incremental adjustment, uranium-238 values in surface soil samples did not exceed background. The revised background value, which is derived using two times the log-transformed mean, is 1.9 pCi/g (DOE 2009). Comparing the surface uranium-238 values to the adjusted, revised background value, there are no surface soil samples exceeding background.

Figure B.30 graphically shows the results with the background value and other comparison values. Figure B.31 illustrates the spatial distribution of the sampling locations in which the background value was exceeded.

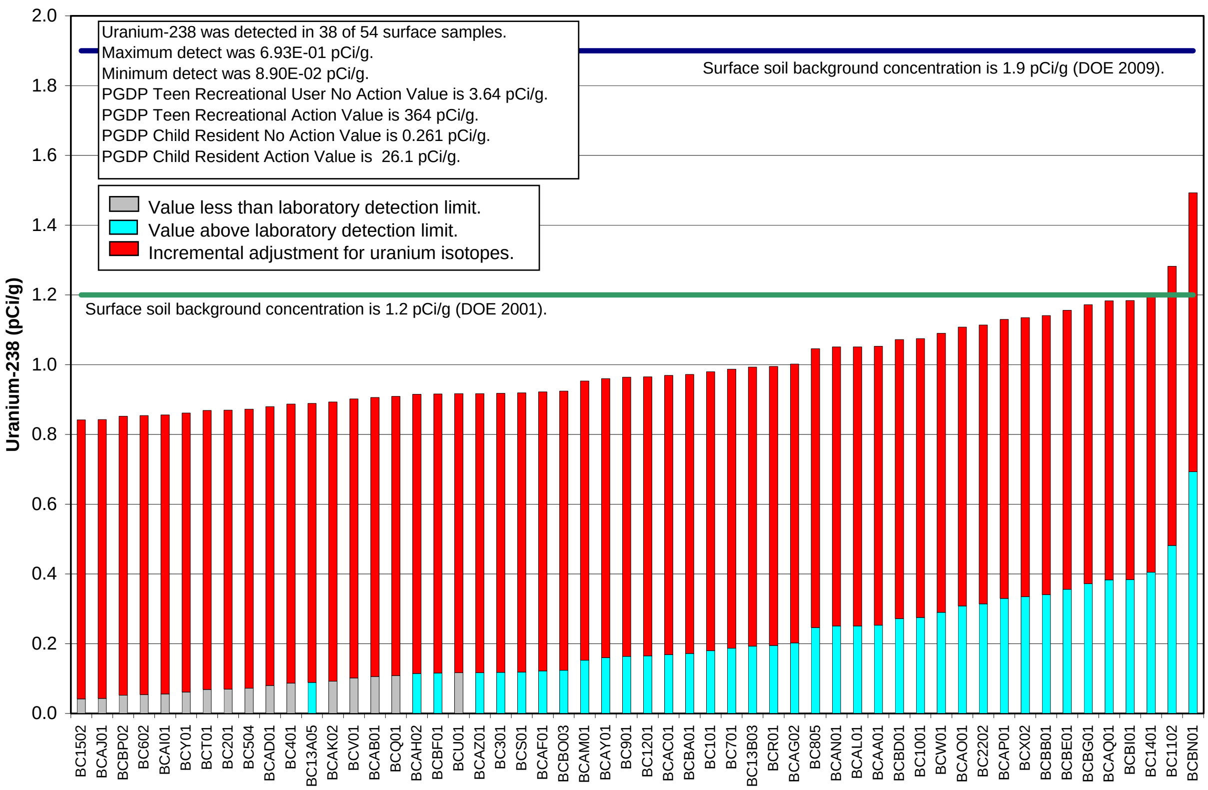
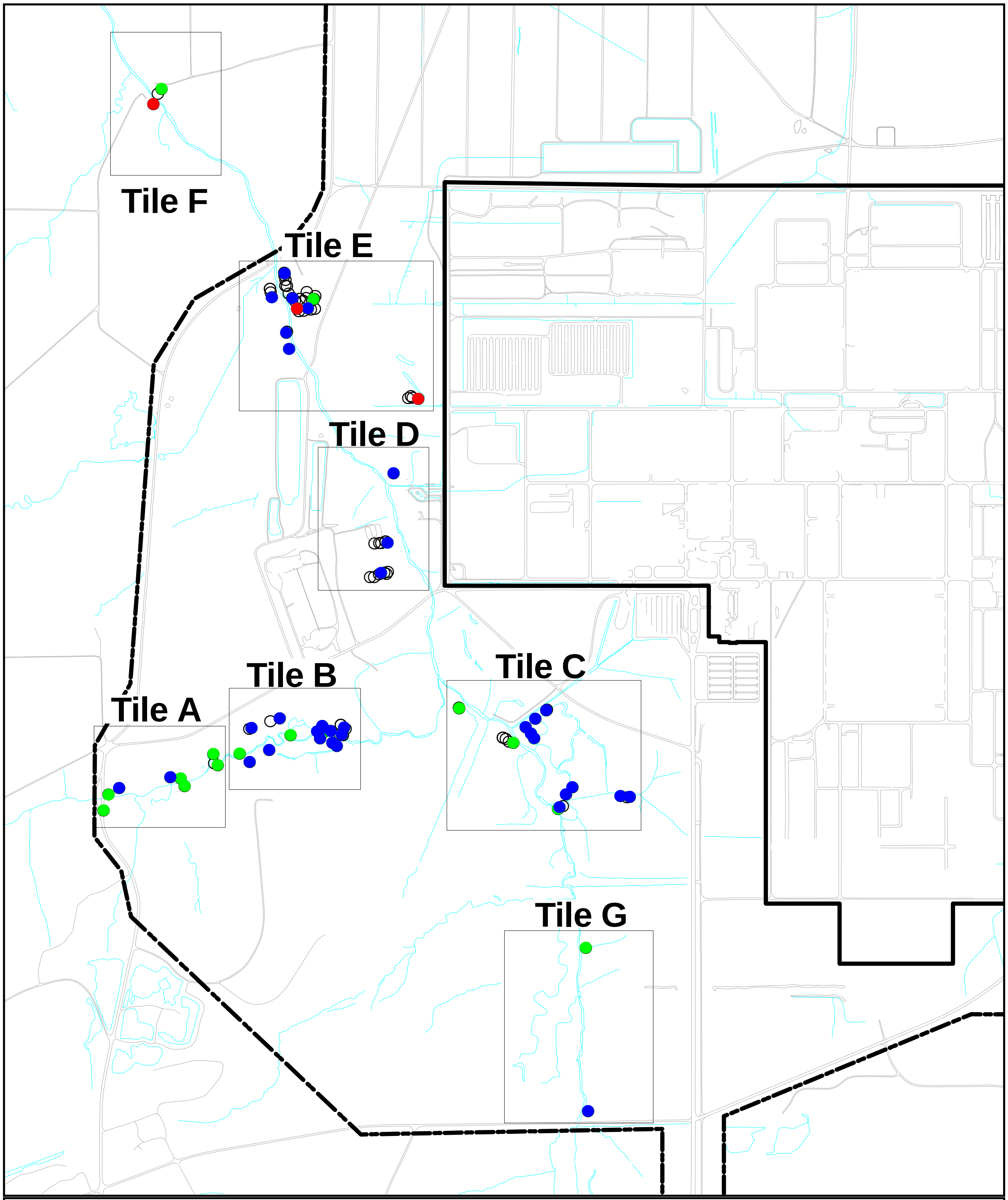


Figure B.30. Comparison between Uranium-238 Concentrations in Samples from Soil Piles Addendum 2 and Surface Soil Background Concentrations

[2] The laboratory reported results for uranium isotopes near background values may be low based on the laboratory's extraction method. Due to this method, an incremental adjustment is necessary prior to comparison of the data to screening values. To simplify the comparison, the adjustment was made to the data results and not the screening values themselves. The incremental adjustments (0.77 pCi/g, 0.04 pCi/g, and 0.8 pCi/g for uranium-234, uranium-235, and uranium-238, respectively) were applied to results less than 10 pCi/g within the dataset. Screening is conducted upon detected values only; thus, the incremental adjustment did not affect results qualified by the laboratory as not detected.



URANIUM-238 SURFACE SAMPLE LOCATIONS

- DETECT GREATER THAN BACKGROUND[1,2]
- DETECT LESS THAN BACKGROUND[1,2]
- NONDETECT[1]
- FIELD ANALYSIS ONLY FOR COPC

[1] Only fixed-base laboratory results are plotted in color.
[2] Background value as presented in DOE 2001.

SURFACE WATER
DOE BOUNDARY
PGDP BOUNDARY
ROAD

U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

COORDINATE SYSTEM: PGDP
PROJECTION: n/a
DATE: 12/09/2009
FILE NAME: SOILPILES\Add2.apr
PADUCAH REMEDIATION SERVICES, LLC
REFERENCES: PRS 2009;

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Figure B.31. Location of Sample Stations in Addendum 2 Soil Pile Sampling for Uranium-238 on the Surface

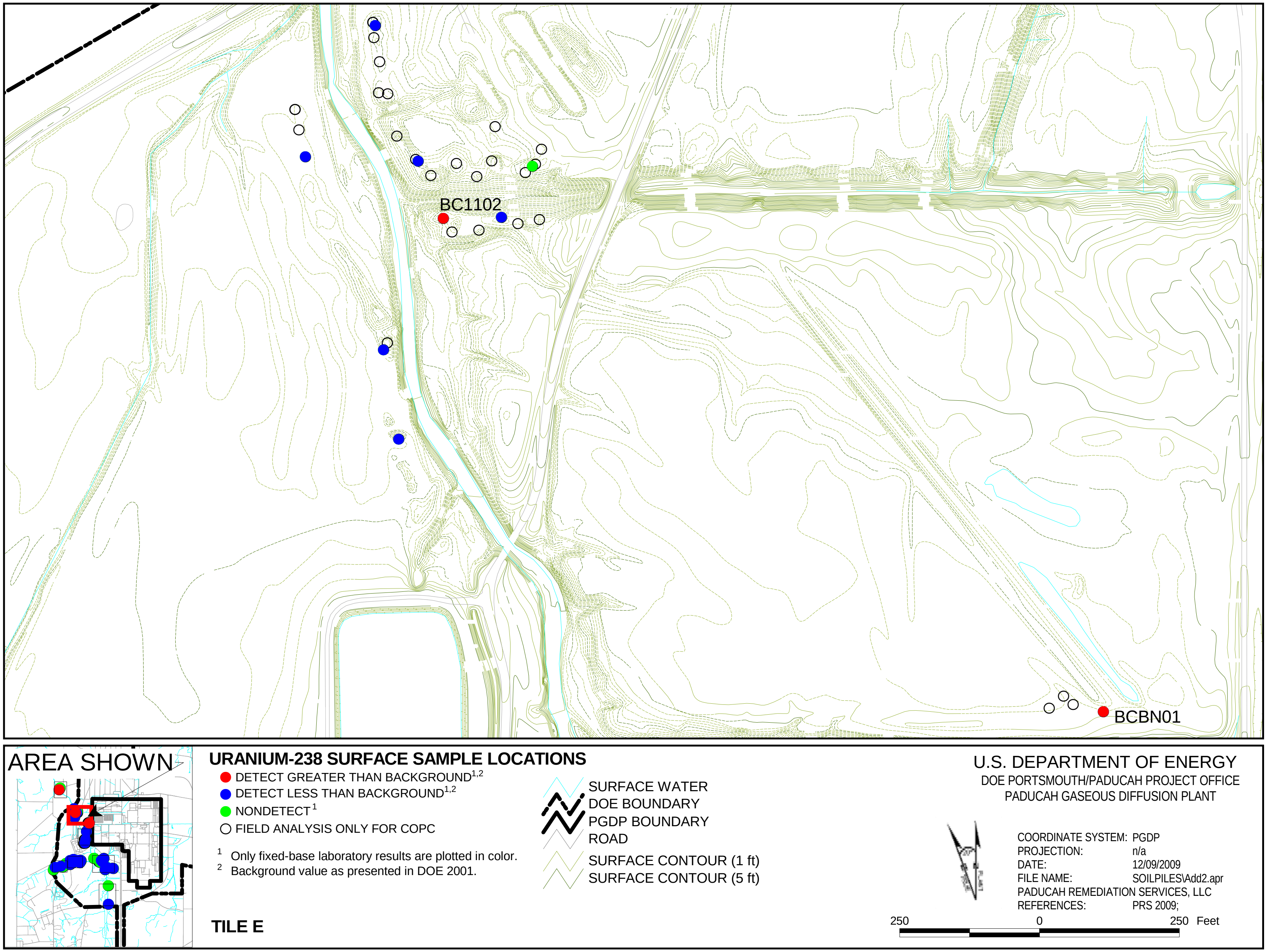

Figure B.31. (Continued)

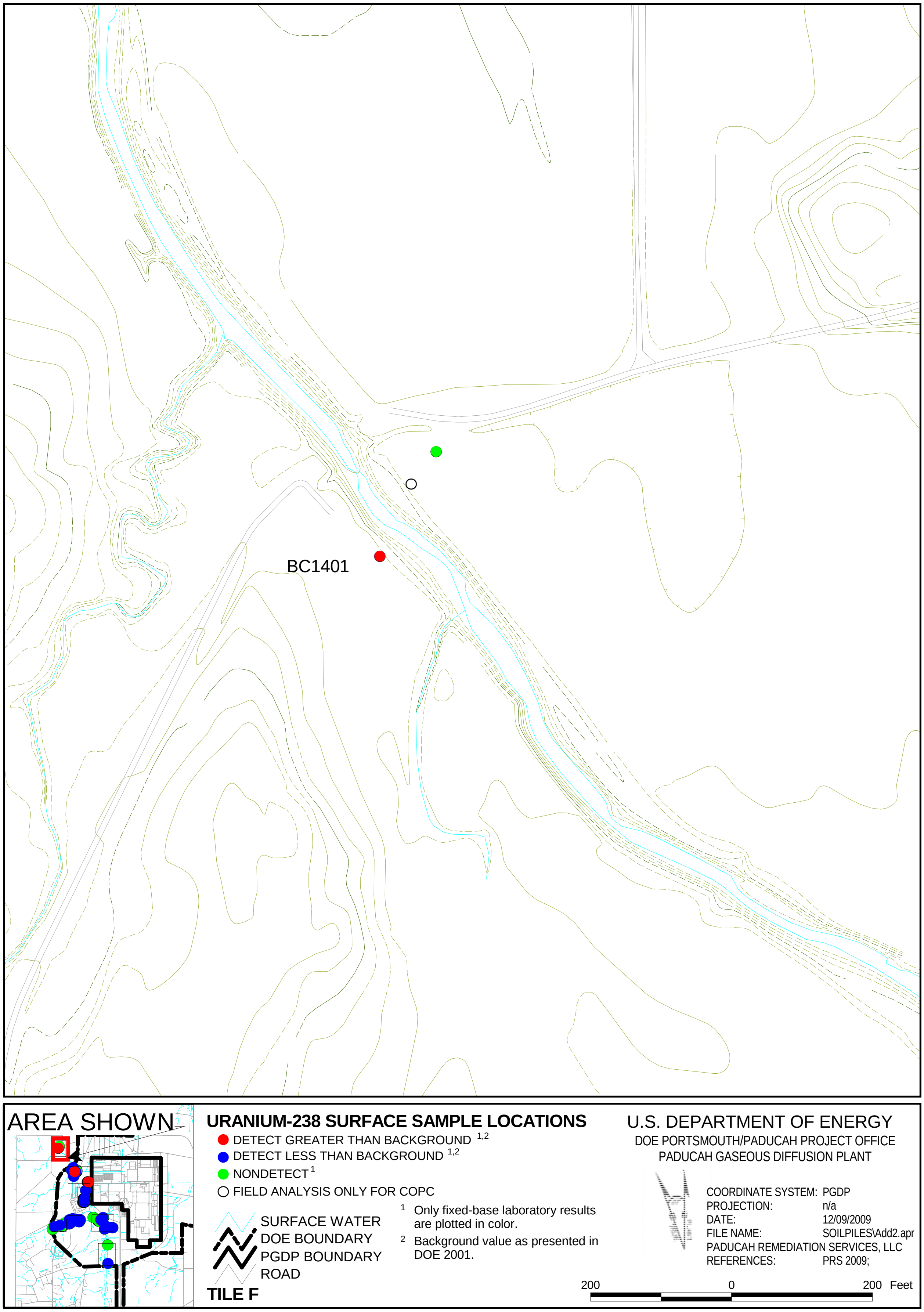

Figure B.31. (Continued)

Uranium-238–Subsurface. Due to the method by which uranium isotopes were analyzed by the laboratory, an incremental adjustment was applied in order to compare these results with screening values.[3] Incrementally adjusted uranium-238 values in subsurface soil samples exceed the background value of 1.2 pCi/g (1.31 and 1.756) in 2 of the 56 samples. The exceeding values are the following: 0.51 and 0.956 pCi/g. Prior to the incremental adjustment, uranium-238 values in subsurface soil samples did not exceed background. The revised background value, which is derived using two times the log-transformed mean, is 1.8 pCi/g (DOE 2009). Comparing the subsurface uranium-238 values to the adjusted, revised background value, there are no subsurface soil samples exceeding background.

Figure B.32 graphically shows the results with the background value and other comparison values. Figure B.33 illustrates the spatial distribution of the sampling locations in which the background value was exceeded.

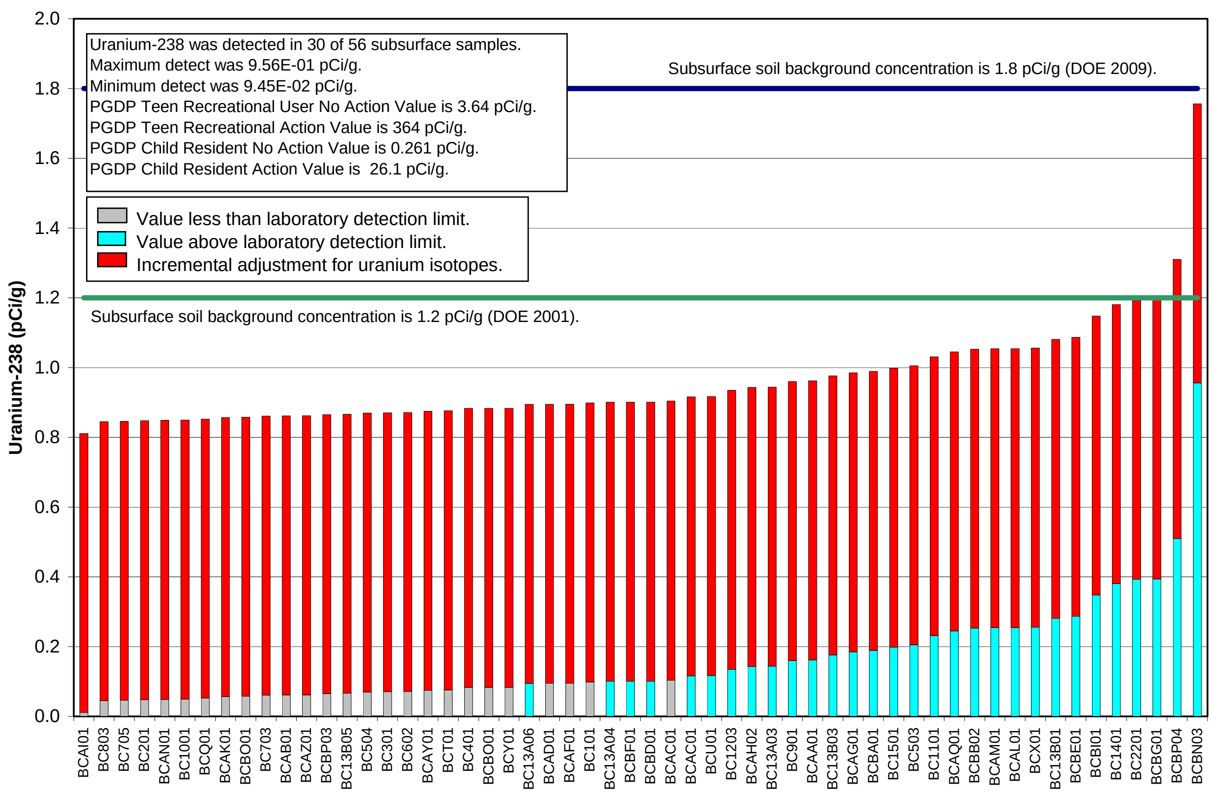

Figure B.32. Comparison between Uranium-238 Concentrations in Samples from Soil Piles Addendum 2 and Subsurface Soil Background Concentrations

[3] The laboratory reported results for uranium isotopes near background values may be low based on the laboratory's extraction method. Due to this method, an incremental adjustment is necessary prior to comparison of the data to screening values. To simplify the comparison, the adjustment was made to the data results and not the screening values themselves. The incremental adjustments (0.77 pCi/g, 0.04 pCi/g, and 0.8 pCi/g for uranium-234, uranium-235, and uranium-238, respectively) were applied to results less than 10 pCi/g within the dataset. Screening is conducted upon detected values only; thus, the incremental adjustment did not affect results qualified by the laboratory as not detected.

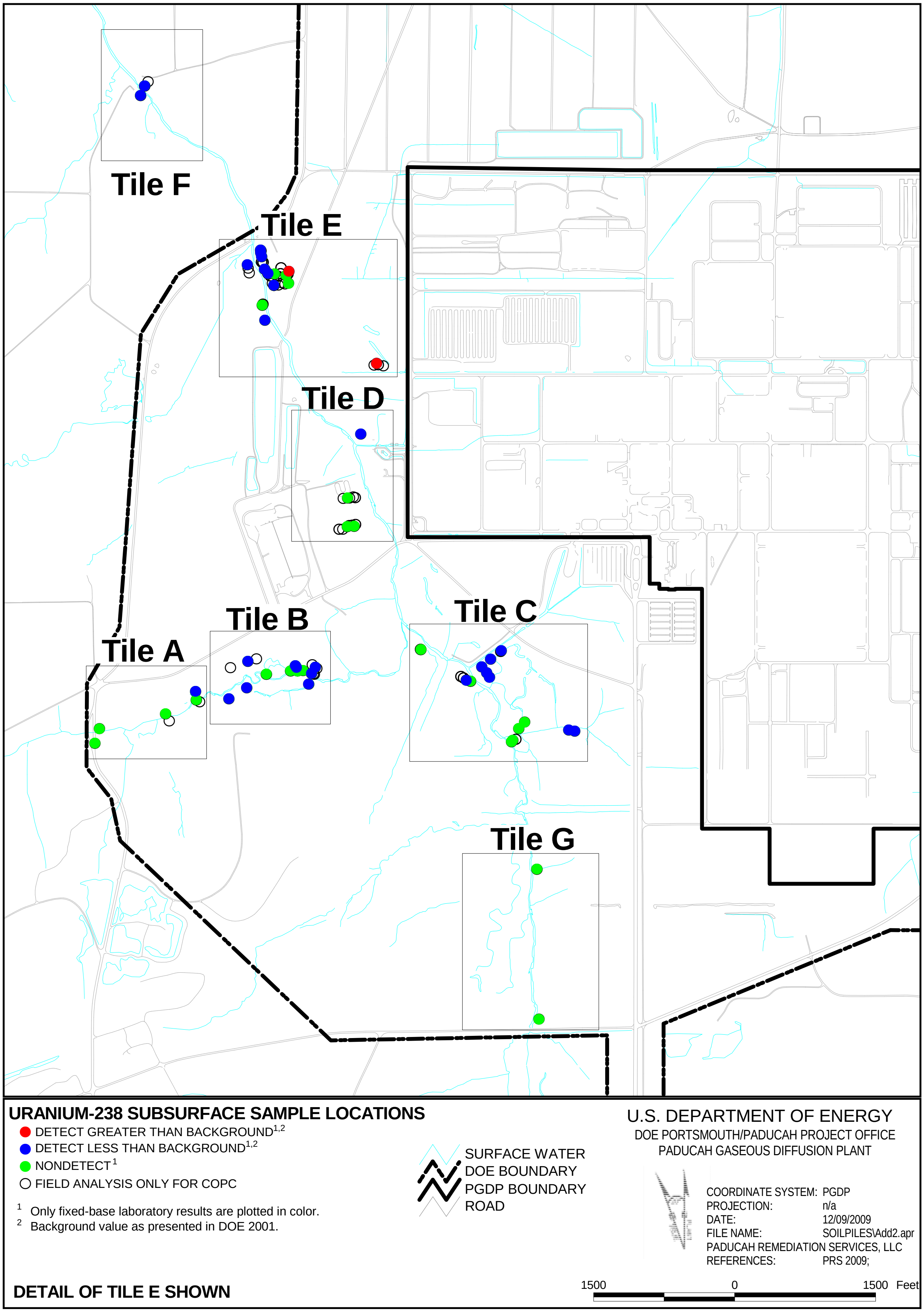

Figure B.33. Location of Sample Stations in Addendum 2 Soil Pile Sampling for Uranium-238 in the Subsurface

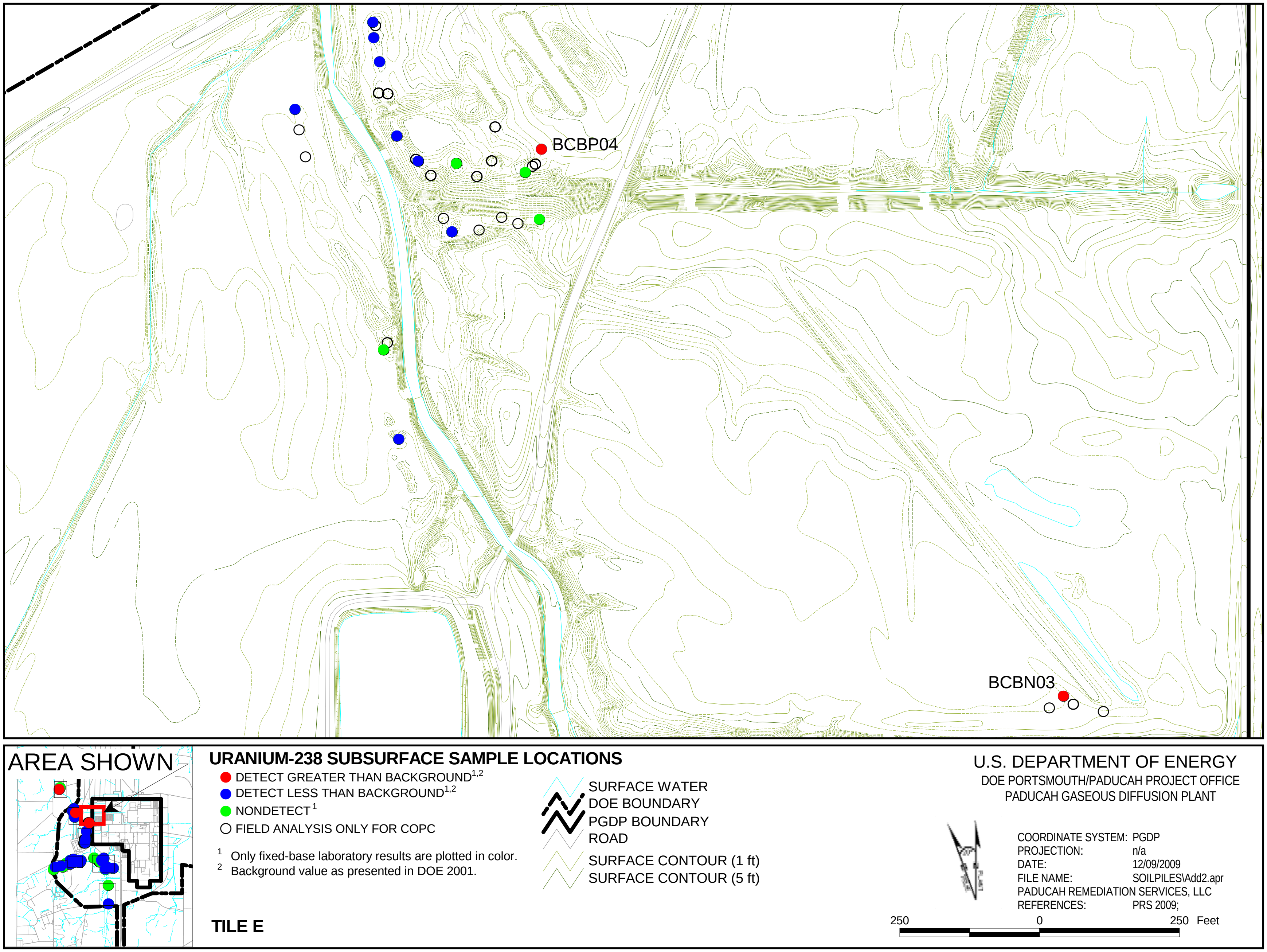

Figure B.33. (Continued)

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DOE/LX/07-0188&D2/R1
Primary Document

Site Evaluation Report for Addendum 2 Soil Piles at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

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Primary Document

Site Evaluation Report for Addendum 2 Soil Piles at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

Date Issued—January 2010

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Deleted: 2009

Prepared for the
U.S. DEPARTMENT OF ENERGY
Office of Environmental Management

Prepared by
PADUCAH REMEDIATION SERVICES, LLC
managing the
Environmental Remediation Activities at the
Paducah Gaseous Diffusion Plant
under contract DE-AC30-06EW05001

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PREFACE

This *Site Evaluation Report for Addendum 2 Soil Piles at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-0188&D2/R1, (SER) was prepared as a result of implementing the *Sampling and Analysis Plan for Soil Piles at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-0015&D2/R1, (DOE 2007a) and associated *Addendum 2 to the Sampling and Analysis Plan at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-0015/A2&D2.

This SER is the second of four to address soil and rubble pile areas in the vicinity of the Paducah Gaseous Diffusion Plant, as identified in the Notification Letter submitted to U.S. Environmental Protection Agency and Kentucky Department for Environmental Protection, dated February 16, 2007 (DOE 2007b). This SER addresses soil sampling at soil piles located west of the Paducah Gaseous Diffusion Plant along Bayou Creek. It was developed in accordance with the requirement in Section IX of the Federal Facility Agreement for submittal of an integrated removal/remedial Site Evaluation and Solid Waste Management Unit Assessment Report.

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ACRONYMS

AL	action level
AOC	area of concern
ASER	Annual Site Environmental Report
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
COPC	chemical of potential concern
CSM	conceptual site model
DOE	U.S. Department of Energy
DQO	data quality objective
EPA	U.S. Environmental Protection Agency
FFA	Federal Facility Agreement
ISOCS	*In Situ* Object Counting System
KEEC	Kentucky Energy and Environment Cabinet
KPDES	Kentucky Pollutant Discharge Elimination System
MDL	method detection limit
MS	matrix spike
MSD	matrix spike duplicate
NA	not applicable
NAL	no action level
NCP	National Contingency Plan
NIST	National Institute of Standards and Technology
ORPS	Occurrence Reporting and Processing System
PAH	polyaromatic hydrocarbon
PCB	polychlorinated biphenyl
PGDP	Paducah Gaseous Diffusion Plant
PSS	plant shift superintendent
QC	quality control
RCRA	Resource Conservation and Recovery Act
RGA	Regional Gravel Aquifer
RPD	relative percent difference
SAP	Sampling and Analysis Plan
SER	Site Evaluation Report
SRM	standard reference material
SWMU	solid waste management unit
SWOU	Surface Water Operable Unit
TCE	trichloroethene
VOC	volatile organic compound
WKWMA	West Kentucky Wildlife Management Area
XRF	X-ray fluorescence

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EXECUTIVE SUMMARY

This Site Evaluation Report (SER) presents the results of the comprehensive sampling effort completed for Addendum 2 Soil Piles along Bayou Creek. Sampling and analysis were completed in accordance with the following agency-approved secondary documents:

- *Sampling and Analysis Plan for Soil Piles at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-0015&D2/R1, (SAP) 2007; and

- *Addendum 2 to the Sampling and Analysis Plan at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-0015/A2/&D2, 2008.

In December 2006, soil sampling was completed at Addendum 2 Soil Piles 14 and 15, which are located off U.S. Department of Energy (DOE) property, to assess further site conditions. The sampling effort indicated results below action levels and at or near background levels for radionuclides, metals, and polychlorinated biphenyls (PCBs). Addendum 2 Soil Piles, distributed across approximately 88 acres, represents over one-half of the total number of soil piles identified in the February 2007 notification letter. The 54 piles that comprise the Addendum 2 soil piles are located along Bayou Creek west of the Paducah Gaseous Diffusion Plant (PGDP) vary in size and shape, ranging from approximately 3 to 450 ft in length and from 2 to 8 ft in height. The field investigation was conducted between August and September 2008.

PROJECT OBJECTIVES

The study was designed to obtain sufficient data of known quality to support the following objectives:

- Establish the nature and extent of contamination of soils in Addendum 2 Soil Piles and adjacent soils.
- Establish the mean concentrations of contaminants in soils.
- Determine if soils pose imminent risks to human health.
- Determine if soils contamination exceeds regulatory thresholds.

INVESTIGATION SUMMARY

The following provides the planned sampling activities for Addendum 2 Soil Piles and an accounting of the actual number and types of samples collected. Addendum 2 to the PGDP Soil Piles SAP specified the collection and analysis of these samples:

- Fifty-four surface samples (24 small piles, 30 large piles) to undergo field measurements and fixed laboratory analysis

- One hundred seven surface samples (24 small pile locations, 83 large pile locations) to undergo field measurements only

- Sixty subsurface samples (25 small pile locations, 35 large pile locations), where subsurface is defined as soil taken at a depth below 1 ft, to undergo field measurements and fixed laboratory analysis

- Two hundred ten subsurface samples (31 small pile locations, 179 large pile locations) to undergo field measurements only
- A number of contingency samples (no more than 40), if contamination was identified

During execution of Addendum 2, the total number of soil samples collected was as follows:

- Fifty-four surface samples underwent field measurements and fixed laboratory analysis
- Fifty-five surface samples underwent field measurements only
- Fifty-six subsurface samples underwent field measurements and fixed laboratory analysis
- One hundred eleven subsurface samples underwent field measurements only
- No contingency samples were collected

The differences between planned and actual sample numbers resulted from three factors.

First, the observed differences in subsurface samples result entirely from variations in soil pile height. Because the soil pile height, on average, was less than 5 ft, a fewer number of samples than that estimated in the Addendum 2 to the SAP were required to reach the natural grade.

Second, many of the large soil piles were smaller than planned in the Addendum 2 SAP, resulting in less area to be sampled.

Third, the concentration of analytes (i.e., chemicals of potential concern) in samples was at or near background or less than the screening criteria in the Addendum 2 SAP; therefore, no contingency samples were required.

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INVESTIGATION FINDINGS

Sample results indicate no PCBs detected. Generally, metals results were statistically the same as background, based upon the results being below the 95th percentile of the generic statewide ambient background values (with the mean of the results being below the 95 upper confidence limit of the mean generic statewide ambient background and at least half of the results less than the 60th percentile). Polyaromatic hydrocarbons (PAHs) were detected (benzoanthracene, pyrene, anthracene, chrysene, and fluoranthene between 0.72 and 2.1 ppm) in two samples collected from the 54 Addendum 2 soil piles. The PAHs detected are considered outliers and not indicative of contamination. Cesium-137 and plutonium-239/240 radionuclides were detected at or near background and are considered the result of fallout. Cesium-137 was detected in several piles; however, most are located upstream of PGDP. As a result, these chemicals are not considered site-related contaminants.

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SUMMARY OF INVESTIGATION CONCLUSIONS

Nature and Extent of Contamination

Data of known quality were acquired in sufficient quantities to allow decision makers to formulate an informed decision as to the need for an action at any of the Addendum 2 Soil Piles, if warranted. Samples were collected from 54 soil piles and, as noted, was less than or similar to background. No documentation was found as a result of the historical document review to demonstrate the presence of wastes. Accordingly, the available information indicates that the piles do not meet the regulatory definition of a

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It should be noted that the February 16, 2007, notification letter indicated that 102 of the 122 soil and rubble areas (including Addendum 2 54 soil piles) are being designated as a SWMU and/or AOC (DOE 2007b). It also states that DOE will be "evaluating whether the areas are SWMUs or AOCs.…" The Addendum 2 SER is the second of four SERs being provided as part of the evaluation and, as stated and detailed within the document, provides documentation to support the conclusion that Addendum 2 piles do not meet the definition of a SWMU or AOC.

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Assessment of Human Health Risks

The results of the background screening for metals indicate concentrations used to quantify risks and hazards were at or near background levels for all 54 soil piles. No PCBs were detected. For uranium, the fixed-base laboratory concentrations are below the individual recreational user screening level for a 1 mrem/year dose and, therefore, below the "walk away" level in the PGDP Risk Methods Document.

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1. INTRODUCTION

This Site Evaluation Report (SER) has been developed in accordance with the requirement in Section IX of the Paducah Gaseous Diffusion Plant (PGDP) Federal Facility Agreement (FFA) for the submittal of an integrated removal/remedial SER/Solid Waste Management Unit (SWMU) Assessment Report. The report is organized as follows:

- Project Scope, Objectives, and Background
- Area Description
- Field and Analytical Methods
- Quality Assurance/Quality Control (QC)
- Discussion and Results
- Data Screening
- Conclusions
- Recommendations

1.1 PROJECT SCOPE

During November, 2006, soil piles were discovered by the U.S. Department of Energy (DOE) and the Commonwealth of Kentucky along Bayou and Little Bayou Creek, outside of the PGDP industrialized area. Initial field radiation surveys of some Little Bayou Creek soil piles indicated elevated levels of radioactivity. However, surveys of piles along Bayou Creek, west of PGDP did not indicate levels of radioactivity above background. Based on these initial field results, DOE planned to determine if any of the piles posed an immediate threat to human health or public safety. A sampling plan to evaluate Addendum 2 Soil Piles was developed and approved by the regulatory agencies. The provisions for this program are contained in two DOE secondary documents:

- *Sampling and Analysis Plan for the Soil Piles at Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-0015&D2/R1, (SAP) 2007; and

- *Addendum 2 to the Sampling and Analysis Plan at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-0015/A2/&D2, 2008.

Addendum 2 field work was implemented at the soil piles between August and September 2008. This SER presents the results of that effort and includes the data generated from field activities, an evaluation of project data quality and usability, assessment of the potential risks to human health, and conclusions. See Figure 1 for Addendum 2 Soil Pile locations along Bayou Creek.

As noted in both the SAP and Addendum 2, the focus of the investigation was to evaluate conditions in the soil piles along Bayou Creek and adjacent soils. The scope of the project was to examine conditions, evaluate potential human health risks, and compare soil pile contaminant concentrations [to background and action levels (ALs)] to support future decisions.

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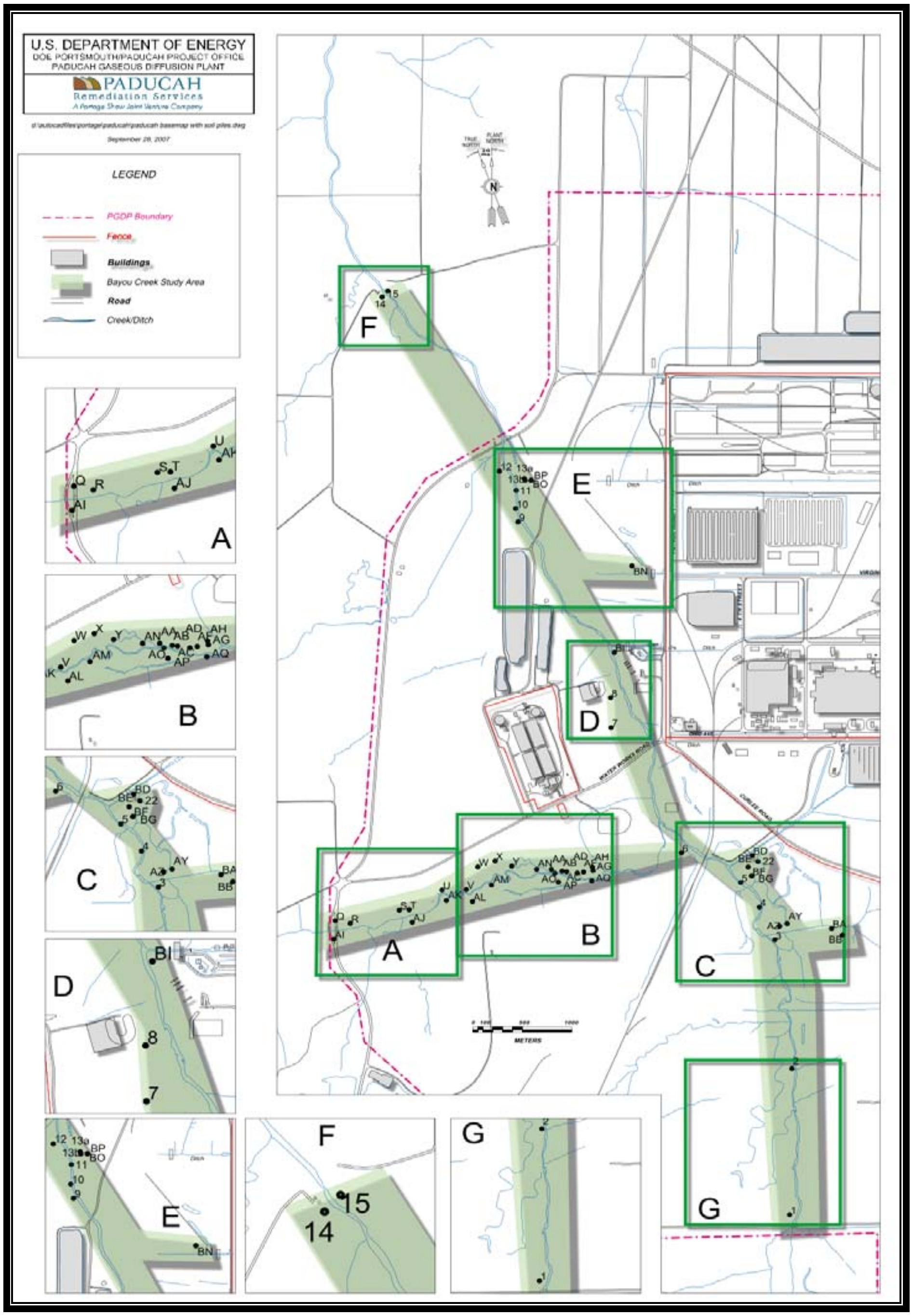

Figure 1. Addendum 2 Soil Piles

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1.2 PROJECT OBJECTIVES

The principal study objective of the Addendum 2 Soil Piles sampling effort was to determine if contamination is present and, if so, determine the nature and extent of soil contamination in soil piles and adjoining soils. The data quality objectives (DQOs) include the following:

- Establish the nature and extent of contamination in Addendum 2 Soil Piles and adjacent soils.
- Establish the mean concentrations of contaminants in soils.
- Determine if soils pose imminent risks to human health.
- Determine if soils contamination exceeds regulatory thresholds.

1.3 REGULATORY OVERVIEW

PGDP was placed on the National Priorities List on May 31, 1994. In accordance with Section 120 of Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), DOE entered into an FFA with the U.S. Environmental Protection Agency (EPA) Region 4 and Kentucky. The FFA established one set of consistent requirements for achieving comprehensive site remediation in accordance with CERCLA and Resource Conservation and Recovery Act (RCRA), including stakeholder involvement.

The DOE Portsmouth/Paducah Project Office is responsible for environmental management activities associated with PGDP (CERCLIS# KY8-890-008-982) and serves as the lead agency for response actions at PGDP. EPA Region 4 and Kentucky Department for Environmental Protection serve as the regulatory oversight agencies for the facility.

Addendum 2 Soil Piles are identified in the notification letter dated February 16, 2007.

1.4 PROJECT BACKGROUND

Following the November 2, 2006, discovery and notifications to the regulators of contamination found in a soil pile located along Little Bayou Creek, field efforts were initiated to identify other piles. Once a pile was identified, the initial effort included a preliminary radiological survey of soil piles and adjoining soils. Initial reconnaissance and subsequent surveys noted no elevated radioactivity in Addendum 2 soil piles.

In December 2006, soil sampling was completed at Addendum 2 Soil Piles 14 and 15 (Figure 1), which are located off DOE property, to further assess site conditions. The results of this sampling effort indicated levels below detection or at background for radionuclides, metals, and polychlorinated biphenyls (PCBs).

A complete gamma walkover survey was performed for Addendum 2 Soil Piles during 2008. The results of this survey confirmed those of the initial survey and found no elevated radioactivity for any of the 54 Addendum 2 Soil Piles along Bayou Creek.

Historical research was performed to attempt to determine the origin of the piles and in response to EPA's previous request for soil and rubble area information pursuant to RCRA 3007 (2007). The origin of the Addendum 2 Soil Piles remains unknown; however, available information (employee interviews) indicates that many of the PGDP-related soil piles may have originated from excavations associated with

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the creation, periodic dredging, and cleanout of the outfalls, ditches, and creeks that comprise the PGDP surface water management system. The Addendum 2 Soil Piles are not operational.

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2. AREA DESCRIPTION

2.1 ADDENDUM 2 SOIL PILES

Field reconnaissance of Addendum 2 Soil Piles identified 54 piles along Bayou Creek. The majority of the soil piles are located west of PGDP industrialized area and are on DOE-owned property. Two soil piles, 14 and 15, are located on West Kentucky Wildlife Management Area (WKWMA) property just off DOE property, on the banks of Bayou Creek, west of PGDP. The soil piles are distributed across approximately 88 acres and generally are bounded by PGDP industrialized area to the east, the WKWMA/DOE boundary to the west, and the DOE boundary to the north and south. See Figure 1 in Section 1 for a map of the piles.

The Addendum 2 Soil Piles vary in size and shape, ranging from approximately 3 to 450 ft in length and from 2 to 8 ft in height. The soil piles are widely dispersed and often occur as clusters. Vegetative re-growth on and adjacent to the piles is very dense, indicating the soil piles have been in their present locations for years. Improvements that may have supported the creation of soil piles (e.g., road improvements) are not visible along the Addendum 2 Soil Piles.

2.2 GEOLOGY AND SOILS

The PGDP and Addendum 2 Soil Piles are located in the Jackson Purchase Region of Western Kentucky, which represents the northern tip of the Mississippi Embayment portion of the Coastal Plain. The Jackson Purchase Region is an area of land that includes all of Kentucky west of the Tennessee River. The stratigraphic sequence in the region consists of Cretaceous, Tertiary, and Quaternary sediments unconformably overlying Paleozoic bedrock.

Relative to the shallow groundwater flow system in the vicinity of the PGDP, the continental deposits and the overlying loess and alluvium are of key importance. The continental deposits locally consist of an upper silt member, with lesser sand and gravel interbeds, and a thick, basal sand and gravel member, which fills a buried river valley. A subcrop of the Porters Creek Clay, located beneath and immediately south of the PGDP marks the south extent of the buried river valley. Fine sand and clay of the McNairy Formation directly underlie the continental deposits. These continental deposits are continuous from beneath PGDP to beyond the present course of the Ohio River.

The general soil map for Ballard and McCracken counties indicates that three soil associations are found within the vicinity of the PGDP (USDA 1976): the Rosebloom-Wheeling-Dubbs association, the Grenada-Calloway association, and the Calloway-Henry association. The predominant soil association in the vicinity of the PGDP is the Calloway-Henry association, which consists of nearly level, somewhat poorly drained, medium-textured soils on upland positions.

Although the soil over most of the PGDP may be Henry silt loam with a transition to Calloway, Falaya-Collins, and Vicksburg away from the site, many of the characteristics of the original soil have been lost due to industrial activity that has occurred over the past 50+ years. Activities that have disrupted the original soil classifications include filling, mixing, and grading.

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2.3 HYDROGEOLOGY

PGDP and Addendum 2 Soil Piles are located in the western portion of the Ohio River drainage basin, approximately 15 miles downstream of the confluence of the Ohio River with the Tennessee River and approximately 35 miles upstream of the confluence of the Ohio River with the Mississippi River. Locally, the PGDP is within the drainage areas of the Ohio River, Bayou Creek, and Little Bayou Creek.

The PGDP is situated on the divide between the two creeks. Surface flow is east-northeast toward Little Bayou Creek and west-northwest toward Bayou Creek. Bayou Creek is a perennial stream on the western boundary of the plant that flows generally northward, from approximately 2.5 miles south of the plant site to the Ohio River. Little Bayou Creek becomes a perennial stream at the east outfalls of PGDP. The Little Bayou Creek drainage originates within WKWMA and extends northward and joins Bayou Creek near the Ohio River. The drainage basins for both creeks are located in rural areas; however, they receive surface drainage from numerous swales that drain residential and commercial properties, including WKWMA, PGDP, and Tennessee Valley Authority Shawnee Steam Plant. The confluence of the two creeks is approximately 4.8 km (3 miles) north of the plant site, just upstream of the location at which the combined flow of the creeks discharges into the Ohio River (DOE 2006a).

Most of the flow within Bayou and Little Bayou Creeks is from process effluents or surface water runoff from the PGDP. Contributions from PGDP comprise approximately 85% of flow within Bayou Creek and near 100% of flow within Little Bayou Creek. A network of ditches discharges effluent and surface water runoff from PGDP to the creeks. Plant discharges are monitored at the Kentucky Pollutant Discharge Elimination System (KPDES) outfalls prior to discharge into the creeks.

The local groundwater flow system at the PGDP site occurs within the sands of the Cretaceous McNairy Formation, Pliocene Terrace Gravel, Plio-Pleistocene lower continental gravel deposits and upper continental deposits, and Holocene alluvium. The primary local aquifer is the Regional Gravel Aquifer (RGA). The RGA consists of the Quaternary sand and gravel facies of the lower continental deposits and Holocene alluvium found adjacent to the Ohio River and is of sufficient thickness and saturation to constitute an aquifer. These deposits have an average thickness of 9.1 m (30 ft), and range up to 15.24 m (50 ft) along an axis that trends east–west through the plant site. Groundwater flow is predominantly north toward the Ohio River (DOE 2006a).

2.4 POTENTIAL SOURCES OF CONTAMINATION

The following provides an evaluation of potential transport mechanisms for contaminants found at PGDP. Figure 2 provides an overview of the PGDP industrial complex and the associated surface water management system.

2.4.1 Contaminant Transport Mechanisms

Transport mechanisms likely include both dissolved constituents and sediment in storm water runoff.

The PGDP surface water management system discharges to Bayou Creek through several outfalls.

Figure 2 illustrates where outfalls discharge relative to PGDP. An investigation was conducted for on-site areas for the Surface Water Operable Unit (SWOU). Transport modeling of contaminated sediment found

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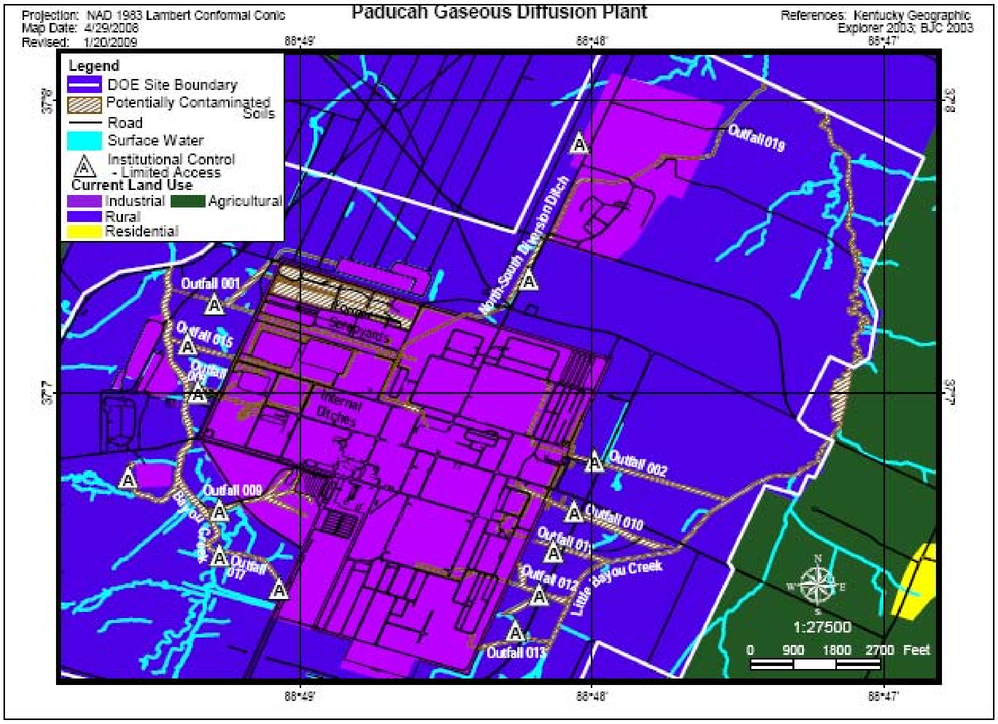

Figure 2. PGDP Outfall Locations

in Outfalls 001, 008, and 015 completed as part of the SWOU on-site investigation concluded that migration through surface water would not result in unacceptable risk to recreational users of Bayou Creek. Ongoing monitoring supports this conclusion.

2.4.2 Documented Releases/Spills

Possible contaminant sources to Bayou Creek may include releases resulting from surface water runoff, originating at spill or release sites inside the PGDP industrial complex, prior to their remediation. These include releases documented in the following reports or logs:

- Occurrence Reporting and Processing System (ORPS) spanning from approximately 1990 to the present,
- Plant shift superintendent (PSS) logs spanning from 1984 through 1990, and
- Annual Site Environmental Reports (ASERs) from 1984 through 2006.

The 3007 information request, occurrence reports and document summary forms from the PSS logs provide a description of the spills and releases and contain pertinent information such as the date and time

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of release, known or suspected contaminants, estimated quantities of material(s) released, and a description of the actions taken.

The types of chemicals involved in historical spills and releases contained in the ORPS include PCBs, recirculated cooling water containing chromium, chilled chromated water, landfill leachate, gasoline and diesel fuel, and various oils. The types of spills and releases documented in the PSS logs include PCBs, recirculated cooling water, trichloroethene (TCE), sanitary waste water, chromated water, paint pigment, gasoline, diesel, miscellaneous oil, uranium, technetium-99, and observed oil sheens in the outfall discharges. Spills and releases reported in the ASERs include recirculated cooling water, chilled water, TCE, battery acid, transformer oil, diesel fuel, soda ash, and landfill leachate.

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2.5 SUMMARY OF RECENT ENVIRONMENTAL MONITORING RESULTS

Bayou Creek is subject to routine environmental monitoring under DOE Order 450.1 (previously DOE Order 5400.1). The KPDES Permit and DOE Orders identify the monitoring and discharge limits for surface water. Monitoring data indicate there have been no recent (2000 to present) releases that could result in unacceptable risk to human health and the environment through the PGDP surface water drainage system and that surface water and sediment transport presently are not acting as a source of contamination to Bayou Creek.

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3. FIELD AND ANALYTICAL METHODS

3.1 ADDENDUM 2 SOIL PILES SAMPLING APPROACH

The Addendum 2 Soil Piles sampling approach was designed to accomplish the project objectives. This approach is detailed in the DOE-, EPA-, and Commonwealth of Kentucky-approved SAP and Addendum 2. A summary of the sampling approach and other field activities is provided in the following sections.

3.1.1 Systematic Sampling

The Addendum 2 Soil Piles were divided into two groups: small and large. Soil piles whose length and width are less than or equal to 30 ft were classified as small; soil piles whose length or width are greater than 30 ft were classified as large. A systematic sampling approach was implemented for small soil piles, and a systematic random sampling approach was implemented for large soil piles. These approaches were designed to ensure sampling results were sufficient to determine the concentration and distribution of constituents throughout the study area.

Each small soil pile was sampled at a single location from the tallest portion of the pile. Each large pile was sampled using a grid with 50-ft spacing. For both small and large piles, surface samples were collected from 0-1 ft followed by subsurface samples collected vertically at 3-ft intervals, starting at the 1 ft level (1–4, 4–7, if required) and extending down to the interface with natural grade.

For all piles, all samples underwent field analyses, and a minimum of one surface, and one subsurface sample per pile was sent to the fixed laboratory analyses. Additionally, if more than 10 samples were collected from a pile, then, at a minimum, 10% of the samples underwent fixed-base laboratory analyses. The samples undergoing fixed-base laboratory analyses subject to this 10% rule were randomly selected from all samples collected.

Field methods included Resource Conservation and Recovery Act metals and uranium analysis by *ex situ* X-ray fluorescence (XRF), *ex situ* radioactivity measurements using *In Situ* Object Counting System (ISOCS), PCBs using immunoassay/colorimetric test kits, and a demonstration of polynuclear aromatic hydrocarbons (PAHs) test kits, which also employ immunoassay/colorimetric techniques.[1] The analyte list for fixed-base laboratory analyses includes the metals and radionuclides on the list of significant chemicals of potential concern (COPCs) in the PGDP Risk Methods Document (DOE 2001), PCBs, and PAHs.[2,3]

3.1.2 Contingency Sampling

The Addendum 2 Soil Piles sampling approach also included provisions for contingency sampling (up to 40 samples) to allow for the collection of data for unexpected field conditions or to augment project data based on field method results. Based upon the field data results, contingency samples were not collected. In addition, no unexpected field conditions were encountered.

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[1] Field PAH analyses were completed on only those samples submitted for fixed laboratory analyses to determine their efficacy for deployment at PGDP on future projects.

[2] PAHs were analyzed in samples sent to the fixed-base laboratory to allow comparison with results from field test kits. The results of the PAH analyses will be used to support the use of field methods in future PGDP projects.

[3] VOCs are not included in the analyte list for the fixed-base laboratory because VOCs were not detected in Soil Pile I samples at concentrations above no action risk-based screening values. Additionally, neither trichloroethene nor trichloroethane was detected in samples collected at Soil Pile I.

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3.1.3 Sampling Summary and Deviations from the SAP

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The following provides the planned sampling activities for Addendum 2 Soil Piles and an accounting of the actual number and types of samples collected. Addendum 2 to the PGDP Soil Piles SAP specified the collection and analysis of these samples:

- Fifty-four surface samples (24 small piles, 30 large piles) to undergo field measurements and fixed laboratory analysis
- One hundred seven surface samples (24 small pile locations, 83 large pile locations) to undergo field measurements only
- Sixty subsurface samples (25 small pile locations, 35 large pile locations), where subsurface is defined as soil taken at a depth below 1 ft, to undergo field measurements and fixed laboratory analysis
- Two hundred ten subsurface samples (31 small pile locations, 179 large pile locations) to undergo field measurements only
- A number of contingency samples (no more than 40), if contamination was identified

During execution of Addendum 2, the total number of soil samples collected was as follows:

- Fifty-four surface samples underwent field measurements and fixed laboratory analysis
- Fifty-five surface samples underwent field measurements only
- Fifty-six subsurface samples underwent field measurements and fixed laboratory analysis
- One hundred eleven subsurface samples underwent field measurements only
- No contingency samples were collected

Sample locations are shown in Figure 3.

The differences between planned and actual sample numbers resulted from three factors.

First, the observed differences in subsurface samples result entirely from variations in soil pile height. Because the soil pile height, on average, was less than 5 ft, a fewer number of samples than that estimated in the Addendum 2 to the SAP were required to reach the natural grade.

Second, many of the large soil piles were smaller than planned in the Addendum 2 SAP, resulting in less area to be sampled.

Third, the concentration of analytes (i.e., COPCs) in samples was less than the screening criteria in the Addendum 2 SAP; therefore, no contingency samples were required.

Additional deviations from the SAP Addendum 2 include one less fixed laboratory field blank and one less fixed laboratory equipment rinseate were collected (only one of each was collected compared to the requirement of 2 each as noted in the SAP Addendum). This was an inadvertent oversight by the field crew. There is minimal impact to the data assessment as these samples were collected to identify cross-contamination that could be introduced between samples. Because contamination was not found, there was no impact to collecting fewer QC samples. Also, 36 of the 110 PAH test kit sample analyses exceeded their holding times due to reagent solutions from the manufacturer not received within the 14-day time frame after sample collection. The order was placed early during project implementation; however, the manufacturer backlogged the order. PAH fixed-base laboratory analyses for the 110 samples

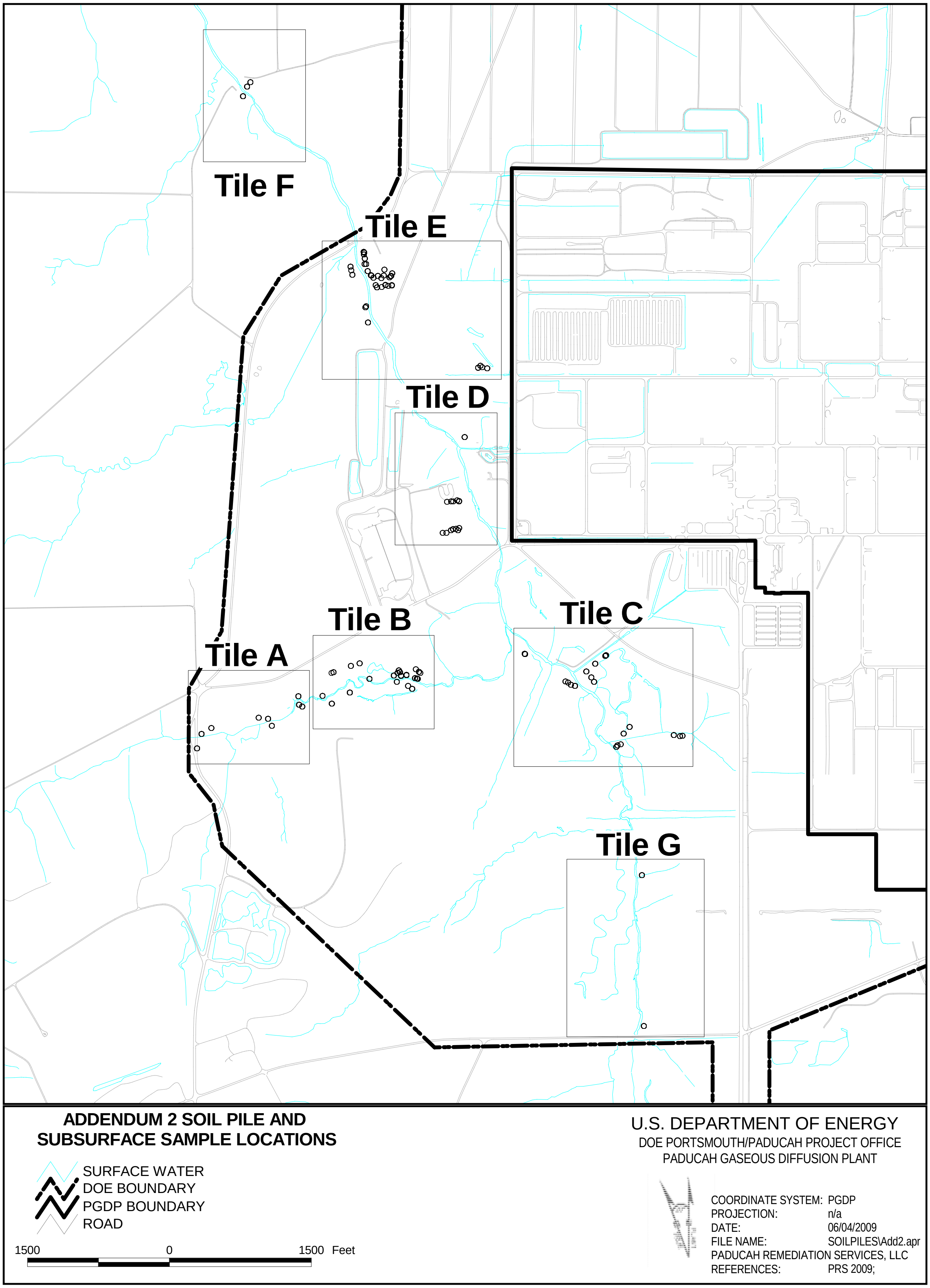
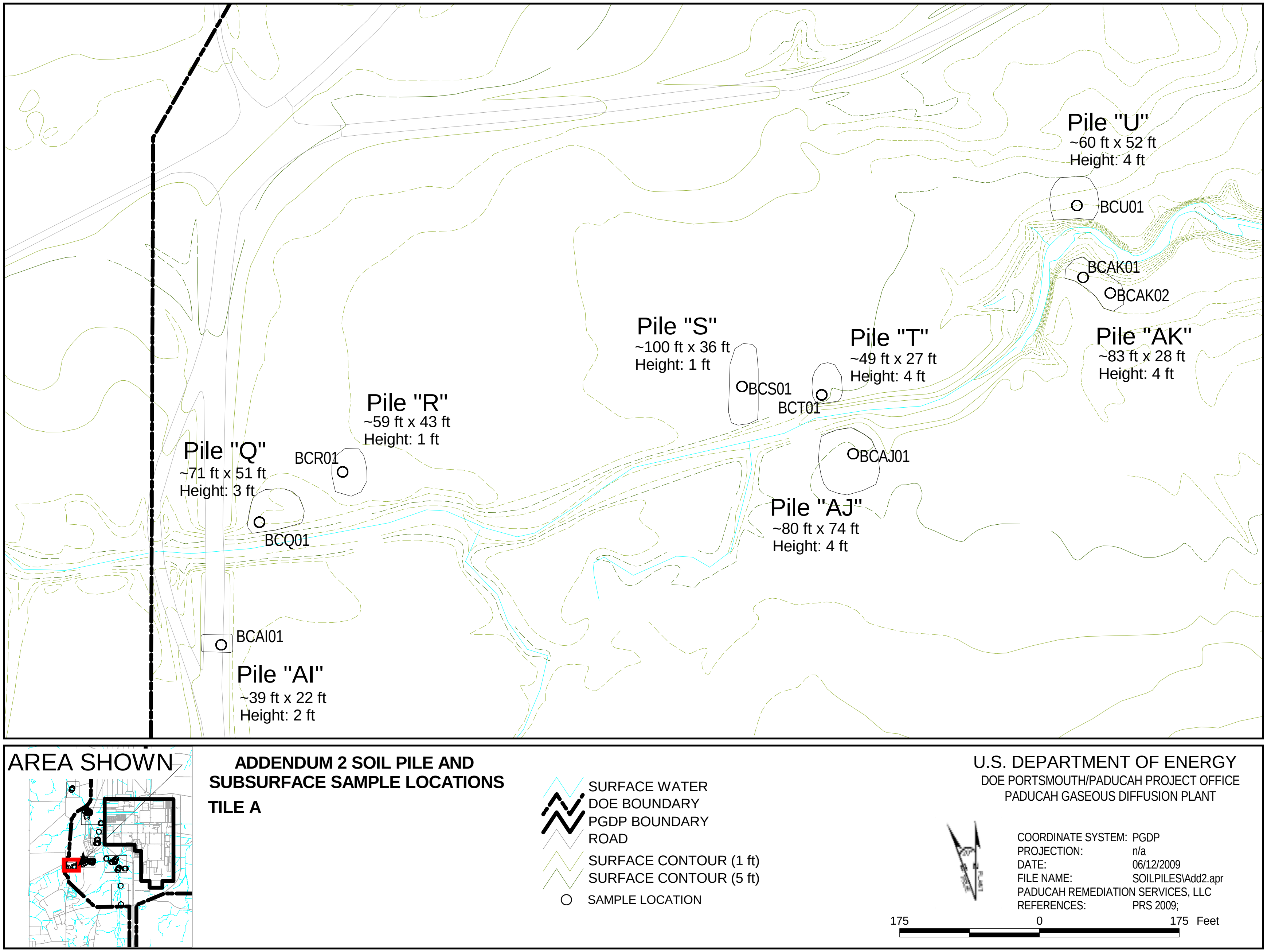


Figure 3. Addendum 2 Sampling Locations



ADDENDUM 2 SOIL PILE AND SUBSURFACE SAMPLE LOCATIONS

TILE A

SURFACE WATER
DOE BOUNDARY
PGDP BOUNDARY
ROAD
SURFACE CONTOUR (1 ft)
SURFACE CONTOUR (5 ft)
SAMPLE LOCATION

U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

COORDINATE SYSTEM: PGDP
PROJECTION: n/a
DATE: 06/12/2009
FILE NAME: SOILPILES\Add2.apr
PADUCAH REMEDIATION SERVICES, LLC
REFERENCES: PRS 2009;

175 0 175 Feet

Figure 3. Addendum 2 Sampling Locations (Continued)

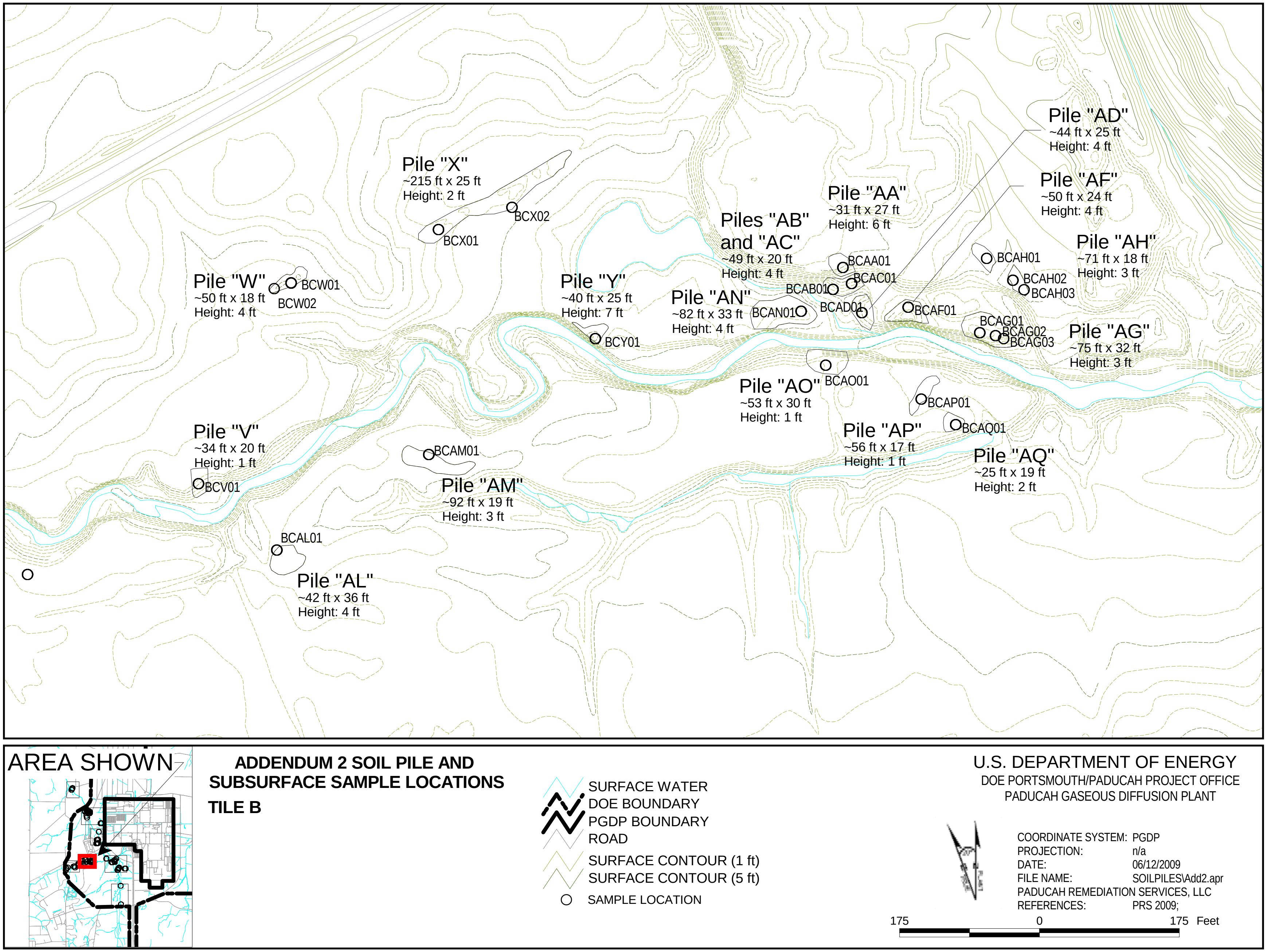
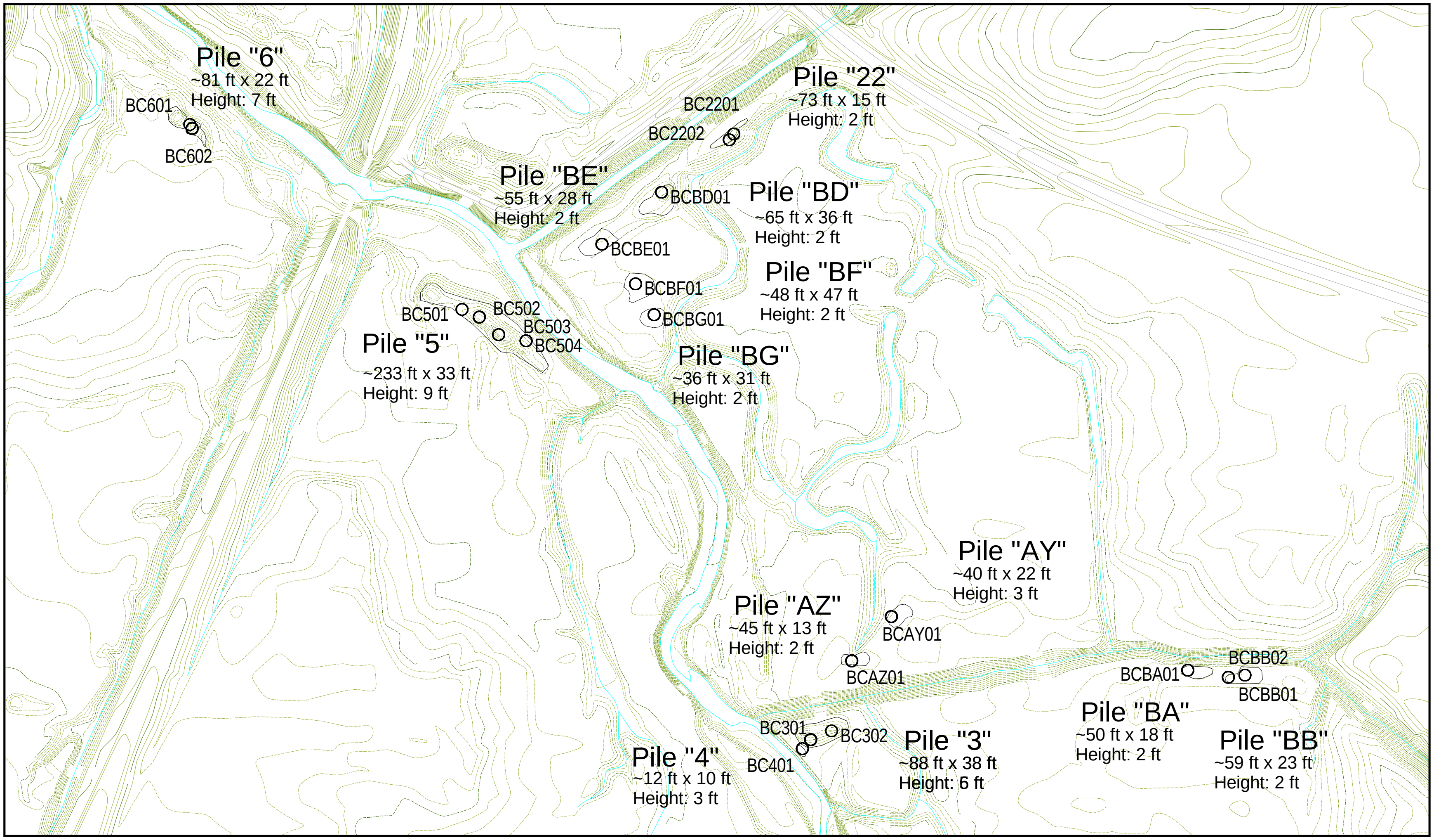


Figure 3. Addendum 2 Sampling Locations (Continued)



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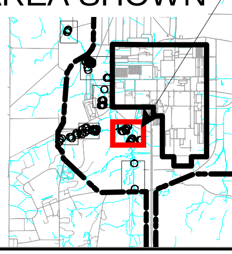


ADDENDUM 2 SOIL PILE AND SUBSURFACE SAMPLE LOCATIONS

TILE C

SURFACE WATER
DOE BOUNDARY
PGDP BOUNDARY
ROAD
SURFACE CONTOUR (1 ft)
SURFACE CONTOUR (5 ft)
SAMPLE LOCATION

U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

COORDINATE SYSTEM: PGDP
PROJECTION: n/a
DATE: 06/12/2009
FILE NAME: SOILPILES\Add2.apr
PADUCAH REMEDIATION SERVICES, LLC
REFERENCES: PRS 2009;

250 0 250 Feet

Figure 3. Addendum 2 Sampling Locations (Continued)

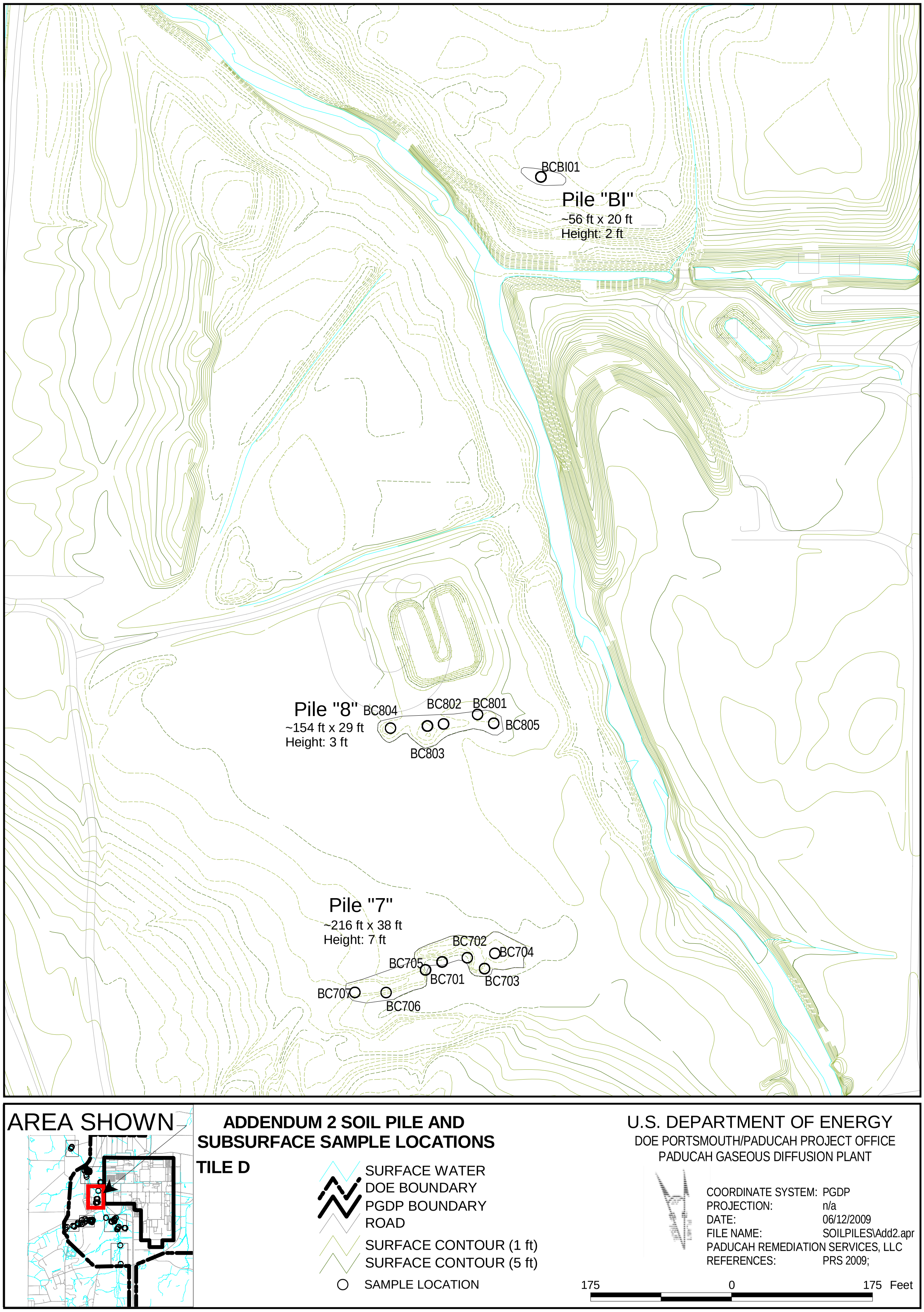
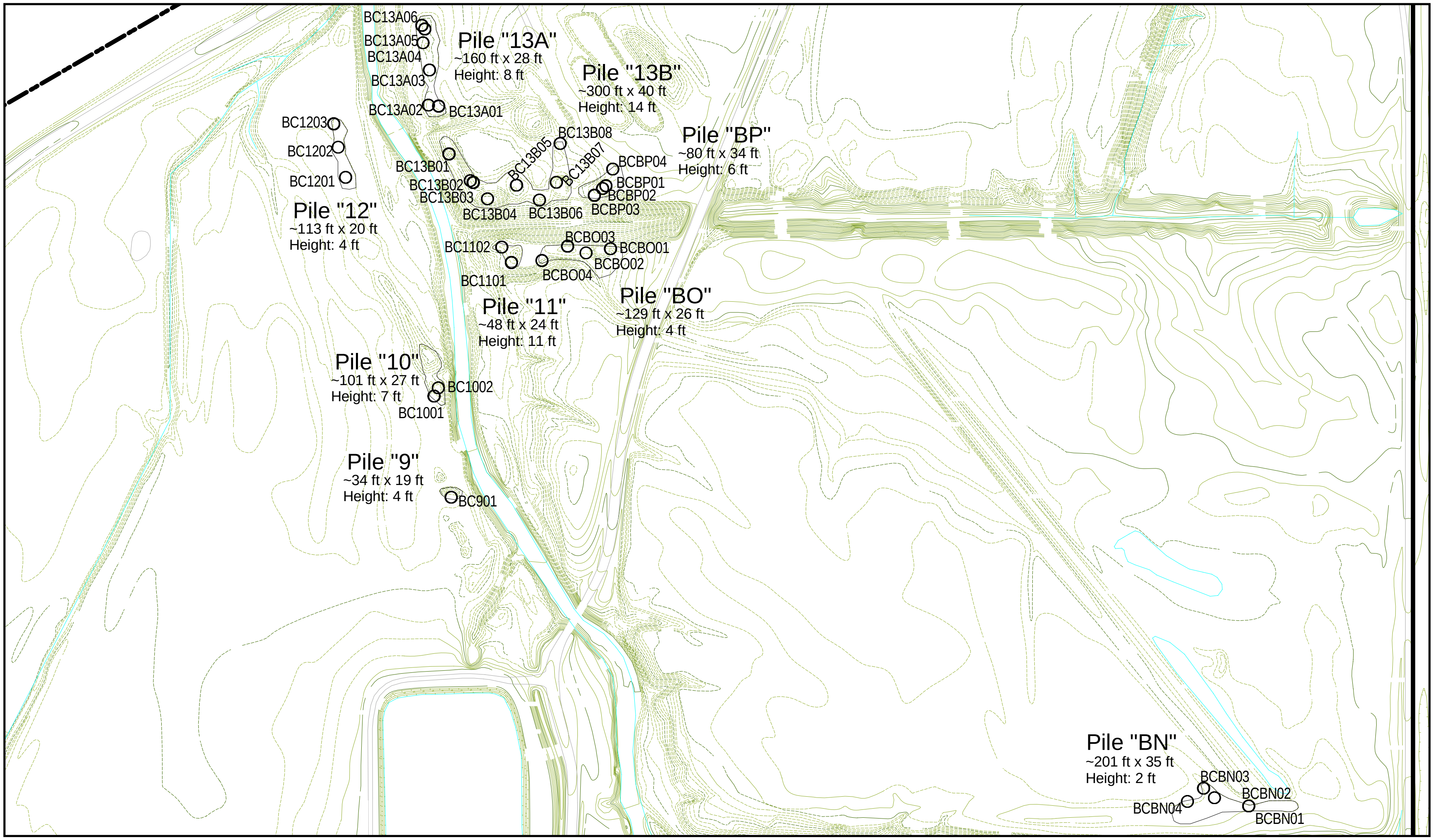
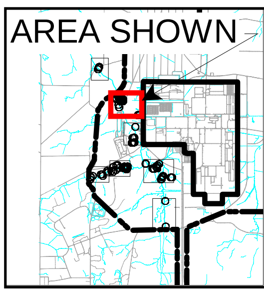


Figure 3. Addendum 2 Sampling Locations (Continued)





ADDENDUM 2 SOIL PILE AND SUBSURFACE SAMPLE LOCATIONS

TILE E

SURFACE WATER
DOE BOUNDARY
PGDP BOUNDARY
ROAD
SURFACE CONTOUR (1 ft)
SURFACE CONTOUR (5 ft)
SAMPLE LOCATION

U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

COORDINATE SYSTEM:	PGDP
PROJECTION:	n/a
DATE:	06/12/2009
FILE NAME:	SOILPILES\Add2.apr
PADUCAH REMEDIATION SERVICES, LLC	
REFERENCES:	PRS 2009;

250 0 250 Feet

Figure 3. Addendum 2 Sampling Locations (Continued)

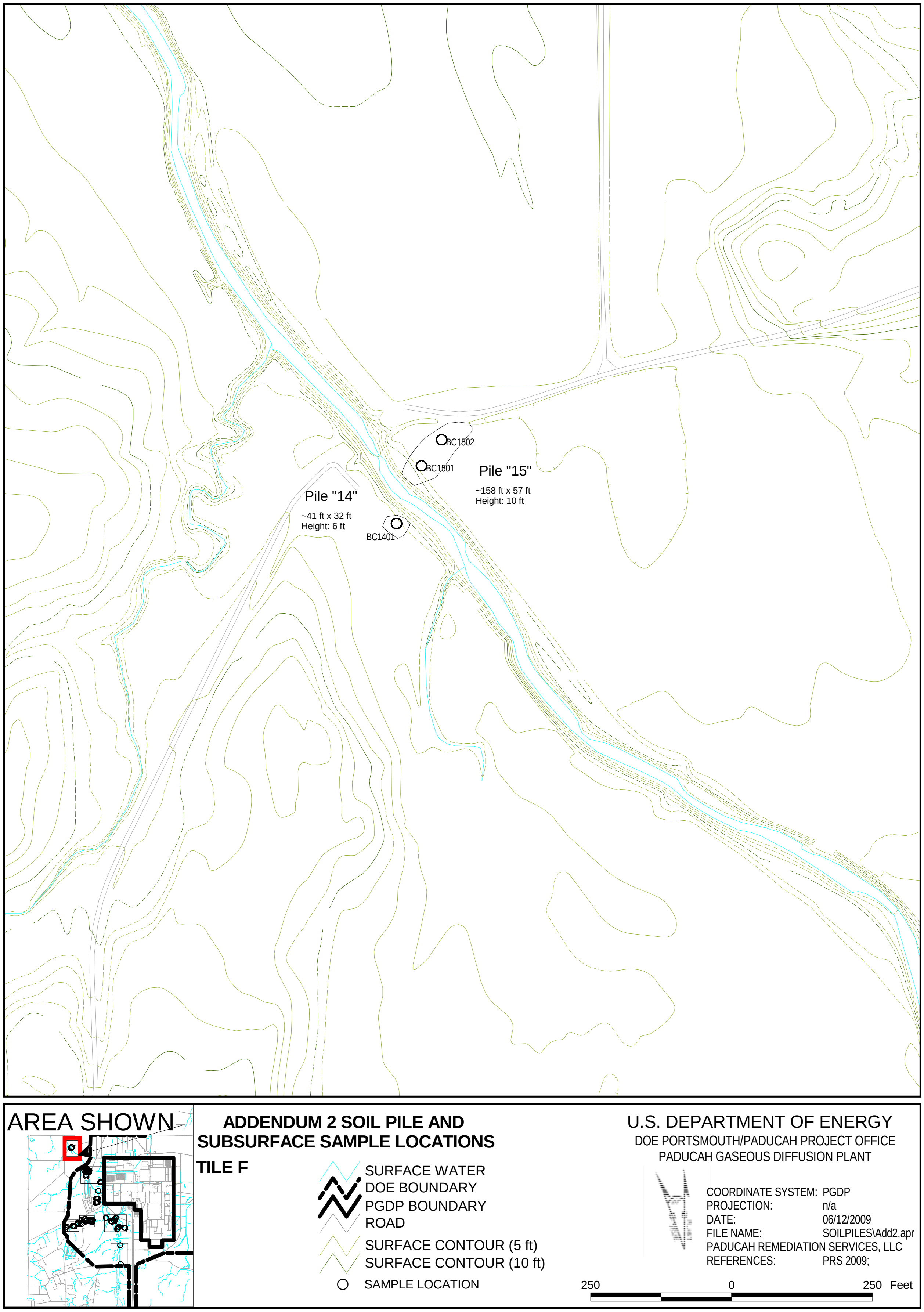
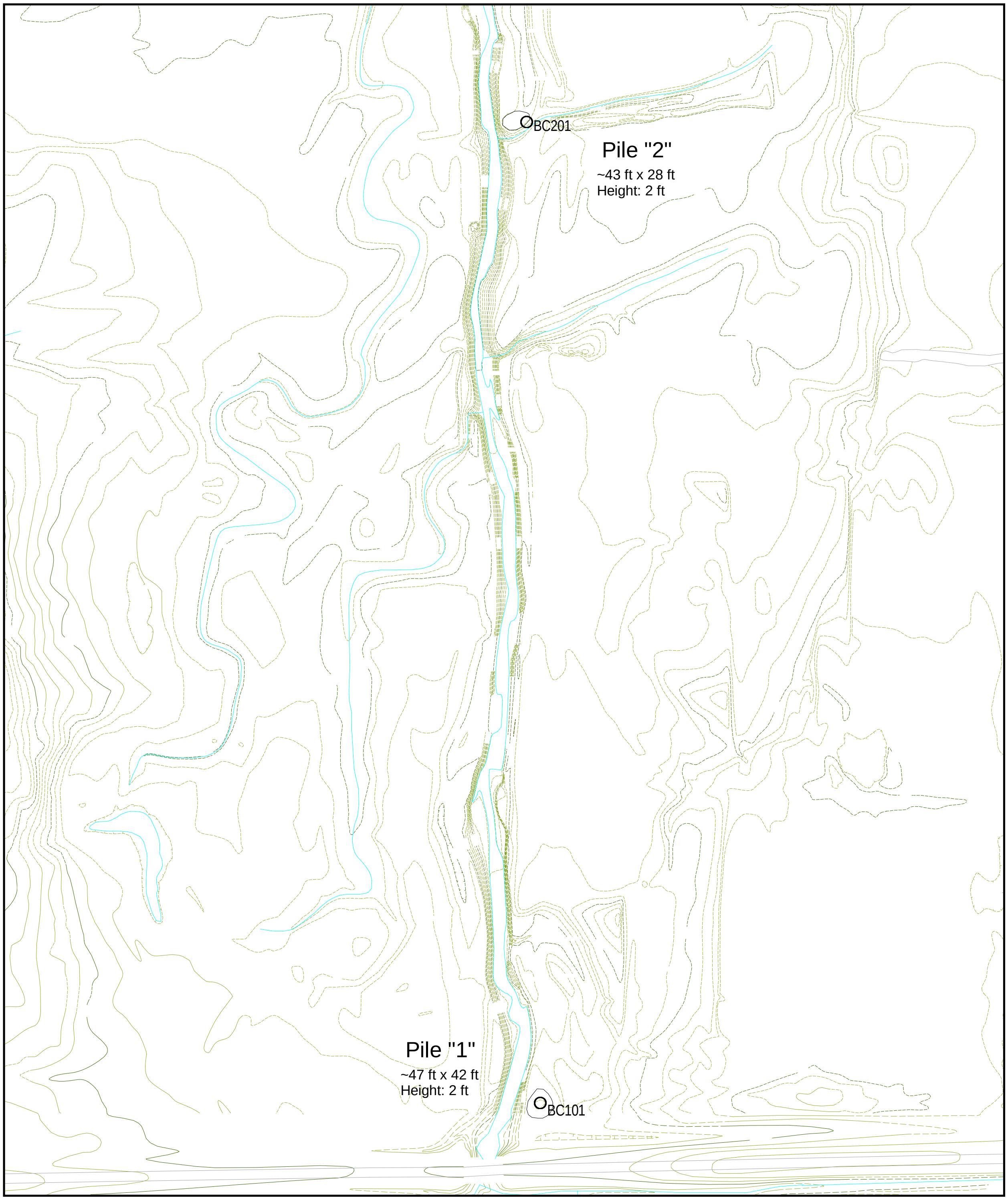


Figure 3. Addendum 2 Sampling Locations (Continued)



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ADDENDUM 2 SOIL PILE AND SUBSURFACE SAMPLE LOCATIONS

TILE G

SURFACE WATER
DOE BOUNDARY
PGDP BOUNDARY
ROAD
SURFACE CONTOUR (1 ft)
SURFACE CONTOUR (5 ft)
SAMPLE LOCATION

U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

COORDINATE SYSTEM: PGDP
PROJECTION: n/a
DATE: 06/12/2009
FILE NAME: SOILPILES\Add2.apr
PADUCAH REMEDIATION SERVICES, LLC
REFERENCES: PRS 2009;

250 0 250 Feet

Figure 3. Addendum 2 Sampling Locations (Continued)

(no holding time exceedances) and the PAH test kit data was collected to determine utility for future projects. The exceedances of holding times on the 36 field samples does not negatively impact the characterization of the Addendum 2 soil piles.

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In addition, it should be noted that the method detection limits were not always the same as contract required detection limits for fixed-base laboratory data; however, the data is of sufficient quality to meet the project objectives.

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3.1.4 Fixed Laboratory Analysis

As noted, a total of 54 surface soil samples and 56 subsurface soil samples underwent fixed laboratory analysis. Each was analyzed in accordance with the method requirements outlined in Table 1 with the exception that six samples were randomly selected for waste characterization (ignitability, reactivity, corrosivity, paint filter, and moisture) in case a removal action was required.

3.1.5 Field Analysis

All of the surface and subsurface samples collected for Addendum 2 Soil Piles underwent field analysis. The total field analysis included 109 surface samples and 167 subsurface samples. The area was surveyed but not posted for radiological occupational exposure. Field measurements included the following:

- RCRA metals and uranium using a XRF spectrometer (*ex situ*)
- Gamma radionuclides using a Canberra® ISOCS (*ex situ*)
- PCBs using Hach® immunoassay sample extraction and colorimetric analysis methods
- PAHs using RaPID Assay® immunoassay sample extraction and colorimetric analysis methods
- Both fixed laboratory and field results for the Addendum 2 Soil Piles Investigation are provided on a CD. The CD also provides a comparison of field and fixed laboratory analyses. It should be noted that field screening methods used may not have always achieved detection limits below background due to limitations of the screening method.

The XRF provides a value and/or delimiter for each metal analyzed for as well as a range of error. This range of error is vital in interpreting XRF results. For example, if the XRF provided a detection of a certain metal at a value of 10 mg/kg with an error of +/-10, the actual result would be between 0–20 mg/kg. For lead, taking into consideration the range of error values, the XRF results were very close to the results provided by the lab. XRF detections for uranium and chromium were mostly < method detection limits (MDLs), so interpretation is limited. Even though readings of <MDL do not produce an actual value, these still provide valuable information. Knowing that field levels for metals of concern are less than a specific value can help make important decisions in the field. Chromium levels in all of our samples were less than 65 mg/kg, which was the MDL. Analytical data proved that the chromium levels all were less than 65 mg/kg. It should be noted that there were a few chromium detections in which the XRF provided an actual value that was less than 65 mg/kg rather than the <MDL. When applying the error associated with this value, the estimated value was very close to the MDL. MDLs and errors for the XRF are presented in Table 2.

The range of detections for sample using the Canberra® ISOCS (*ex situ*) are listed in Table 3.

Table 1. Fixed Laboratory Analysis Requirements for Soils

CHARACTERIZATION PARAMETERS	ANALYTICAL METHOD
PAHs	SW846-8270
PCBs (Aroclors/Total)	SW846-3540/8082
Inorganic Target Analyte List (Total Metals)	SW846-6010B or SW846-6020
^{241}Americium	Alpha Spectroscopy Nitric Only Digestion (RL-7128)
^{137}Cesium	Gamma Spectroscopy (RL-7124)
^{237}Neptunium	Alpha Spectroscopy Nitric Only Digestion (RL-7128)
^{238}Plutonium	Alpha Spectroscopy Nitric Only Digestion (RL-7128)
$^{239/240}$Plutonium	Alpha Spectroscopy Nitric Only Digestion (RL-7128)
^{99}Technetium	Liquid Scintillation (RL-7100)
^{228}Thorium	Alpha Spectroscopy Nitric Only Digestion (RL-7128)
$^{230/232}$Thorium	Alpha Spectroscopy Nitric Only Digestion (RL-7128)
Total Uranium	Alpha Spectroscopy Nitric Only Digestion (RL-7128)
^{234}Uranium	Alpha Spectroscopy Nitric Only Digestion (RL-7128)
^{235}Uranium radioactivity	Alpha Spectroscopy Nitric Only Digestion (RL-7128)
^{238}Uranium	Alpha Spectroscopy Nitric Only Digestion (RL-7128)
Arsenic	SW846-6020[1]
Barium	SW846-6010B[1]
Cadmium	SW846-6020[1]
Chromium	SW846-6010B[1]
Lead	SW846-6020[1]
Mercury	SW846-7471[1]
Selenium	SW846-6020[1]
Silver	SW846-6010B[1]
Ignitability	SW846-1010

ASTM = American Society for Testing and Materials
EPA = U.S. Environmental Protection Agency
PAH = polyaromatic hydrocarbon
PCB = polychlorinated biphenyl
[1] Toxicity Characteristic Leaching Procedure (TCLP) analyses will be performed only if Underlying Hazardous Constituents (UHC) exceed 20 times the TCLP limit.

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CHARACTERIZATION PARAMETERS ... [1]

Table 2. XRF SRM Recovery Information

Element	MDL (mg/kg)	Associated Error (mg/kg)
Antimony	7.9	+/- 0.6
Arsenic	17.7	+/- 0.8
Barium	968.0	+/- 40
Cadmium	0.38	+/- 0.01
Chromium	130.0	+/- 4.0
Cobalt	13.4	+/- 0.7
Copper	34.6	+/- 0.7
Lead	18.9	+/- 0.5
Manganese	535.0	+/- 17.0
Mercury	1.40	+/- 0.08
Nickel	88.0	+/- 5.0
Selenium	1.57	+/- 0.06
Silver	0.41	+/- 0.03
Strontium	231.0	+/- 2.0
Thallium	0.74	+/- 0.05
Uranium	3*	N/A
Vanadium	112.0	+/- 5.0
Zinc	106.0	+/- 3.0

*Noncertified value–NIST Standard 2709
N/A–Not available

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Table 3. Canberra® ISOCS Range of Detections*

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Element	Count of Samples	Minimum Activity (pCi)	Maximum Activity (pCi)	Mean Activity (pCi)	Median Activity (pCi)	Standard Deviation (pCi)
Cesium-137	274	0.00781	0.856847	0.103742949	0.04280447	0.133794435
Uranium-238	274	0.846	20.3621	2.411435252	1.3370765	2.160625678

*Due to short count times and small sample volume, the results have a large degree of uncertainty. Please see Appendix A.

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4. QUALITY ASSURANCE/QUALITY CONTROL

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4.1 DATA QUALITY/DATA USABILITY

The following sections summarize the results of data verification, data validation, reconciliation of measurement quality objectives, and the comparisons of field and laboratory data obtained from the Addendum 2 Soil Piles investigation.

4.1.1 Precision

Precision is the measure of agreement or reproducibility between individual measurements for the same property under the same analytical conditions.

Precision for Addendum 2 Soil Piles data was measured based on the performance of field and laboratory duplicate samples and laboratory matrix spike (MS) and matrix spike duplicate (MSD) pairs.

NOTE: Precision does not affect the quality or usability of organic analyses whose precision is measured by MS/MSD pairs. As the SAP notes, precision results do not impact on PCBs, semivolatile organic compounds, or volatile organic compounds (VOCs) in terms of data quality/data usability. Where performance criteria for precision are exceeded, there is less confidence in the reported result because of error introduced from sampling or analysis caused by unequal representation of target compounds or analytes between the two sample pairs.

The SAP required that a minimum of 9 of 10 samples (90%) for each analysis type meet method prescribed precision criteria. Based on the data received from the fixed-base laboratory, each analysis met this goal.

4.1.2 Accuracy

Accuracy is the comparison of a known quantity of a reference standard to the value measured during analysis. Accuracy for Addendum 2 Soil Piles data was assessed by evaluating the performance of the following QC standards designed to monitor accuracy during sample preparation and analysis:

- Laboratory control samples
- Radioactive tracers
- MS
- MSDs
- Surrogate compounds

The SAP required that a minimum of 9 of 10 samples (90%) for each analysis type meet method/PGDP prescribed accuracy criteria. Based on the data received from the fixed-base laboratory, each analysis type met this goal.

4.1.3 Completeness

Completeness is defined as the number of valid data points obtained from a sampling effort, compared with the total number of data points obtained. Valid data are those generated when analytical systems and the resulting analytical data meet all of the quantitative measurement objectives for the project.

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The SAP required that a minimum of 9 of 10 samples (90%) for each analysis type meet completeness criteria. Based on the data received from the fixed-base laboratory, each analysis type met this goal.

4.1.4 Detection Limits

To ensure the fixed laboratory data acquired from Addendum 2 Soil Piles supports the DQOs, MDLs were pre-established for each analysis type and defined in the laboratory scope of work. The contract required detection limits in the SAP were to be attained if possible, however, if not, the MDLs were to be low enough to compare to background. The MDLs were designed to ensure that sufficiently sensitive data were obtained from the contract laboratories to enable comparison to background and other action/no action levels.

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For field analytical methods, method sensitivity was a variable determined during the project. Field MDLs were determined in accordance with manufacturer analytical protocols. The field analytical methods do not achieve the same level of sensitivity as fixed-base laboratory methods. However, sufficient sensitivity was achieved for each method to support/direct field activities should actions be necessary at Addendum 2 Soil Piles.

Reporting limits were met as specified in the SAP.

4.1.5 Comparability

Comparability is the degree to which one data set can be compared to another, when both are obtained from the same sample population. Comparability can be achieved only through the use of consistent sampling procedures, experienced sampling personnel, the same or comparable analytical methods, standard field and laboratory documentation, and traceable laboratory standards.

Because the samples were collected from the nearly identical locations, samplers employed similar sampling techniques, and similar analytical methods. As a result, the data are comparable.

4.1.6 Representativeness

Representativeness is a measure of the degree to which data accurately and precisely represents the characteristics of a population at a sampling point, process condition, or environmental condition. Representativeness is a qualitative term evaluated to determine if sample measurements and physical sample locations result in data that appropriately reflects the population parameter of interest in the media and phenomenon measured or studied.

The data provides a good representation of the environmental conditions of Addendum 2 soil piles based upon data verification, validation, and assessment. The investigation has successfully determined that there is no contamination that warrants immediate action at soil piles along Bayou Creek.

4.1.7 Field Quality Control Summary

Field QC samples are independently generated samples from a pre-defined sampling scheme, designed to monitor the reproducibility, cleanliness, and accuracy of the sampling and analytical process. The following are the field QC samples prescribed for the Addendum 2 Soil Piles investigation:

- Field split samples
- Field blanks

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- Trip blanks
- Equipment rinseate blanks

QC samples were required for Addendum 2 at a frequency of 1 QC sample for every 20 samples collected or 5%. The collection frequency for QC samples applied to all samples whether undergoing field analysis or fixed laboratory analysis.

Field split samples were collected and analyzed to evaluate the reproducibility (precision) of sampling techniques, laboratory methods, and to monitor the natural variability of the sample matrix. Field split samples were submitted as separate samples, with separate field identification numbers to the contract laboratory. The prescribed collection frequency was met with field split samples collected and analyzed at a frequency of 5% for the investigation.

Field blanks were collected and analyzed to evaluate any cross contamination attributable to field methods including sample container handling. As noted previously, one less field blank was collected compared to the SAP Addendum requirement (two were planned, however, one collected).

Field rinseate blanks were collected and analyzed where subsurface samples were collected and sampling equipment was decontaminated and reused. Field rinseate blanks provide a measure of cross-contamination attributable to field equipment decontamination procedures. As noted previously, one less rinseate blank was collected compared to the SAP Addendum requirement (two were planned, however, one collected).

In summary, field, trip, and rinseate blanks were analyzed to verify the cleanliness of the sampling, decontamination, and the overall analytical process. Each is designed to monitor at least one aspect of the process, with all providing meaningful information as to the reliability of low-level contaminant results.

4.1.8 Data Quality Summary/Fixed Laboratory Data

As stated, the DQOs for the Addendum 2 Soil Piles investigation were to acquire sufficient data of known quality to support decision making. Experience and properly trained field personnel were utilized to execute the sampling and operating procedures. Project samples were collected, preserved, handled, and shipped in accordance with the SAP and industry and PGDP standard procedures. A reputable analytical laboratory using industry standard analytical procedures was utilized to generate sample data that complies with the requirements of the laboratory statements(s) of work and specified protocols.

Project data underwent 10% Level C validation, with all data undergoing verification. Precision, accuracy, and completeness criteria were met for all fixed-base laboratory data indicating the data set will support decision making.

4.1.9 Data Quality Summary/Field Analytical Data

Each of the field techniques employed for the Addendum 2 Soil Piles investigation utilized QC measures to monitor the accuracy, precision, and drift of the method during use. The following summarizes the results of QC analysis.

4.1.9.1 XRF

To support field XRF analysis, three types of QC samples were analyzed with each batch of 20 samples. These included (1) blanks, (2) duplicates, and (3) standard reference materials (SRMs). The XRF blank was vendor-provided, consisting of silica-certified clean for use as a blank.

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Blank results for XRF analysis showed no positive detections during execution of the investigation for those parameters such as uranium. Precision for XRF duplicates was < 35% relative percent difference (RPD) for all field-laboratory duplicates.

Three SRMs were analyzed daily to monitor XRF accuracy. They represent low [National Institute of Standards and Technology (NIST) 2709], moderate (NIST 2711), and high (NIST 2710) level standards for soil analysis for metals. SRM performance was mixed for the three standards, with the low-level standard performing well for lead and barium, and moderately well for arsenic. The low concentrations for the remaining metals were outside the operating range of the XRF (below the MDL).[4] The mid-range standard performed well for barium and lead, with moderate performance for arsenic, zinc, and cadmium. The high-end standard performed very well for arsenic, barium, uranium,[5] and lead. The remaining metals concentrations were below the MDL for the XRF.

4.1.9.2 Field PCBs

To support field PCB analysis, three types of QC samples were analyzed with each batch of 20 samples: (1) blanks, (2) duplicates, and (3) calibration verification standards. The following summarizes QC performance.

- No positive detections were noted in any of the PCB method blanks.
- Precision for PCB duplicates was < 35% RPD for all field-laboratory duplicates.
- All calibration verifications had recoveries within 90–110%.

4.1.9.3 ISOCS

To support *ex situ* ISOCS field analysis, two types of QC samples were analyzed daily. Daily checks included (1) a background and (2) a NIST traceable calibration/check source.

Background results for ISOCS analysis were all within acceptable limits (i.e., two sigma of weekly background). In addition to daily QC checks, a chamber background count was performed weekly for a predetermined count time. The predetermined background count time was equal to or greater than the sample count time. The weekly background count is used for background subtraction in the activity calculation. An accurate representation of the background for the detector is necessary to produce high quality sample results.

The NIST traceable calibration/check source consists of a mixed radionuclide with gamma peaks that cover the range (i.e., low, mid, high) of detections, generally 59 keV to 2,000 keV. All daily check source results for ISOCS analysis were within acceptable limits (i.e., 2 sigma).

4.1.10 PAH Summary

Correlation between laboratory and field PAH results were consistent as most all results were below the detection limits. A better comparison of data is recommended as a result of Addendum 1-B soil pile investigation due to the nondetects obtained from the Addendum 2 soil piles investigation.

[4] Selenium was not added to any of the standards.
[5] Chromium and uranium levels for the NIST SRMs are not certified values.

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5. DISCUSSION AND RESULTS

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The following section presents and evaluates the results for the Addendum 2 Soil Piles investigation. It includes a discussion of the conceptual site model (CSM) as it was defined for investigation planning and a discussion of findings. This section also provides data screening versus PGDP decision levels.

5.1 CONCEPTUAL SITE MODEL

The following description of the CSM is taken from the PGDP soil piles SAP (DOE 2007a). It summarizes the expected receptors and exposures for Soil Pile I, however, also applies to others including Addendum 2 soil piles. See Figure 4 for the CSM representation.

Recreational activities known to take place in and near some of the PGDP soil piles include the following:

- Bow hunting
- Field trials (horses and dogs)
- Other recreational uses (e.g., hiking)

Recreational user exposure to surface soils is the primary exposure pathway. The recreational user could be exposed to contaminants through contact with surface soils through the following exposure routes:

- External exposure to ionizing radiation
- Dermal contact
- Incidental ingestion
- Inhalation

Recreational user exposure to surface soils through the dermal contact, incidental ingestion, and inhalation is likely limited given that most soil piles and soils in the adjoining areas are covered by continuous vegetation. Industrial worker exposure would be similar for nonintrusive activities.

Addendum 2 Soil Piles are located adjacent to Bayou Creek. This proximity to surface water drainage areas could have resulted in potential secondary exposure routes that could impact human health and the environment. The majority of the secondary routes assume the soils or contaminants they contain have been released to adjacent waterways or moved through the food chain.

Precipitation could result in contaminant migration from the soil piles if contaminated; however, PGDP historical monitoring data indicate little if any migration is occurring.

The majority of the contaminants analyzed for samples collected at Addendum 2 Soil Piles do not bioaccumulate in plants to a great degree. As a result, plant uptake and corresponding accumulation in animal tissue is unlikely, but soil ingestion as part of normal feeding activities is likely a complete pathway. Ecological receptors also may be exposed to on-site contaminants; however, the primary focus of the characterization effort is to determine risks to human health.

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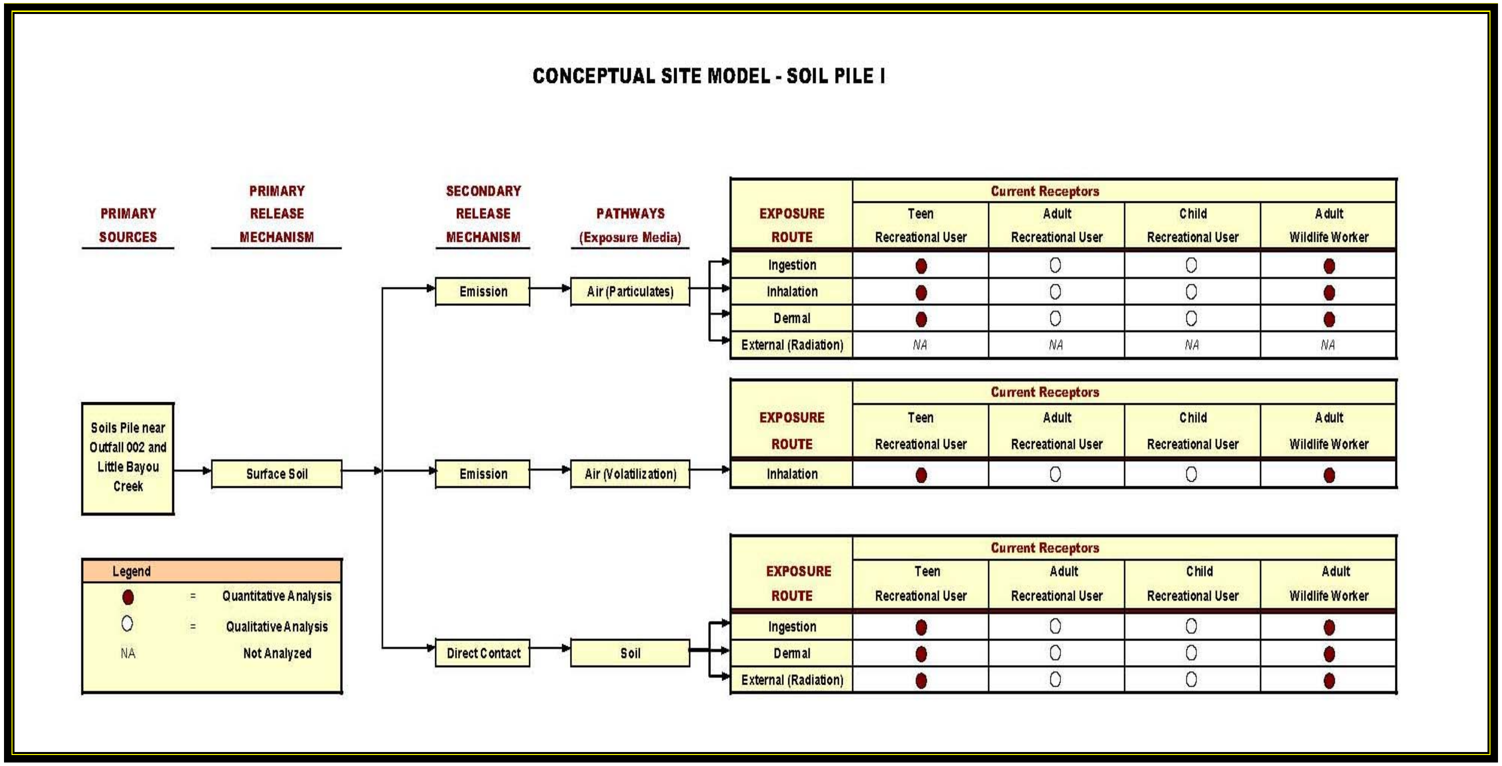

Figure 4. Conceptual Site Model for Soil Piles

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5.2 EXAMINATION OF SAMPLE POPULATIONS

As part of project planning, the Soil Piles operating hypothesis for investigative purposes was that each pile likely represents a unique population, in terms of contaminant type, concentrations, and distribution. To examine this hypothesis, the data from each subpile of Soil Pile I was examined to determine if individual sample populations were present. Following this examination, each pile was compared to all the other piles to determine if any/all were the same population (DOE 2008).

The Soil Pile I comparison has been applied by this project to the Soil Piles from Addendum 2. Soil Piles 1–54 are similar to one another in that all were believed to have been created for maintenance actions and are considered one population for this project.

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5.3 SURFACE DISTRIBUTION OF CONTAMINANTS

The first step in examining project data from Addendum 2 Soil Piles was to perform a data screening to establish which constituents will be retained for further consideration as COPCs. The data screening steps employed for Addendum 2 Soil Piles include the following:

- Comparison of maximum contaminant concentrations to PGDP background levels for soils;
- Comparison of contaminant concentrations to established teen recreational user no action levels (NALs); [6]
- Evaluation of frequency of detection for each contaminant.

See Section 6 for further discussion of the data screening. As constituents detected were near background ranges, no migration of contamination is occurring.

[6] No Action Levels were taken from the PGDP Risk Methods Document (DOE 2001).

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6. DATA SCREENING

This data screening used data collected in the summer 2008 from Addendum 2 Soil Piles. The principal objective of this screening is to inform risk managers in support of decision making for the site. Key considerations include the following:

- Determine whether all or portions of the study area may be eliminated from concern.
- Identify where risk characterization suggest actions may be needed.
- Determine whether additional data gathering and/or risk assessments are warranted.

The data screening provides information to the stakeholders based on the Commonwealth of Kentucky and nationally accepted risk assessment methods. These objectives are consistent with the goals, objectives, and requirements identified in the *Methods for Conducting Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant Paducah, Kentucky, Volume 1, Human Health* (DOE 2001).

The scope of the Addendum 2 Soil Piles data screening is to assess risks to human receptors who, through use of the Addendum 2 Soil Piles area, may be exposed to chemicals or radionuclides through normal use of the site. This data screening does not examine ecological risks.

6.1 METHODOLOGY

The following describes the process used to develop the data screening activity.

6.1.1 Data Screening

Following background comparisons, those contaminants retained were evaluated for comparison to other criteria as described below.

Data collected as part of Addendum 2 Soil Piles sampling was screened first against PGDP background values. These values are documented in DOE 2001. Screening against other values representing the range of background (i.e., additional background information) also was used to determine whether a chemical exceeded background in order to better focus on chemicals presenting potential concern for the soil piles. Additional background information included the generic statewide ambient background value available in Kentucky Energy and Environment Cabinet (KEEC) guidance (KEEC 2004) for metals and values expected from global fallout for radionuclides (ANL 2007).

Secondly, maximum concentrations were compared to the PGDP Risk Methods Document and site-specific health guidelines. To complete this evaluation, NALs for the teen recreational use scenario listed in Table A-17 of the Risk Methods Document (DOE 2001) were used for comparisons with maximum concentrations. Site-specific ALs and NALs for the teen recreational use scenario and the wildlife worker scenario were developed as part of *Site Evaluation Report for Soil Pile I at the Paducah Gaseous Diffusion Plant Paducah, Kentucky* (DOE 2008), specifically found within Appendix Q. These values are presented in Tables 4–6.

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Figure 5 presents a data screening flow chart that was used for evaluating the results of this sampling effort.

Table 4. Comparison of Teen Recreational Site-Specific and PGDP NALs

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Contaminants	Units	Site-Specific Teen Recreational User NALs[1] Hazard	Carcinogen	NAL	PGDP Risk Methods Document Teen Recreational User NALs[1] Hazard	Carcinogen	NAL
Aluminum	mg/kg	100,000		100,000	3,010		3,010
Antimony	mg/kg	26.4		26.4	0.242		0.242
Arsenic	mg/kg	13.8	1.79	1.79	5.98	0.346	0.346
Barium	mg/kg	40,707		40,707	148		148
Beryllium	mg/kg	67.9	466,490	67.9	0.606	60,200	0.606
Iron	mg/kg	100,000		100,000	1,350		1,350
Lead[2]	mg/kg	NA	NA	1,420			400
Manganese	mg/kg	17,263		17,263	29.0		29.0
Uranium	mg/kg	529		529	14.7		14.7
Vanadium	mg/kg	4,036		4,036	2.12		2.12
Total PCB	mg/kg	0.436	0.636	0.436	0.191	0.127	0.127
Total PAH	mg/kg		0.066	0.066		0.0133	0.0133
Cesium-137	pCi/g		1.19	1.19		0.178	0.178
Plutonium-239	pCi/g		237	237		30.3	30.3
Thorium-230	pCi/g		302	302		39.0	39.0
Uranium-234	pCi/g		407	407		52.2	52.2
Uranium-235	pCi/g		5.53	5.53		0.826	0.826
Uranium-238	pCi/g		24.6	24.6		3.64	3.64

[1]No action level (NAL) values are based on a risk of 1E-6 and a hazard index of 0.1. Site-Specific values were derived in DOE 2008. The PGDP Risk Methods Document values are presented in DOE 2001.

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[2]The value for lead is a regulatory value provided by the Commonwealth of Kentucky Risk Assessment Branch.

Table 5. Comparison of Site-Specific Action Levels and PGDP Risk Methods Action Levels

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Contaminants	Units	Site-Specific Teen Recreational User ALs Hazard	Carcinogen	Action	PGDP Risk Methods Document Teen Recreational User ALs Hazard	Carcinogen	Action
Aluminum	mg/kg	100,000		100,000	100,000		100,000
Antimony	mg/kg	793		793	344		344
Arsenic	mg/kg	413	179	179	2,590	314	314
Barium	mg/kg	100,000		100,000	100,000		100,000
Beryllium	mg/kg	2,036	46,649,028	2,036	884	100,000	884
Iron	mg/kg	100,000		100,000	100,000		100,000
Lead[2]	mg/kg			400			400
Manganese	mg/kg	100,000		100,000	39,100		39,100
Uranium	mg/kg	15,877			6,830		6,830
Vanadium	mg/kg	121,076		121,076	3,090		3,090
Total PCB	mg/kg	13.1	63.6	13.1	2.02	10.5	2.02
Total PAH	mg/kg		6.60	6.60		4.24	4.24
Cesium-137	pCi/g		119	119		1.28	1.28
Plutonium-239	pCi/g		23,724	23,724		222	222
Thorium-230	pCi/g		30,237	30,237		285	285

Table 5. Comparison of Site-Specific Action Levels and PGDP Risk Methods Action Levels (Continued)

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Contaminants	Units	Site-Specific Teen Recreational User ALs[1] Hazard	Carcinogen	Action	PGDP Risk Methods Document Teen Recreational User ALs[1] Hazard	Carcinogen	Action
Uranium-234	pCi/g		40,716	40,716		381	381
Uranium-235	pCi/g		553	553		5.91	5.91
Uranium-238	pCi/g		2,461	2,461		26.1	26.1

[1] The action levels (ALs) are based on a risk of 1E-4 and a hazard index of 3. Site-Specific values were derived in DOE 2008. The PGDP Risk Methods Document values are presented in DOE 2001.
[2] The value for lead is a regulatory value provided by the Commonwealth of Kentucky Risk Assessment Branch.
[3] Toxicity values for radionuclides account for short-lived daughter products, where applicable.

Table 6. Site-Specific NALs for the Wildlife Worker

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Contaminants	Units	Site-Specific Wildlife Worker NALs[1] Hazard	Carcinogen	NAL
Aluminum	mg/kg	100,000		100,000
Antimony	mg/kg	98.0		98.0
Arsenic	mg/kg	64.3	8.22	8.22
Barium	mg/kg	62,819		62,819
Beryllium	mg/kg	374	976,375	374
Iron	mg/kg	100,000		100,000
Lead[2]	mg/kg			50
Manganese	mg/kg	40,173		40,173
Uranium	mg/kg	211		211
Vanadium	mg/kg	3,057		3,057
Total PCB	mg/kg	11,789	3.24	3.24
Total PAH	mg/kg		0.368	0.368
Cesium-137	pCi/g		1.53	1.53
Plutonium-239	pCi/g		103	103
Thorium-230	pCi/g		137	137
Uranium-234	pCi/g		179	179
Uranium-235	pCi/g		6.93	6.93
Uranium-238	pCi/g		29.3	29.3

[1]No action level (NAL) values are based on a risk of 1E-6 and a hazard index of 0.1. Site-Specific values were derived in DOE 2008. The PGDP Risk Methods Document values are presented in DOE 2001.
[2]The value from the Risk Methods Document (50 ppm) has since been withdrawn by the Commonwealth of Kentucky. Currently, 400 and 800 ppm are used for screening lead at PGDP, consistent with EPA guidance.

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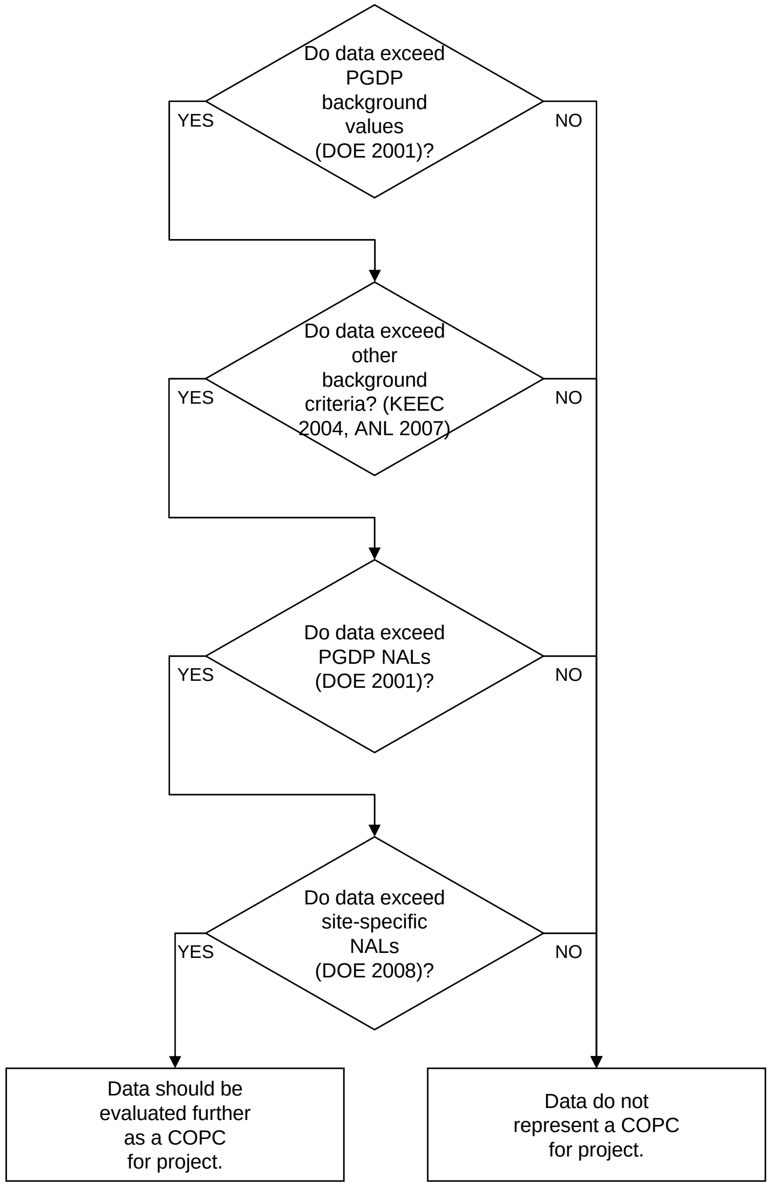

Figure 5. Data Screening

6.1.2 Addendum 2 Soil Piles Receptors

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Addendum 2 Soil Piles are part of the WKWMA. Access to the portion of the WKWMA adjoining PGDP is controlled to the public throughout the year. In order to legally access the site, members of the public must check in with the United States Enrichment Corporation security force at the main guard outpost to PGDP. Known uses of DOE lands included in the WKWMA are defined in the CSM and include a) recreational users and b) wildlife workers.[7]

Known recreational uses of Addendum 2 Soil Piles include field trials, which incorporate horseback riding and dog trials, bow hunting, and similar outdoor activities. Generally, the defined recreational uses will be engaged in by teens and adults.

The soil piles CSM, as defined in the SAP, details the routes of exposure (as included in the derivation of the NALs and ALs shown in the previous tables) to be considered in a risk assessment and includes the following:

- Incidental ingestion of soil
- Inhalation of soil particles (i.e., dust)
- Inhalation of vapors emitted from soil
- Dermal contact with soil
- External exposure to ionizing radiation

6.1.3 Chemicals of Potential Concern

See Table 7 for data screening results. Table 8 shows twelve chemicals exceeding site-specific PGDP background in Addendum 2 Soil Piles as defined in the Risk Methods Document (DOE 2001). These chemicals indicate the detects are statistically at background. Appendix B provides additional information regarding the background comparisons. Additionally in Appendix B, detections noted were evaluated graphically to determine if detects were clustered or random and then compared from low to high.

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KEEC has provided generic statewide background values for inorganic chemicals to assist in comparing site data and background data. The criteria for comparing these values to site results to demonstrate that the site data is background are the following:

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1. The mean site concentration for inorganic constituents must be below the 95% upper confidence limit of the mean concentrations of background for inorganic constituents.

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2. At least half of the data points should be less than the 60^{th} percentile.

3. No data points should be above the upper bound value (95^{th} percentile).

Analytical results of the metals that exceeded site-specific background meet all of these criteria and can be considered background.

Two radionuclides also exceeded site-specific PGDP background, cesium-137 and plutonium-239. The concentrations for these chemicals are below that associated with fallout. Cesium-137 and plutonium-239/240 are major contributors to global fallout due to atmospheric testing of nuclear weapons in the

[7] The receptors for Addendum 2 soil piles are current use receptors only.

1950s to the early 1960s. A summary from Argonne National Laboratory states that concentrations up to 1 pCi/g cesium-137 and 0.1 pCi/g plutonium-239/240 are expected from fallout (ANL 2007).

NALs for specific parameters were exceeded; however, the parameters are not recommended for further evaluation as COPCs in regard to risk due to their existence being below values that could be reasonably expected to occur naturally.

6.1.4 Radiation Dose Comparison

The PGDP Risk Methods Document provides radionuclide screening concentrations derived for human health based target doses for 1, 15, and 25 mrem/year. Of the two known receptors (recreational user and wildlife worker) at Addendum 2 Soil Piles, screening concentrations for the recreational user are considered for this analysis because the recreational user's screening concentration is less than the wildlife worker's screening concentration at the same target risk and hazard levels. The target dose of 25 mrem/year is based on criteria in DOE Order 5400.5, Chapter II. The target dose of 15 mrem/year is based on the U.S. EPA memorandum dated August 22, 1997. The PGDP Risk Methods Document and *National Council on Radiation Protection and Measures* (NCRP) 116 describes a screening level from the target dose of 1 mrem/year as the "walk away" level. See Table 9 for a comparison of radiological results to the human health based target doses.

The concentrations (range of concentration noted in Table 9) are from the fixed-base laboratory data obtained as a result of all samples collected for Addendum 2 soil piles and are below the individual recreational user screening levels for a 1 mrem/year dose and, therefore, below the "walk away" level in the PGDP Risk Methods Document. Negative concentration data (as noted in Table 9) sometimes is reported for radionuclides when data represents activity below background.

6.1.5 PCB Comparison

All piles sampled for Addendum 2 Soil Piles show no detection of PCBs; therefore, a comparison was not performed.

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Table 7. Data Screening Results

Analysis	Units	Detected Results: Minimum	Detected Results: Maximum	Detected Results: Average	Frequency of Detection	Exceeds Background[1]	Exceedances of No Action Levels: Site-Specific Teen Recreational User	Exceedances of No Action Levels: PGDP-Specific Teen Recreational User	Exceedances of No Action Levels: Site-Specific Wildlife Worker	Exceedances of No Action Levels: PGDP-Specific Child Resident	Detection Limit Range
Aluminum	mg/kg	1.95E+03	1.31E+04	6.75E+03	110/110	2/110	0/110	108/110	0/110	110/110	17 - 194
Antimony	mg/kg				0/110	0/110	0/110	0/110	0/110	0/110	6.6 - 9.97
Arsenic	mg/kg	1.96E+00	1.02E+01	4.28E+00	110/110	3/110	110/110	110/110	4/110	110/110	0.849 - 1
Barium	mg/kg	1.78E+01	1.35E+02	6.17E+01	110/110	0/110	0/110	0/110	0/110	90/110	2.12 - 2.5
Beryllium	mg/kg	4.44E-01	7.16E-01	5.59E-01	26/110	3/110	0/110	6/110	0/110	26/110	0.425 - 0.5
Cadmium	mg/kg	4.66E-01	6.74E-01	5.47E-01	14/110	14/110	N/A	0/110	N/A	0/110	0.425 - 0.5
Calcium	mg/kg	1.24E+02	6.62E+04	1.87E+03	108/110	2/110	N/A	N/A	N/A	N/A	84.9 - 898
Chromium	mg/kg	6.36E+00	5.46E+01	1.22E+01	110/110	6/110	N/A	0/110	N/A	0/110	2.12 - 2.5
Cobalt	mg/kg	2.93E+00	1.26E+01	5.29E+00	110/110	0/110	N/A	0/110	N/A	0/110	0.849 - 1
Copper	mg/kg	2.45E+00	1.71E+01	6.49E+00	110/110	0/110	N/A	0/110	N/A	0/110	2.12 - 2.5
Iron	mg/kg	5.55E+03	2.13E+04	1.03E+04	110/110	0/110	0/110	110/110	0/110	110/110	17 - 20
Lead	mg/kg	3.02E+00	2.88E+01	1.05E+01	110/110	1/110	0/110	0/110	0/110	0/110	0.849 - 4.82
Magnesium	mg/kg	1.30E+02	2.13E+03	7.37E+02	110/110	0/110	N/A	0/110	N/A	0/110	4.25 - 5
Manganese	mg/kg	8.51E+01	1.58E+03	4.91E+02	110/110	1/110	0/110	110/110	0/110	110/110	2.12 - 2.5
Mercury	mg/kg	1.30E-02	8.60E-02	2.66E-02	97/110	N/A	N/A	0/110	N/A	0/110	0.011 - 0.017
Molybdenum	mg/kg				0/110	N/A	N/A	0/110	N/A	0/110	4.25 - 5
Nickel	mg/kg	4.54E+00	1.15E+01	7.82E+00	75/110	0/110	N/A	0/110	N/A	0/110	4.25 - 5
Selenium	mg/kg				0/110	0/110	N/A	0/110	N/A	0/110	0.849 - 1
Silver	mg/kg				0/110	0/110	0/110	0/110	0/110	0/110	1.65 - 2.49
Sodium	mg/kg				0/110	0/110	0/110	0/110	0/110	0/110	170 - 200
Thallium	mg/kg				0/110	0/110	N/A	0/110	N/A	0/110	1.7 - 2
Uranium	mg/kg	9.48E-01	3.74E+00	1.38E+00	45/110	0/110	0/110	0/110	0/110	2/110	0.849 - 1
Vanadium	mg/kg	1.07E+01	3.77E+01	1.76E+01	110/110	1/110	0/110	110/110	0/110	110/110	2.12 - 2.5
Zinc	mg/kg	1.82E+01	5.82E+01	2.61E+01	70/110	0/110	N/A	0/110	N/A	0/110	17 - 20
Americium-241	pCi/g				0/110	N/A	N/A	0/110	N/A	0/110	0.0214 - 0.0259
Cesium-137	pCi/g	3.91E-02	9.79E-01	2.72E-01	75/110	15/110	0/110	41/110	0/110	75/110	0.0359 - 0.0747
Neptunium-237	pCi/g				0/110	0/110	N/A	0/110	N/A	0/110	0.0169 - 0.0554
Plutonium-238	pCi/g				0/110	0/110	N/A	0/110	N/A	0/110	0.0107 - 0.014
Plutonium-239/240	pCi/g	1.22E-02	3.53E-02	2.07E-02	15/110	3/110	0/110	0/110	0/110	0/110	0.00977 - 0.018
Technetium-99	pCi/g	6.83E-01	1.45E+00	9.42E-01	23/110	0/110	N/A	0/110	N/A	0/110	0.632 - 0.655
Thorium-228	pCi/g	1.41E-01	5.11E-01	3.06E-01	108/110	0/110	N/A	108/110	N/A	108/110	0.112 - 0.118
Thorium-230	pCi/g	1.30E-01	4.71E-01	2.34E-01	103/110	0/110	0/110	0/110	0/110	0/110	0.127 - 0.133
Thorium-232	pCi/g	1.19E-01	5.38E-01	3.33E-01	110/110	0/110	N/A	0/110	N/A	0/110	0.0739 - 0.0803
Uranium	pCi/g	2.32E-01	1.80E+00	5.64E-01	32/110	N/A	N/A	N/A	N/A	N/A	0.218 - 0.294
Uranium-234[2]	pCi/g	1.22E-01	7.99E-01	2.24E-01	37/110	0/110	0/110	0/110	0/110	0/110	0.119 - 0.154
Uranium-235[2]	pCi/g	1.49E-02	4.55E-02	2.54E-02	12/110	0/110	0/110	0/110	0/110	8/110	0.0117 - 0.0345
Uranium-238[2]	pCi/g	8.90E-02	9.56E-01	2.47E-01	68/110	5/110	0/110	0/110	0/110	68/110	0.0859 - 0.118

[1] Background Values from DOE 2001. Samples whose bottom depth less than or equal to 1 screened against surface values, those with depth greater than 1 screened against subsurface values.

[2] Uranium isotopes are compared to screening values using an incremental adjustment, as appropriate. N/A = not applicable or not available

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Table 8. Chemicals Exceeding PGDP Background

Analysis	Depth	Frequency Exceeding Site-Specific PGDP Background[1, 2]
Aluminum	Subsurface	2/56
Arsenic	Subsurface	4/56
Beryllium	Surface	3/54
Cadmium	Surface Subsurface	6/54 8/56
Calcium	Subsurface	3/56
Chromium	Surface Subsurface	5/54 1/56
Lead	Subsurface	1/56
Manganese	Surface	1/54
Vanadium	Subsurface	1/56
Cesium-137	Surface Subsurface	6/54 9/56
Plutonium-239/240	Surface	3/54
Uranium-238[3]	Surface Subsurface	3/54 2/56

[1] Background values taken from the provisional background values provided in DOE 2001.
[2] These eleven chemicals exceed site-specific PGDP background; however, Appendix B provides additional information to show these chemicals are not COPCs.
[3] Isotopic uranium were compared to screening values using an incremental adjustment, as appropriate.

Table 9. Comparison of Addendum 2 Soil Piles Radionuclide Concentrations and Radiation Dose/Concentration Limits

Radionuclide	Range of Concentration (pCi/g)	Teen Recreator Screening Level (pCi/g)[b]			Residual Concentration Limit for Release of DOE Property (pCi/g)
		1 mrem/year	15 mrem/year	25 mrem/year	
Cesium-137	-0.0229 – 0.979	1.07E+01	1.60E+02	2.67E+02	
Thorium-230	-0.00525 – 0.471	1.38E+03	2.07E+04	3.44E+04	5/15[c]
Thorium-232	0.119 – 0.538	2.88E+02	4.33E+03	7.21E+03	5/15[c]
Uranium-234	-0.0357 – 0.799	2.72E+03	4.07E+04	6.79E+04	
Uranium-238	0.0112 – 0.956	2.44E+02	3.67E+03	6.11E+03	

[ab] From the PGDP Risk Methods Document. All Risk Methods Document values are presented for comparison purposes; however, not all of these values may be appropriate for response action decision making.
[c] 5 pCi/g, averaged over the first 15 cm of soil below the surface; 14 pCi/g, averaged over 15-cm-thick layers of soil more than 15 cm below the surface.

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7. CONCLUSIONS

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The following provides a summary of the major findings and conclusions for the Addendum 2 soil piles evaluation. The following lists the objectives of the Addendum 2 soil piles investigation:

- Establish the nature and extent of contamination in Addendum 2 Soil Piles and adjacent soils.
- Establish the mean concentrations of contaminants in soils.
- Determine if soils pose imminent risks to human health.
- Determine if soils contamination exceeds regulatory thresholds.

Consistent with Section 40 *CFR* § 300.420(c)(5) of the National Contingency Plan (NCP), information on the nature of waste handling, known contaminants, pathways of migration of contaminants, human and environmental targets, and a recommendation on further action is contained in this report.

Consistent with Section 40 *CFR* § 300.415(b)(2) of the NCP, the factors that should be considered in determining the appropriateness of a removal action for Addendum 2 soil piles are discussed below.

(i) **Actual or potential exposure to nearby human populations, animals, or food chain from hazardous substances or pollutants or contaminants.**
The screening (Appendix B) found that the detects are statistically at background based upon the results being below the 95th percentile of the generic statewide ambient background values. PCBs were not detected.

(ii) **Actual or potential contamination of drinking water supplies or sensitive ecosystem.**
There is no known use of groundwater for drinking water, feedstock watering, or crop irrigation from the Addendum 2 soil piles area.

(iii) **Hazardous substances or pollutants or contaminants in drums, barrels, banks, or other bulk storage containers that may pose a threat of release.**
There are no containers or tanks associated with the Addendum 2 soil piles.

(iv) **High levels of hazardous substances or pollutants or contaminants in soils largely at or near the surface that may migrate.**
Sampling results from Addendum 2 and PGDP historical monitoring data indicate no migration is occurring.

(v) **Weather conditions that may cause hazardous substances or pollutants or contaminants to migrate or be released.**
Sampling results from Addendum 2 and PGDP historical monitoring data indicate no migration is occurring.

(vi) **Threat of fire or explosion.**
The Addendum 2 soil piles do not present a threat of fire or explosion.

(vii) **The availability of other appropriate federal or state response mechanisms to respond to the release.**
This factor is not applicable to the Addendum 2 soil piles.

(viii) **Other situations or factors that may pose threats to public health or welfare of the United States or the environment.**
There are no other situations or factors at Addendum 2 soil piles that would pose a threat to public health or the environment.

7.1 NATURE AND EXTENT OF CONTAMINATION

As expected, the soil does not pose imminent risks to human health and are at or near background, based upon field and fixed laboratory samples collected from the 54 soil pile samples. Data (see Appendix A) of known quality were acquired in sufficient quantities to allow decision makers to formulate an informed decision as to the need for an action at any of the Addendum 2 soil piles, if warranted. No evidence was found of a release of hazardous waste or hazardous constituents that would pose a current or potential threat to human health or the environment. Additionally, no indication was found of treatment, storage, or disposal of solid or hazardous waste.

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7.2 HUMAN HEALTH RISKS

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The results of the background screening for metals indicate concentrations used to quantify risks and hazards were at or near background levels for all 54 soil pile samples. Eleven chemicals exceeded site-specific background; however, the results either were below the 95^{th} percentile of the generic statewide ambient background values (with the mean of the results being below the 95 upper confidence limit of the mean generic statewide ambient background and at least half of the results less than the 60^{th} percentile) or are considered as a result of fallout.

7.2.1 Radiation Dose Limits

Concentrations of radiological parameters detected in Addendum 2 soil piles are below recreational user screening levels for a 1 mrem/year dose and, therefore, below the “walk away” level in the PGDP Risk Methods Document.

7.2.2 PCB Remediation Waste

PCBs were not detected in any of the field and laboratory samples collected from the 54 soil piles.

8. RECOMMENDATIONS

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The following provides recommendations for future activities at Addendum 2 Soil Piles. The recommendations are based on the findings of the investigation and lessons learned during the planning and execution of study efforts at Addendum 2 Soil Piles.

8.1 FUTURE ACTIVITIES

The following are recommendations and future actions to be taken based on the findings of the Addendum 2 Soil Piles:

- The Addendum 2 piles do not meet the definition of a SWMU or AOC because the constituent concentrations in soil are at or near background levels or do not exceed NALs, and no documentation exists to indicate the presence of wastes. The soil piles do not pose a current or potential threat to human health or the environment. As a result, no further investigation is recommended for the 54 soil piles along Bayou Creek (Addendum 2 Soil Piles).

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- The PAH test kit evaluation will be completed in the Addendum 1-B SER because most all results for Addendum 2 Soil Piles were below the detection limit for both field and fixed laboratory results.

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Table 1. Fixed Laboratory Analysis Requirements for Soils **CHARACTERIZATION PARAMETERS**	**ANALYTICAL METHOD**
PAHs	EPA 8270
PCBs (Aroclors/Total)	EPA 3540/8082
Inorganic Target Analyte List (Total Metals)	EPA 6010 or EPA 6020
^{241}Americium	DOE EML HASL-300, Am-05-RC
^{137}Cesium	EML HASL 300, 4.5.2.3
^{237}Neptunium	DOE EML HASL 300
^{238}Plutonium	DOE EML HASL-300, Pu-11-RC
$^{239/240}$Plutonium	DOE EML HASL-300, Pu-11-RC
^{99}Technetium	DOE EML HASL-300, Tc-02-RC
^{228}Thorium	DOE EML HASL-300, Th-01-RC
$^{230/232}$Thorium	DOE EML HASL-300, Th-01-RC
Total Uranium	DOE EML HASL-300, U-02-RC
^{234}Uranium	DOE EML HASL-300, U-02-RC
^{235}Uranium radioactivity	DOE EML HASL-300, U-02-RC
^{238}Uranium	DOE EML HASL-300, U-02-RC
Arsenic	EPA 1311/6010 or 6020[1]
Barium	EPA 1311/6010 or 6020[1]
Cadmium	EPA 1311/6010 or 6020[1]
Chromium	EPA 1311/6010 or 6020[1]
Lead	EPA 1311/6010 or 6020[1]
Mercury	EPA 1311/7470[1]
Selenium	EPA 1311/6010 or 6020[1]
Silver	EPA 1311/6010 or 6020[1]
Ignitability	EPA 1030[1]
Reactivity Cyanide	EPA 9014[1]
Reactivity Sulfide	EPA 9034[1]
Corrosivity to Steel	EPA 1110
Paint Filter Test	EPA 9095B
%Moisture/%Solid	ASTM D2216

APPENDIX A

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SER ADDENDUM 2 DATA

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APPENDIX B

SCREENING OF DETECTED CHEMICALS EXCEEDING PGDP SITE-SPECIFIC BACKGROUND

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Background Exceedances for Addendum 2 Soil Pile Sampling

Twelve chemicals exceeded site-specific Paducah Gaseous Diffusion Plant (PGDP) background during the Addendum 2 sampling. Four of those chemicals exceeded background in both surface and subsurface sampling. The twelve chemicals are listed in Table 1.

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Table 1. Addendum 2 Chemicals Exceeding PGDP Background

Analysis	Depth	Frequency Exceeding Site-Specific PGDP Background*
Aluminum	Subsurface	2/56
Arsenic	Subsurface	4/56
Beryllium	Surface	3/54
Cadmium	Surface	6/54
	Subsurface	8/56
Calcium	Subsurface	3/56
Chromium	Surface	5/54
	Subsurface	1/56
Lead	Subsurface	1/56
Manganese	Surface	1/54
Vanadium	Subsurface	1/56
Cesium-137	Surface	6/54
	Subsurface	9/56
Plutonium-239/240	Surface	3/54
Uranium-238	Surface	3/54
	Subsurface	2/56

*Background values for this analysis were taken from the provisional background values provided in DOE 2001. Material presented later in this section considers estimates of background concentrations from other sources. Isotopic uranium results were compared to screening values using incremental adjustments, as appropriate.

Of the soil piles with results exceeding background, Soil Pile BP has the most background exceedances with 6 [2 surface exceedances (cadmium and chromium) and 4 subsurface exceedances (cadmium, lead, cesium-137, and uranium-238)]. The next highest ranking soil piles have 4 background exceedances each: Soil Piles AG, BI, and W. [Soil Pile AG has 1 surface exceedance (cadmium) and 3 subsurface exceedances (aluminum, cadmium, calcium). Soil Pile BI has 1 surface exceedance (cadmium) and 3 subsurface exceedances (arsenic, cadmium, cesium-137). Soil Pile W has 4 surface exceedances (beryllium, manganese, cesium-137, plutonium-239/240).] Soil Piles AH, AB, and X have 3 background exceedances each. Several other soil piles have 1 or 2 background exceedances.

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The following soil piles have no background exceedances:

2	8	15	AN	Q
3	10	AD	AY	R
4	12	AI	BD	U
5	13A	AJ	BF	V
7	13B	AK	BO	Y

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The following text describes and illustrates the spatial distribution of these background exceedances with accompanying charts of results compared to background. The 2001 Risk Methods Document (DOE 2001) was the primary source used for comparing Addendum 2 results with background; however, in order to better focus on chemicals presenting potential concern for the soil piles, additional screening values were considered. These screening values used for comparison are the revised site background values for PGDP published for review in 2009 (DOE 2009),[1] the generic statewide ambient background value available in Kentucky Energy and Environment Cabinet (KEEC) guidance (KEEC 2004), and values expected from global fallout (ANL 2007). The background screen is not meant necessarily to screen against the most conservative of the background values available, but to screen results that are below values that reasonably could be expected to occur naturally. The documents and values presented in this appendix define values that reasonably could be expected to occur.

To apply the guidance established by the KEEC, the criteria were used as listed here:

1. The mean site concentration for inorganic constituents must be below the 95% upper confidence limit (UCL) of the mean concentrations of background for inorganic constituents.

2. At least half of the data points should be less than the 60th percentile.

3. No data points should be above the upper bound value (95th percentile).

Aluminum–Subsurface. Aluminum values in subsurface soil samples exceed the background value of 12,000 mg/kg in 2 of 56 samples. The two exceeding values are 12,300 and 13,100 mg/kg. The locations from which the exceeding samples were collected are from different soil piles and are not related. Further, several other samples were collected near these two and did not exceed background. The criteria for applying ambient background values established by KEEC were met: (1) the mean site concentration (6,740 mg/kg) is below the 95% UCL of the mean concentrations of KEEC background (11,314 mg/kg), (2) at least half of the data points are less than the 60th percentile (10,800 mg/kg), and (3) no data points are above the upper bound value (21,000 mg/kg) (KEEC 2004); therefore, aluminum is not present in the Addendum 2 soil piles as a contaminant.

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Figure B.1 graphically shows the results with the background value and other comparison values. Figure B.2 illustrates the spatial distribution of the sampling locations in which the background value was exceeded.

[1] The draft site background values published for review in 2009 represent two times the log-transformed median (mean for radionuclides) value for use in screening to determine if inorganic chemical or radionuclide detected at naturally occurring concentration in surface or subsurface soil.

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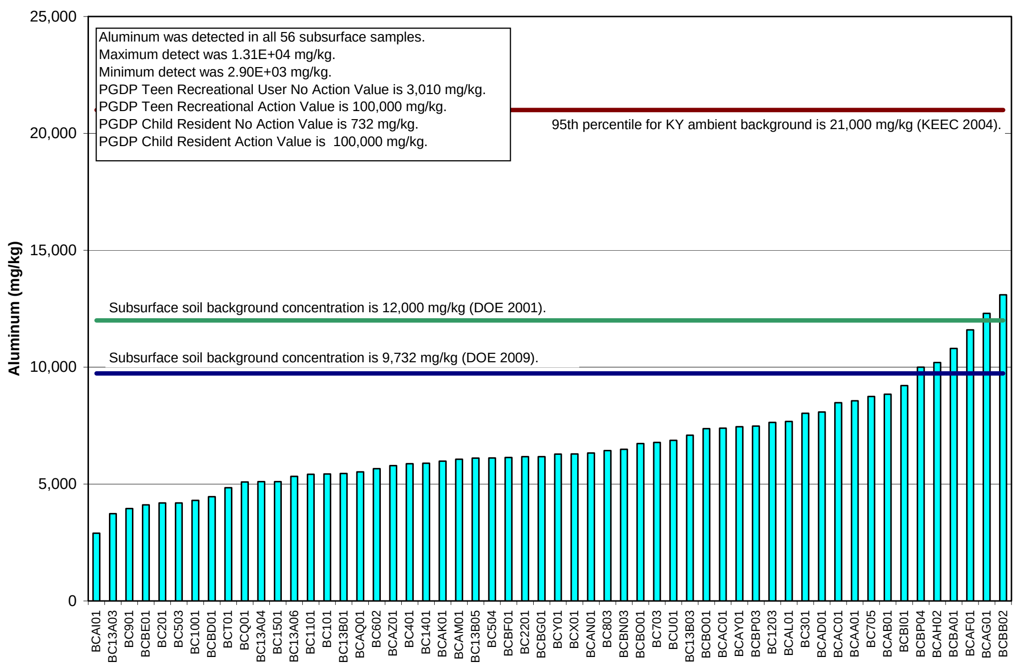

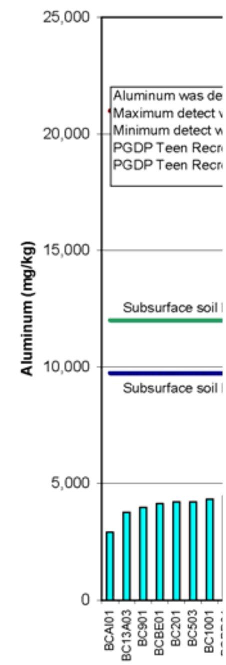

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Figure B.1. Comparison between Aluminum Concentrations in Samples from Soil Piles Addendum 2 and Subsurface Soil Background Concentrations

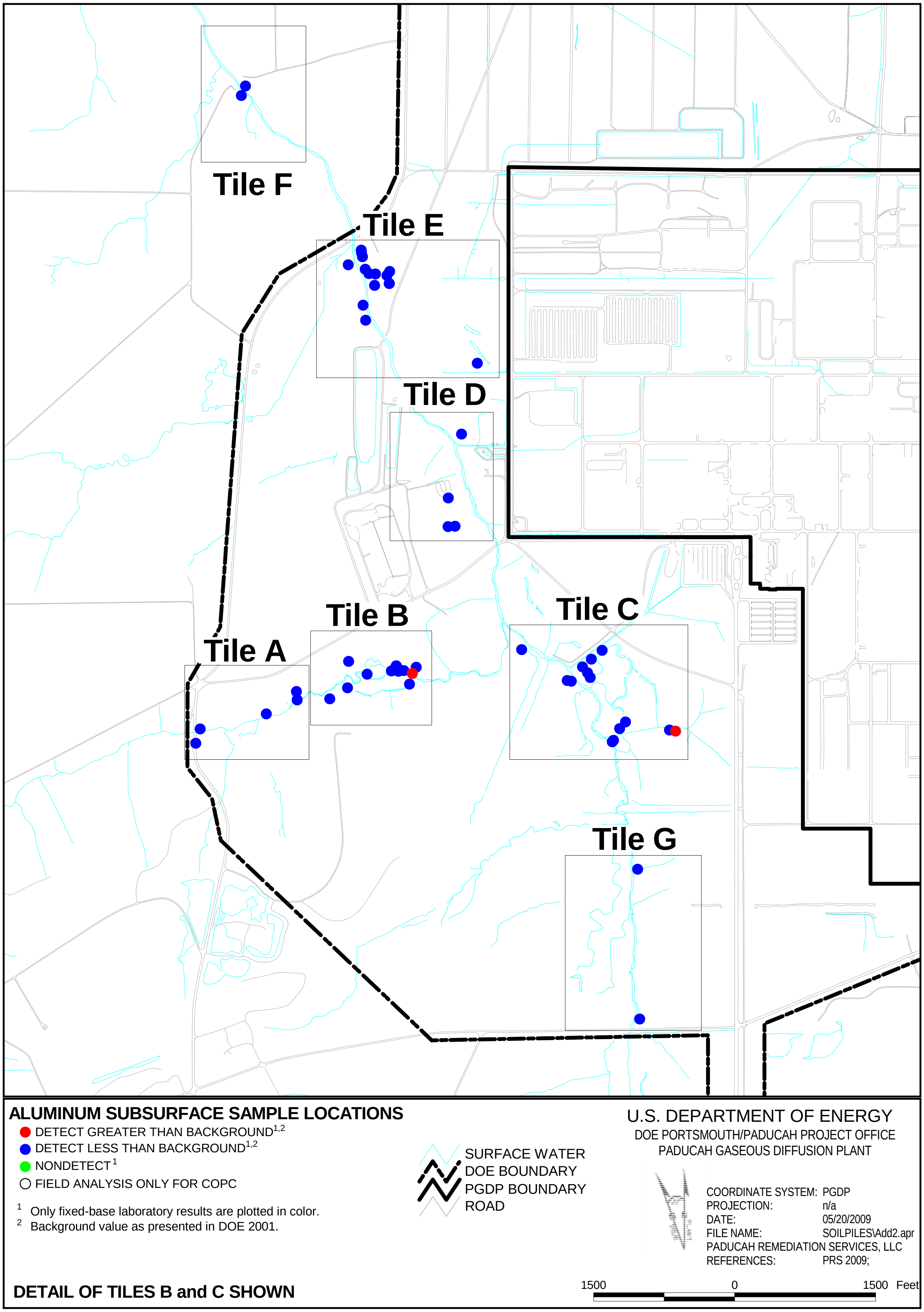
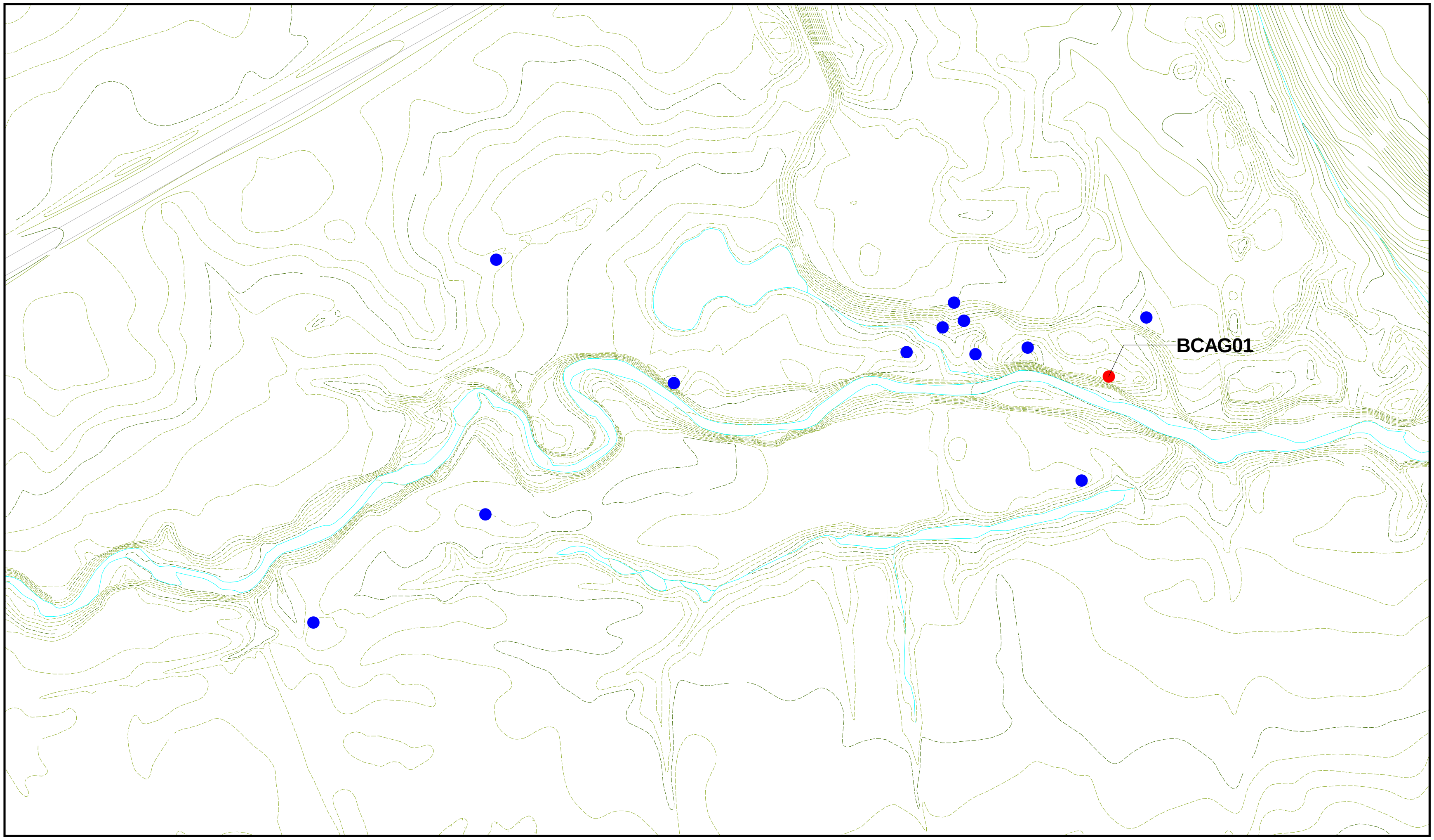


Figure B.2. Location of Sample Stations in Addendum 2 Soil Pile Sampling for Aluminum in the Subsurface



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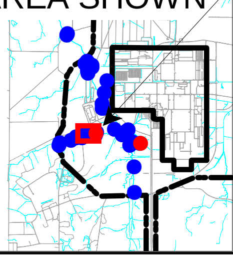

ALUMINUM SUBSURFACE SAMPLE LOCATIONS

- DETECT GREATER THAN BACKGROUND[1,2]
- DETECT LESS THAN BACKGROUND[1,2]
- NONDETECT[1]
- FIELD ANALYSIS ONLY FOR COPC

[1] Only fixed-base laboratory results are plotted in color.
[2] Background value as presented in DOE 2001.

SURFACE WATER
DOE BOUNDARY
PGDP BOUNDARY
ROAD
SURFACE CONTOUR (1 ft)
SURFACE CONTOUR (5 ft)

TILE B

U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

COORDINATE SYSTEM: PGDP
PROJECTION: n/a
DATE: 05/20/2009
FILE NAME: SOILPILES\Add2.apr
PADUCAH REMEDIATION SERVICES, LLC
REFERENCES: PRS 2009;

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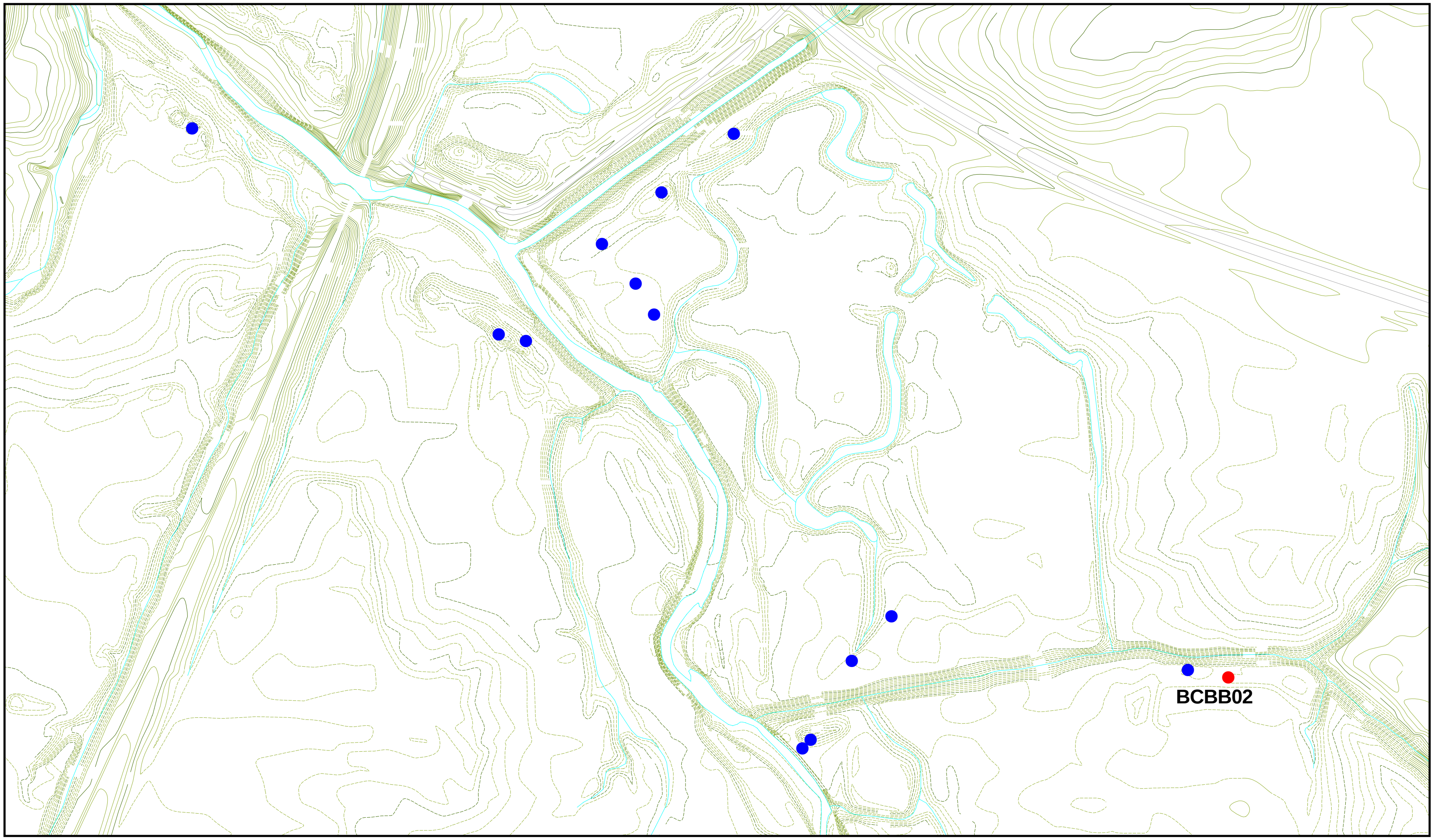

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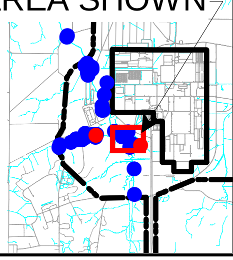

ALUMINUM SUBSURFACE SAMPLE LOCATIONS

- DETECT GREATER THAN BACKGROUND[1,2]
- DETECT LESS THAN BACKGROUND[1,2]
- NONDETECT[1]
- FIELD ANALYSIS ONLY FOR COPC

[1] Only fixed-base laboratory results are plotted in color.
[2] Background value as presented in DOE 2001.

SURFACE WATER
DOE BOUNDARY
PGDP BOUNDARY
ROAD
SURFACE CONTOUR (1 ft)
SURFACE CONTOUR (5 ft)

TILE C

U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

COORDINATE SYSTEM:	PGDP
PROJECTION:	n/a
DATE:	05/20/2009
FILE NAME:	SOILPILES\Add2.apr
PADUCAH REMEDIATION SERVICES, LLC	
REFERENCES:	PRS 2009;

250 0 250 Feet

Arsenic–Subsurface. Arsenic values in subsurface soil samples exceed the background value of 7.9 mg/kg in 4 of 56 samples. The four exceeding values are 7.94, 8.3, 8.85, and 9 mg/kg.

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Figure B.3 graphically shows the results with the background value and other comparison values. Figure B.4 illustrates the spatial distribution of the sampling locations in which the background value was exceeded. As illustrated in Figure B.4, the arsenic results from piles BA and BB are the only piles in relative proximity to one another. These results are 8.85 and 8.3 mg/kg, respectively.

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These 4 of 56 samples were evaluated more extensively by applying the criteria for ambient background values established by KEEC: (1) the mean site concentration (4.29 mg/kg) is below the 95% UCL of the mean concentrations of KEEC background (9.4 mg/kg); (2) at least half of the data points are less than the 60th percentile (8.3 mg/kg); and (3) no data points are above the upper bound value (21.2 mg/kg) (KEEC 2004). Therefore, although arsenic is detected in 4 samples at levels greater than the benchmark background value, arsenic is below the range of background presented and should not be considered present as a contaminant in the Addendum 2 soil piles.

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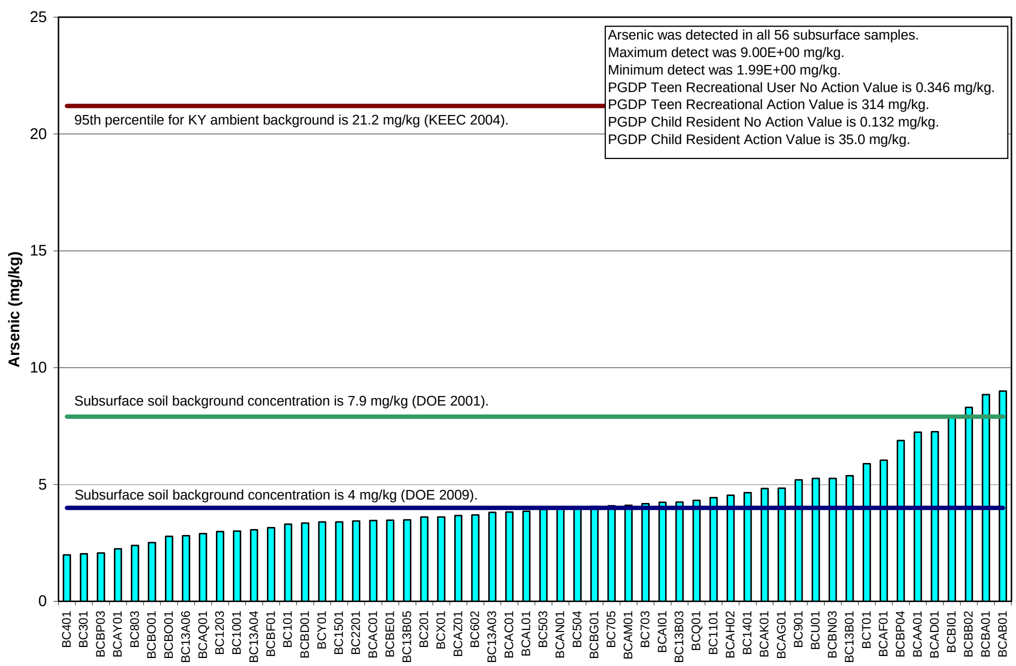

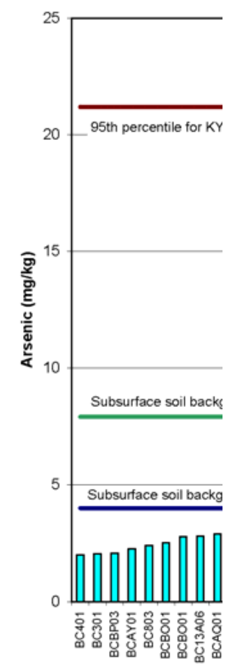

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Figure B.3. Comparison between Arsenic Concentrations in Samples from Soil Piles Addendum 2 and Subsurface Soil Background Concentrations

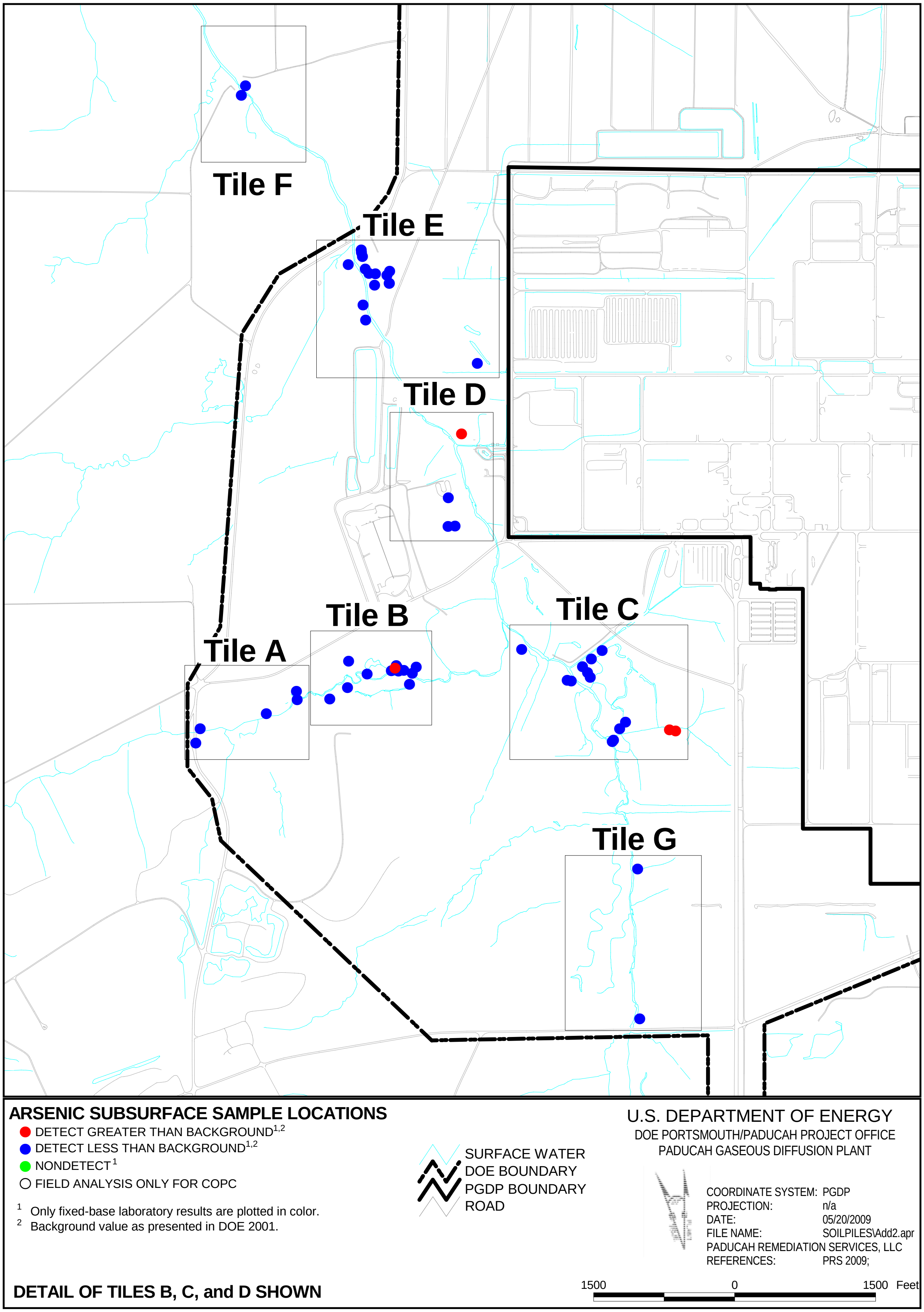
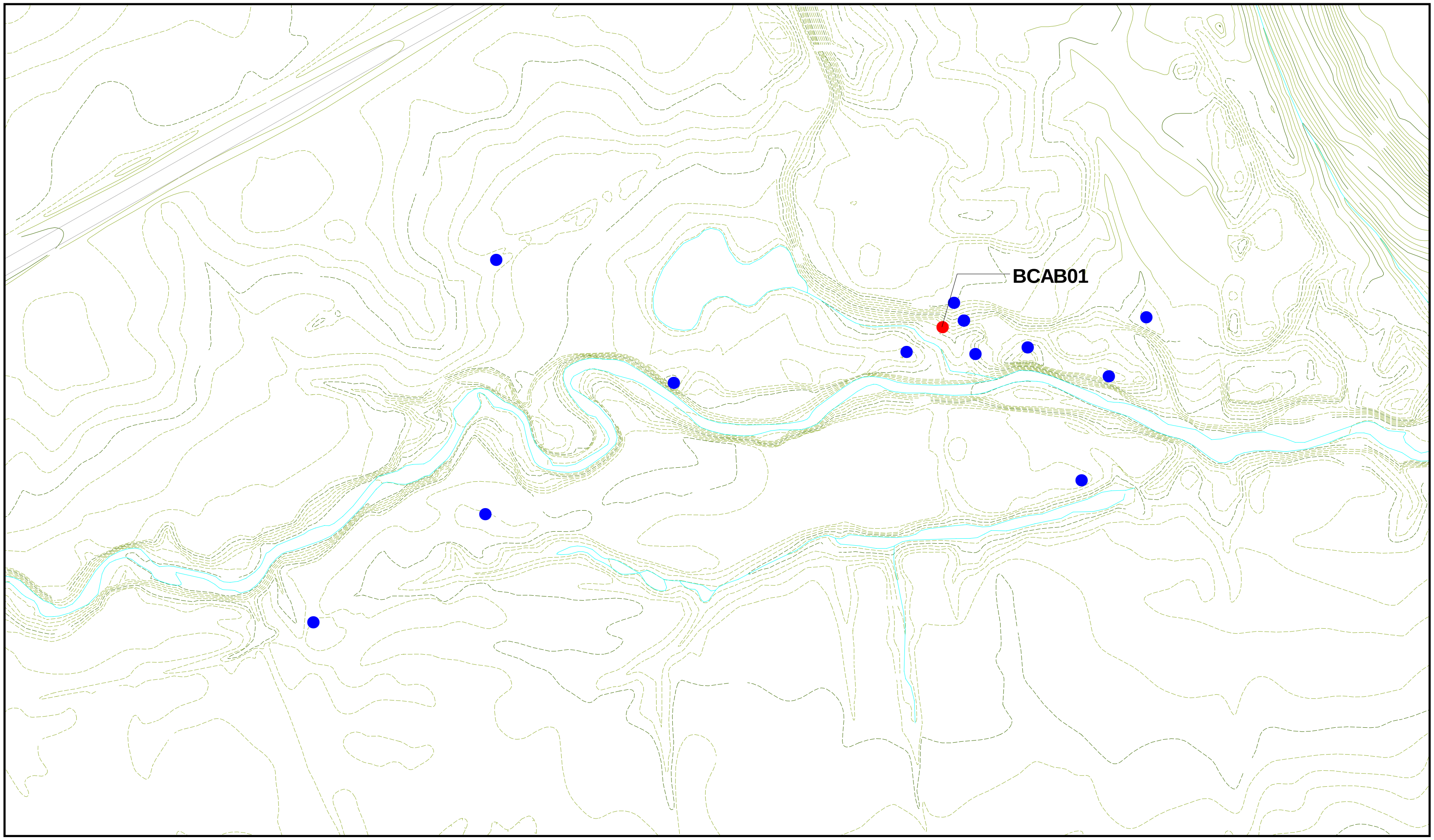
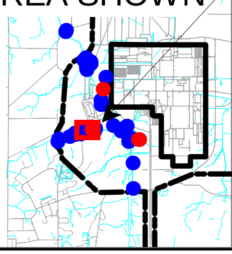


Figure B.4. Location of Sample Stations in Addendum 2 Soil Pile Sampling for Arsenic in the Subsurface



AREA SHOWN



ARSENIC SUBSURFACE SAMPLE LOCATIONS

- DETECT GREATER THAN BACKGROUND[1,2]
- DETECT LESS THAN BACKGROUND[1,2]
- NONDETECT[1]
- FIELD ANALYSIS ONLY FOR COPC

[1] Only fixed-base laboratory results are plotted in color.
[2] Background value as presented in DOE 2001.

SURFACE WATER
DOE BOUNDARY
PGDP BOUNDARY
ROAD
SURFACE CONTOUR (1 ft)
SURFACE CONTOUR (5 ft)

TILE B

U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

COORDINATE SYSTEM: PGDP
PROJECTION: n/a
DATE: 05/20/2009
FILE NAME: SOILPILES\Add2.apr
PADUCAH REMEDIATION SERVICES, LLC
REFERENCES: PRS 2009;

175 0 175 Feet

Figure B.4. (Continued)

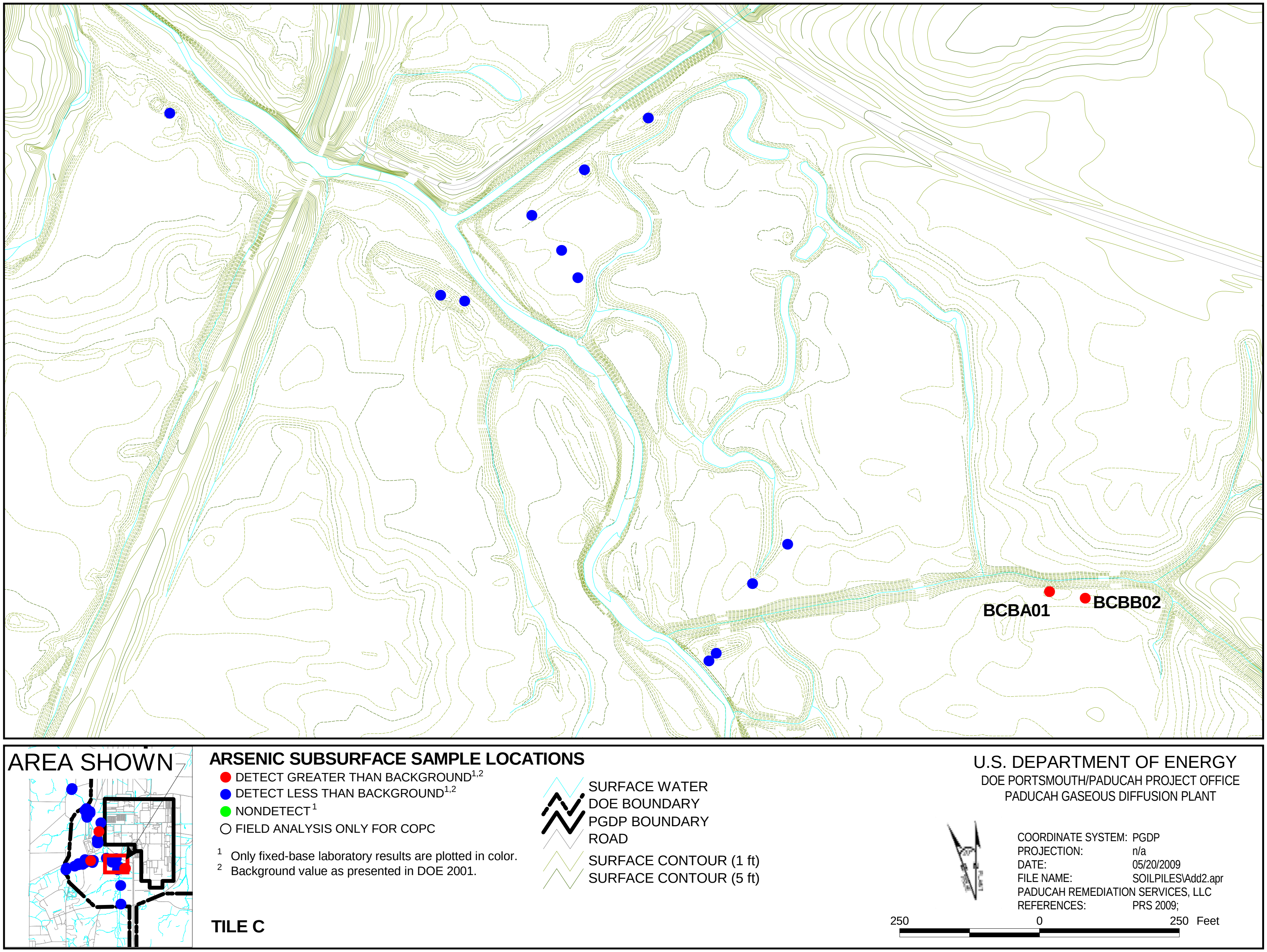


Figure B.4. (Continued)

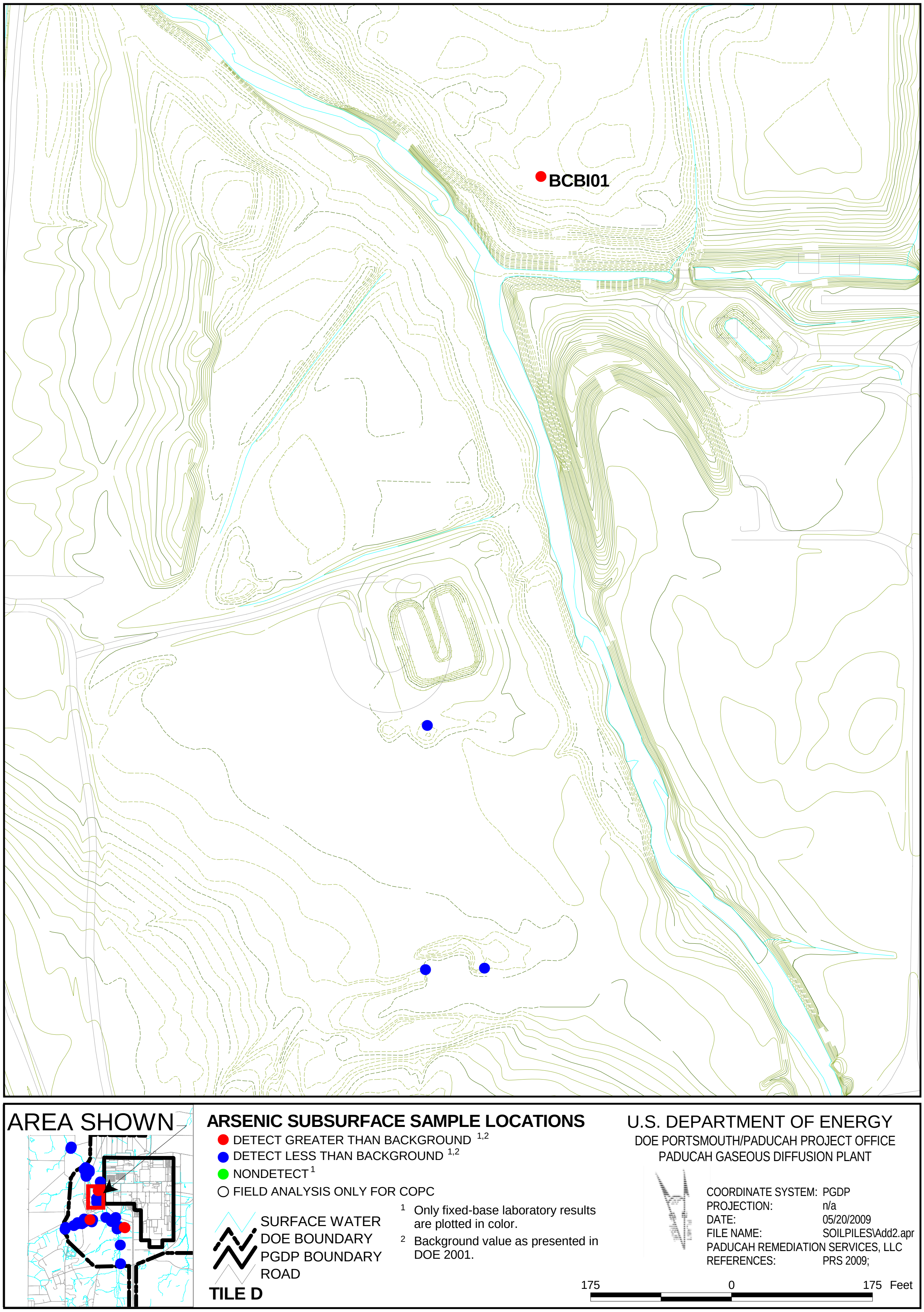


Figure B.4. (Continued)

Beryllium–Surface. Beryllium values in surface soil samples exceed the background value of 0.67 mg/kg in 3 of 54 samples. The three exceeding values are 0.676, 0.686, and 0.716 mg/kg. The criteria for applying ambient background values established by KEEC were met: (1) the mean site concentration (0.559 mg/kg) is below the 95% UCL of the mean concentrations of KEEC background (0.83 mg/kg); (2) at least half of the data points are less than the 60th percentile (0.75 mg/kg); and (3) no data points are above the upper bound value (1.8 mg/kg) (KEEC 2004). Figure B.5 graphically shows the results with the background value and other comparison values.

Figure B.6 illustrates the spatial distribution of the sampling locations in which the background value was exceeded. The soil piles from which the samples were collected are not related spatially.

Although beryllium is detected in 3 of 54 samples at levels greater than the benchmark background value, beryllium is below the range of background presented and should not be considered present in the Addendum 2 soil piles as a contaminant.

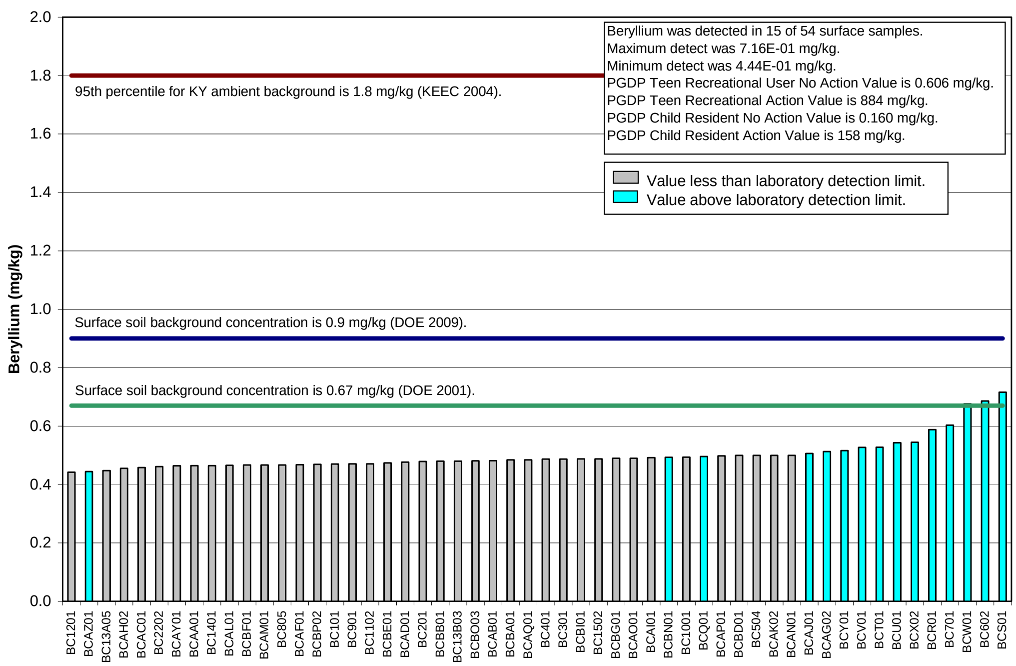


Figure B.5. Comparison between Beryllium Concentrations in Samples from Soil Piles Addendum 2 and Surface Soil Background Concentrations

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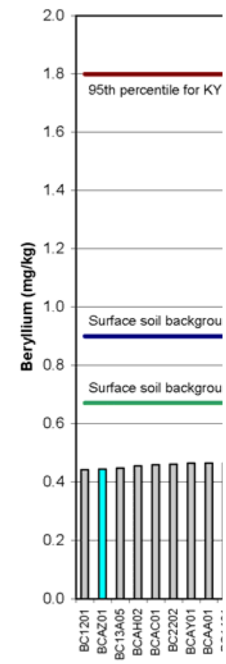

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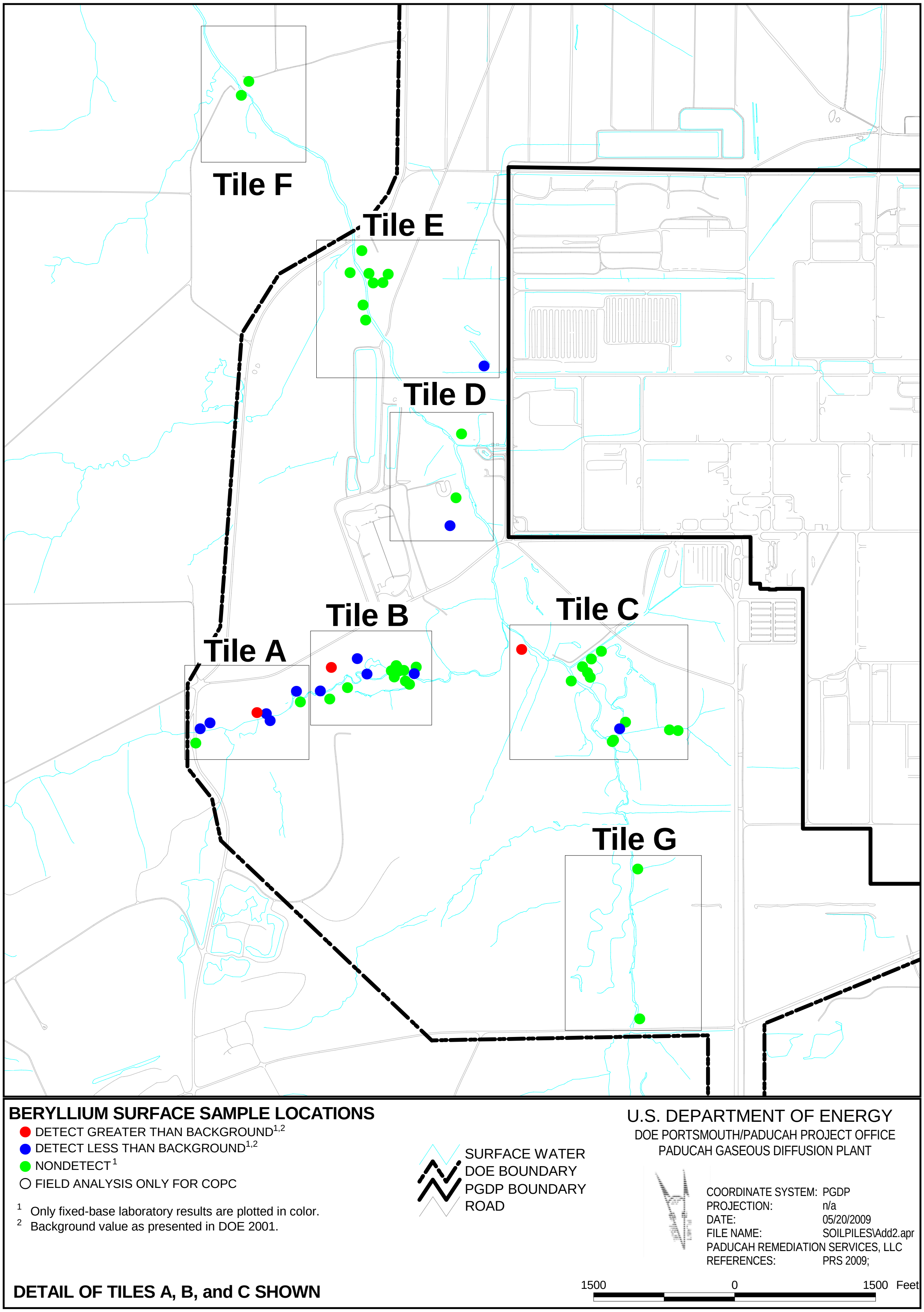


Figure B.6. Location of Sample Stations in Addendum 2 Soil Pile Sampling for Beryllium in the Surface

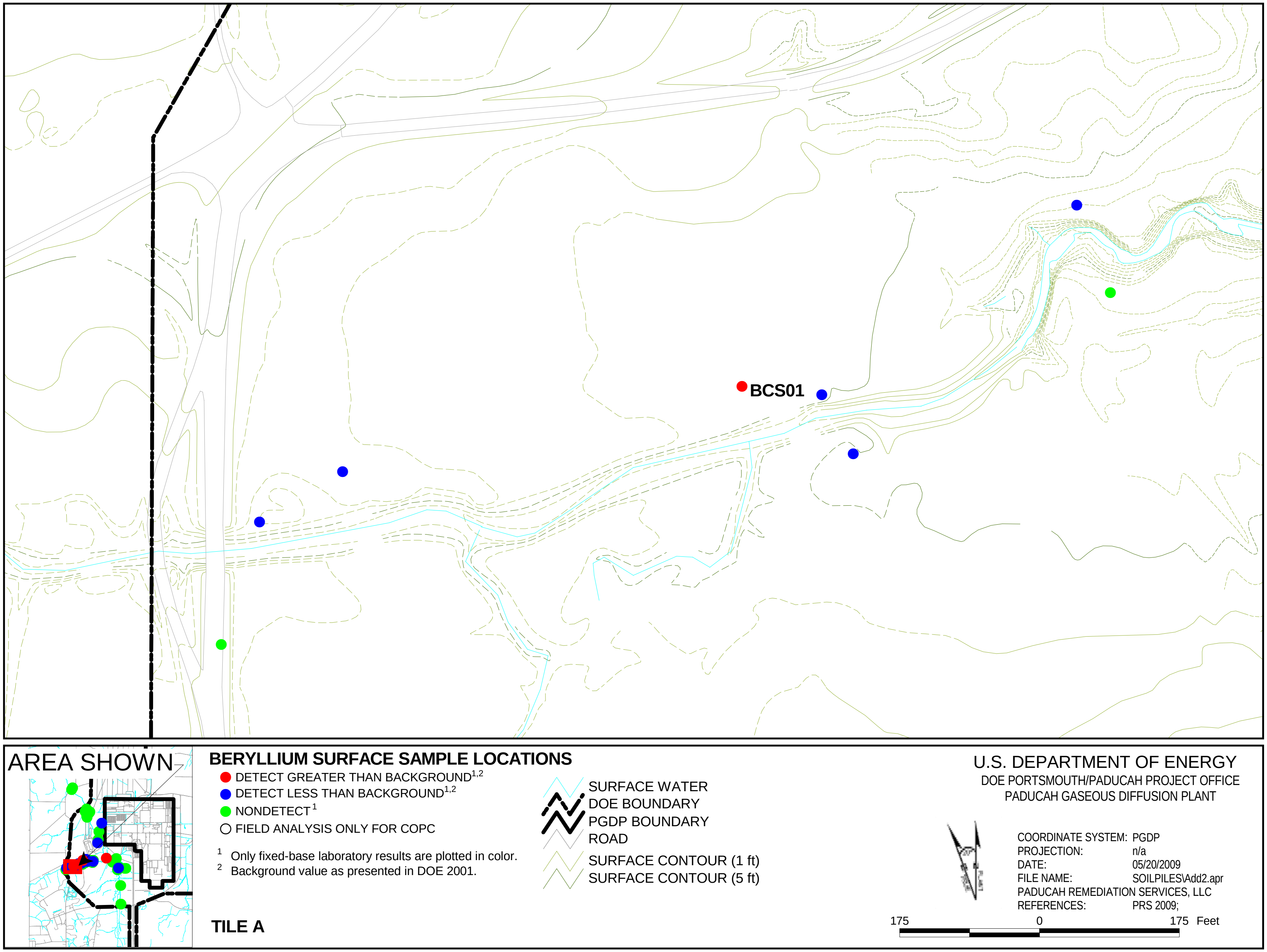
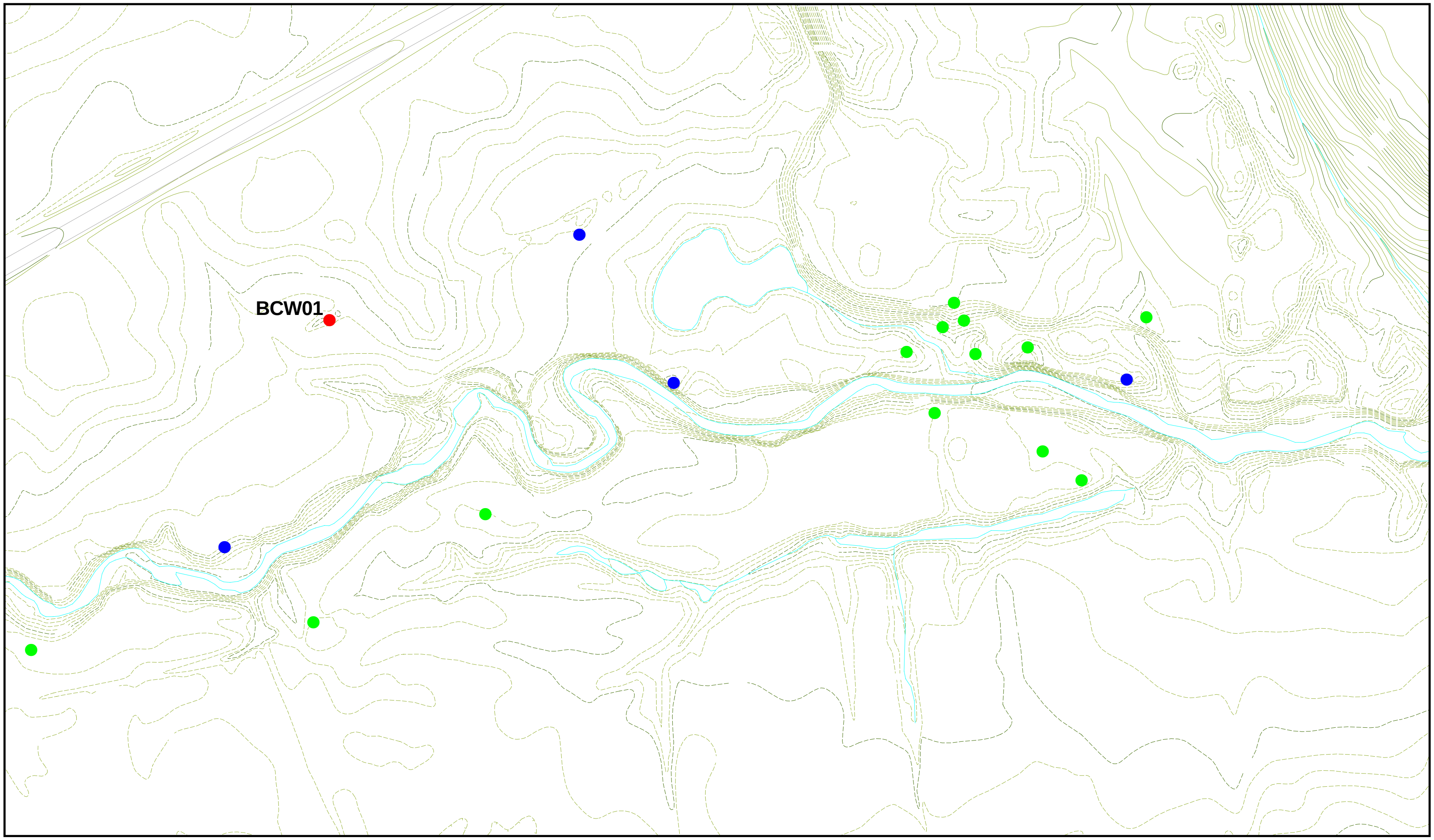
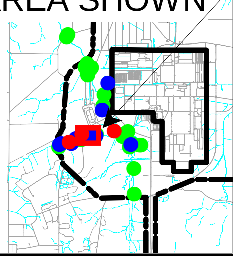


Figure B.6. (Continued)



AREA SHOWN



BERYLLIUM SURFACE SAMPLE LOCATIONS

- DETECT GREATER THAN BACKGROUND[1,2]
- DETECT LESS THAN BACKGROUND[1,2]
- NONDETECT[1]
- FIELD ANALYSIS ONLY FOR COPC

[1] Only fixed-base laboratory results are plotted in color.
[2] Background value as presented in DOE 2001.

SURFACE WATER
DOE BOUNDARY
PGDP BOUNDARY
ROAD
SURFACE CONTOUR (1 ft)
SURFACE CONTOUR (5 ft)

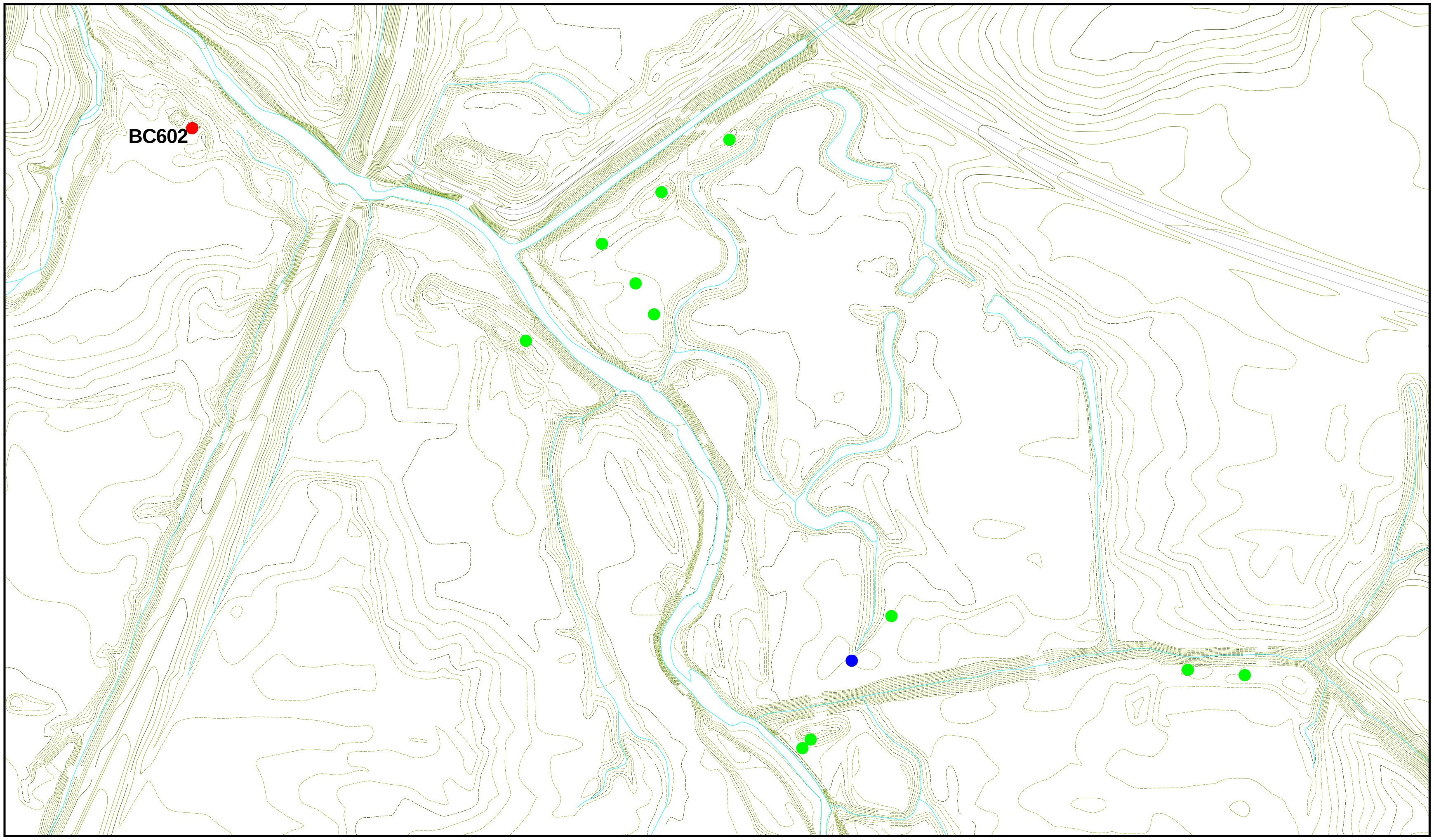
TILE B

U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

COORDINATE SYSTEM:	PGDP
PROJECTION:	n/a
DATE:	05/20/2009
FILE NAME:	SOILPILES\Add2.apr
PADUCAH REMEDIATION SERVICES, LLC	
REFERENCES:	PRS 2009;

175 0 175 Feet

Figure B.6. (Continued)



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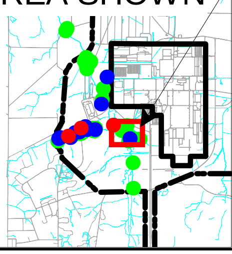

BERYLLIUM SURFACE SAMPLE LOCATIONS

- DETECT GREATER THAN BACKGROUND[1,2]
- DETECT LESS THAN BACKGROUND[1,2]
- NONDETECT[1]
- FIELD ANALYSIS ONLY FOR COPC

[1] Only fixed-base laboratory results are plotted in color.
[2] Background value as presented in DOE 2001.

SURFACE WATER
DOE BOUNDARY
PGDP BOUNDARY
ROAD
SURFACE CONTOUR (1 ft)
SURFACE CONTOUR (5 ft)

TILE C

U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

COORDINATE SYSTEM:	PGDP
PROJECTION:	n/a
DATE:	05/20/2009
FILE NAME:	SOILPILES\Add2.apr
PADUCAH REMEDIATION SERVICES, LLC	
REFERENCES:	PRS 2009;

250 0 250 Feet

Figure B.6. (Continued)

Cadmium–Surface. Cadmium values in surface soil samples exceed the background value of 0.21 mg/kg in 6 of 54 samples. The exceeding values were the only detects of cadmium in surface samples because the background value is lower than the detection limit for cadmium. Detected values in the samples range from 0.477 to 0.674 mg/kg. The criteria for applying ambient background values established by KEEC were met: (1) the mean site concentration (for detects) (0.554 mg/kg) is below the 95% UCL of the mean concentrations of KEEC background (0.78 mg/kg); (2) at least half of the data points are not detected and therefore less than the 60th percentile (0.27 mg/kg); and (3) no data points are above the upper bound value (3.9 mg/kg) (KEEC 2004). Figure B.7 graphically shows the results with the background value and other comparison values.

Figure B.8 illustrates the spatial distribution of the sampling locations in which the background value was exceeded. Although 4 of the 6 detected values are primarily located within close proximity, their values (ranging 0.477 to 0.674 mg/kg) are close to the laboratory detection limits (ranging 0.455 to 0.468 mg/kg). These values all are well below the statewide ambient background values and, as such, are not of consequence; therefore, cadmium is not present in the Addendum 2 soil piles as a contaminant in the surface.

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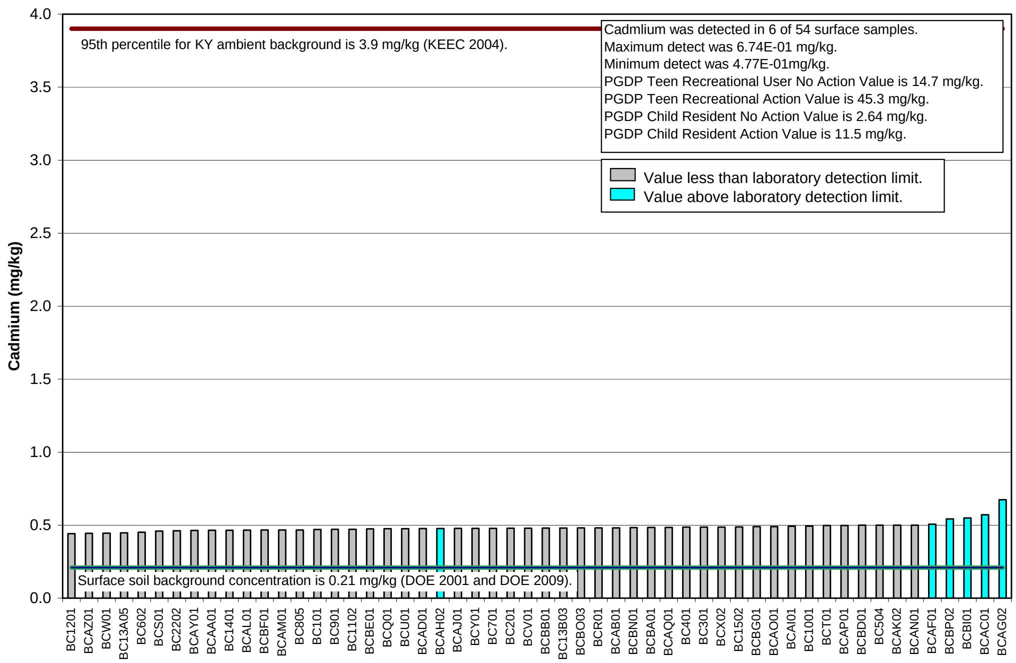

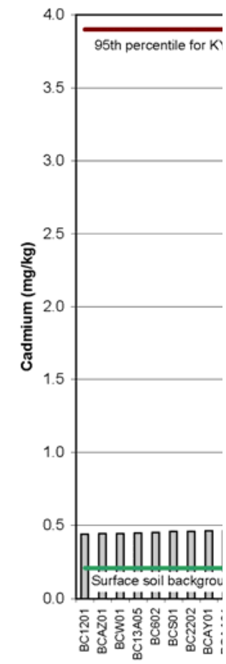

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Figure B.7. Comparison between Cadmium Concentrations in Samples from Soil Piles Addendum 2 and Surface Soil Background Concentrations

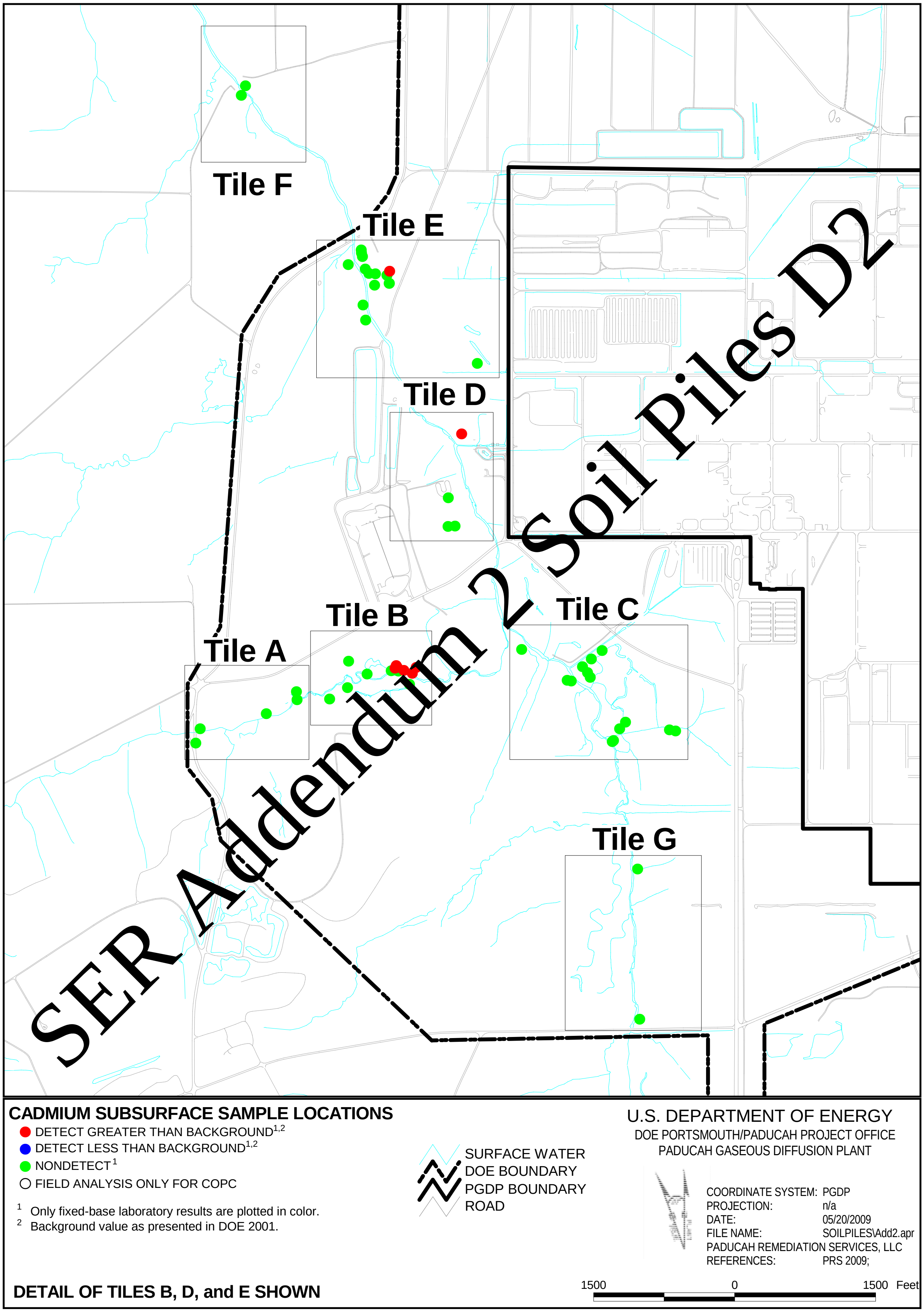


Figure B.8. Location of Sample Stations in Addendum 2 Soil Pile Sampling for Cadmium in the Surface

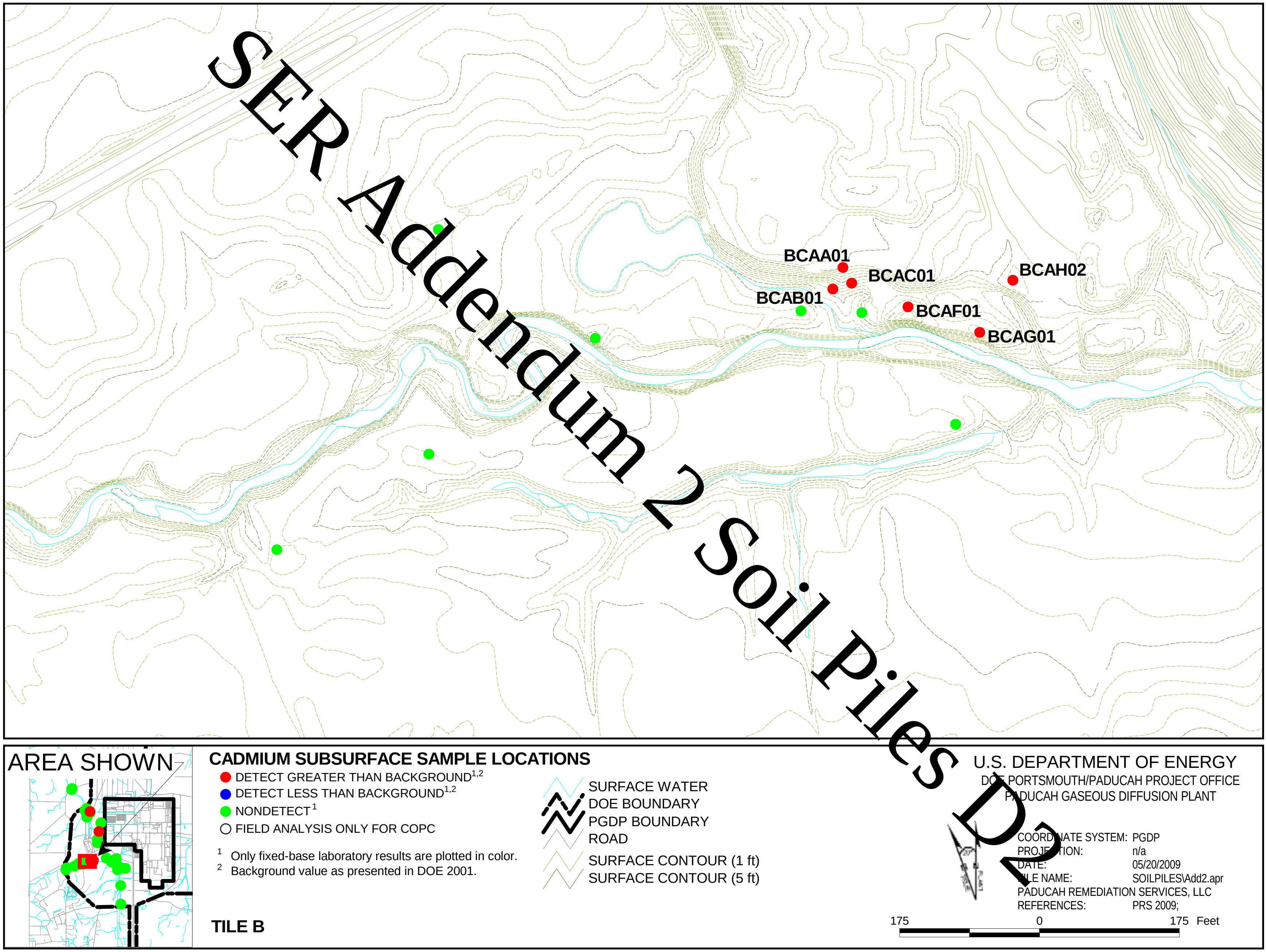
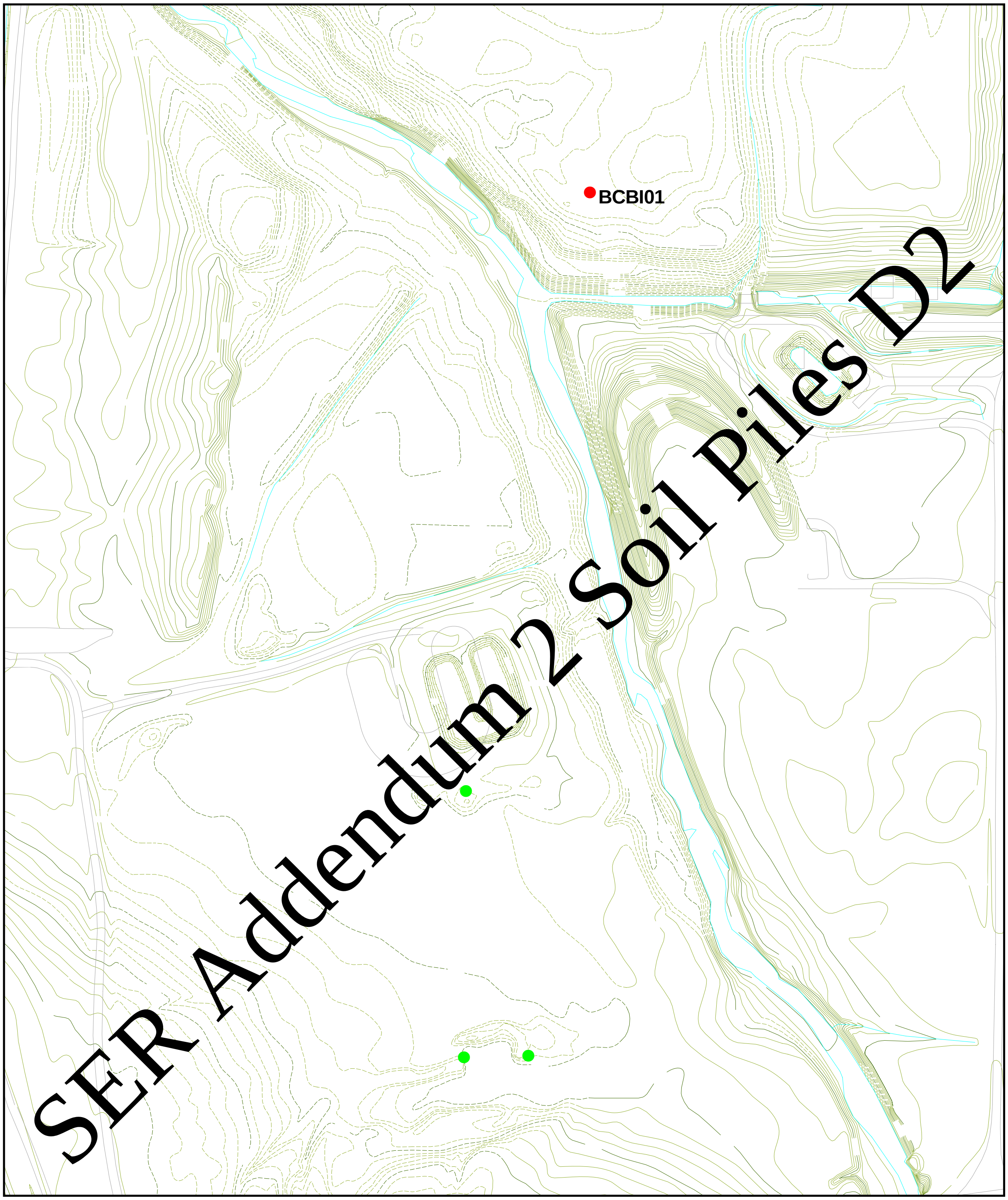


Figure B.8. (Continued)



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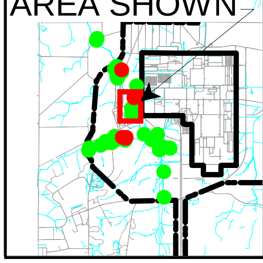


CADMIUM SUBSURFACE SAMPLE LOCATIONS

- DETECT GREATER THAN BACKGROUND [1,2]
- DETECT LESS THAN BACKGROUND [1,2]
- NONDETECT [1]
- FIELD ANALYSIS ONLY FOR COPC

SURFACE WATER
DOE BOUNDARY
PGDP BOUNDARY
ROAD

TILE D

[1] Only fixed-base laboratory results are plotted in color.

[2] Background value as presented in DOE 2001.

U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

COORDINATE SYSTEM:	PGDP
PROJECTION:	n/a
DATE:	05/20/2009
FILE NAME:	SOILPILES\Add2.apr
PADUCAH REMEDIATION SERVICES, LLC	
REFERENCES:	PRS 2009;

175 0 175 Feet

Figure B.8. (Continued)

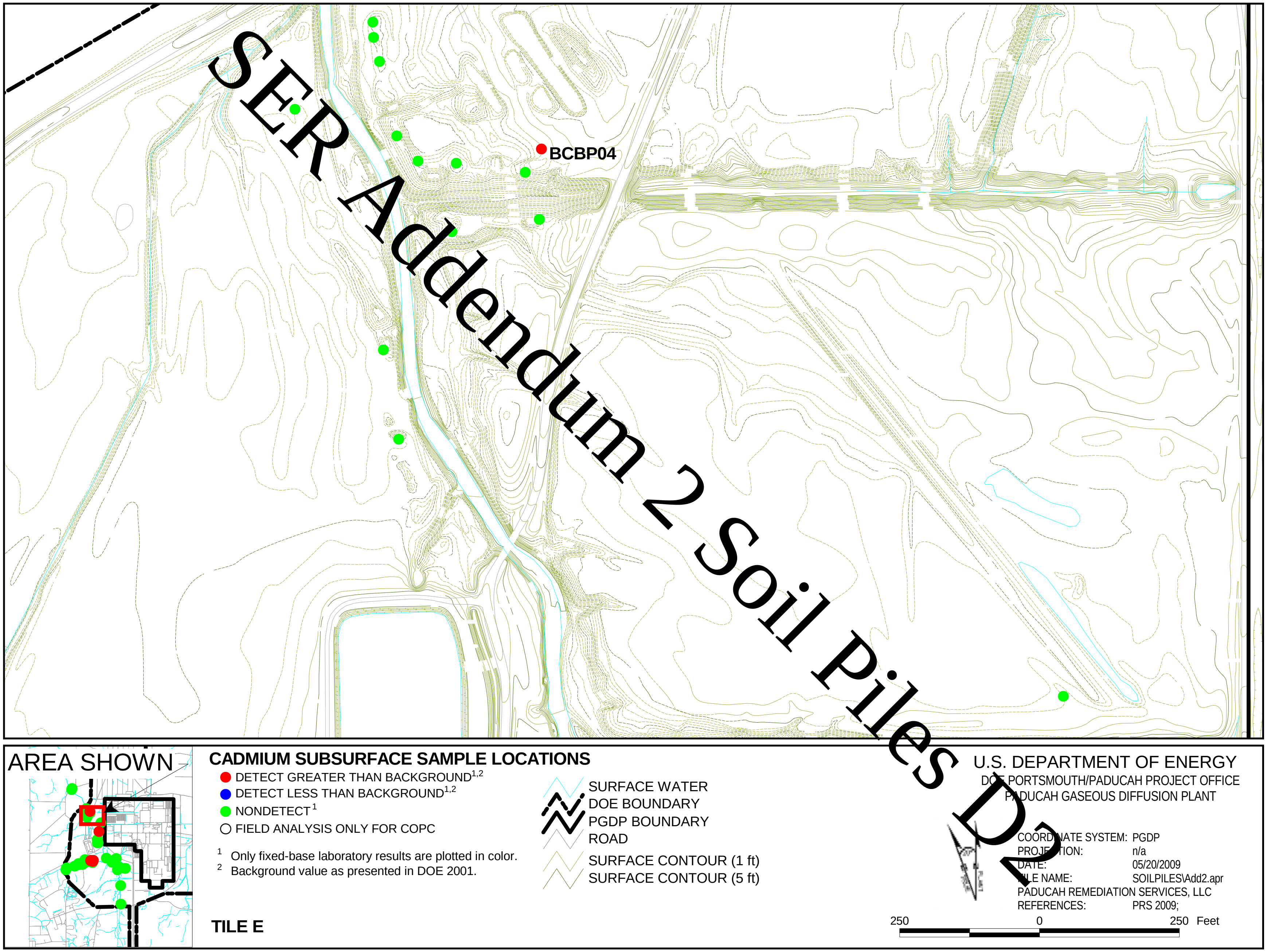


Figure B.8. (Continued)

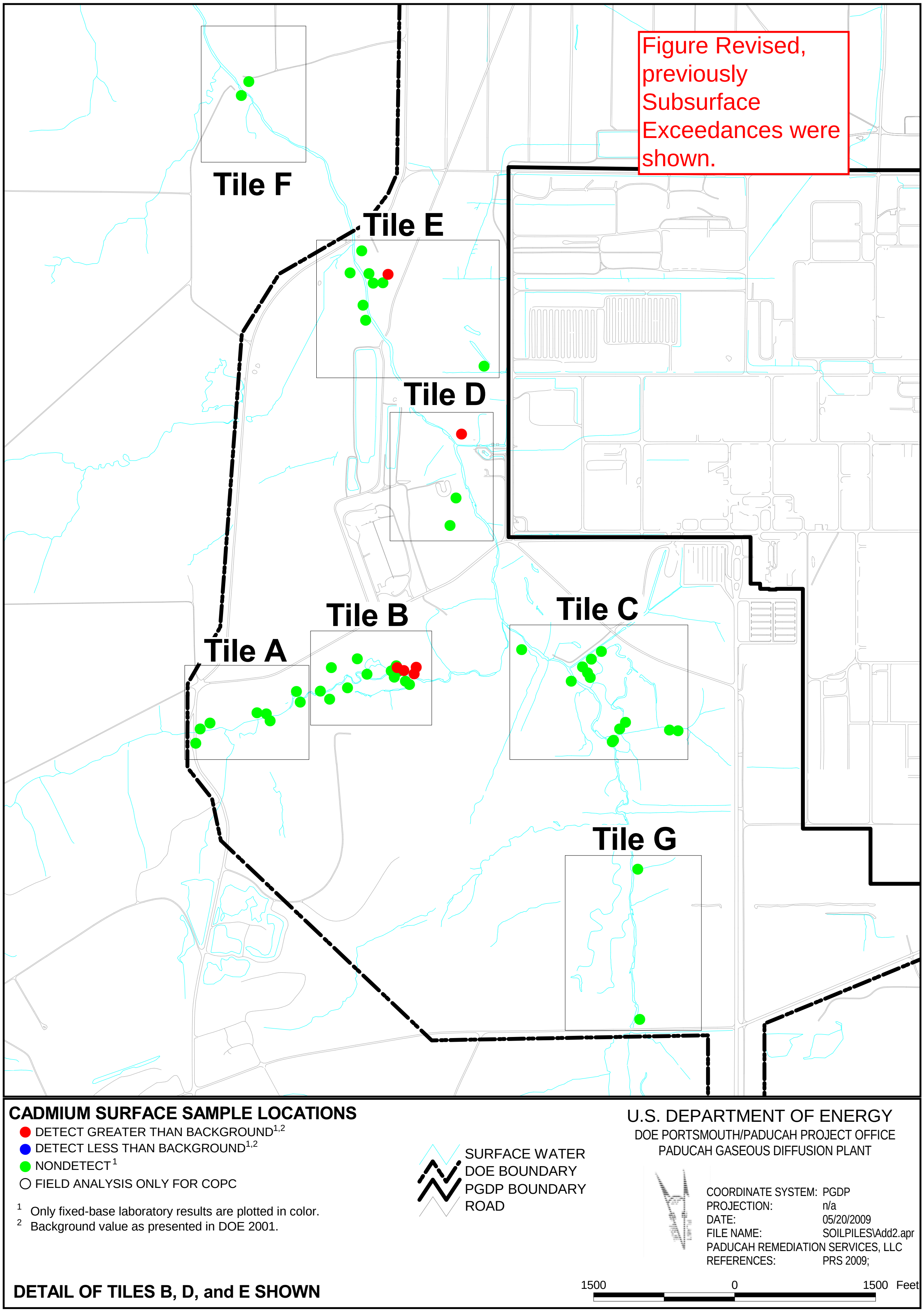


Figure B.8. Location of Sample Stations in Addendum 2 Soil Pile Sampling for Cadmium in the Surface

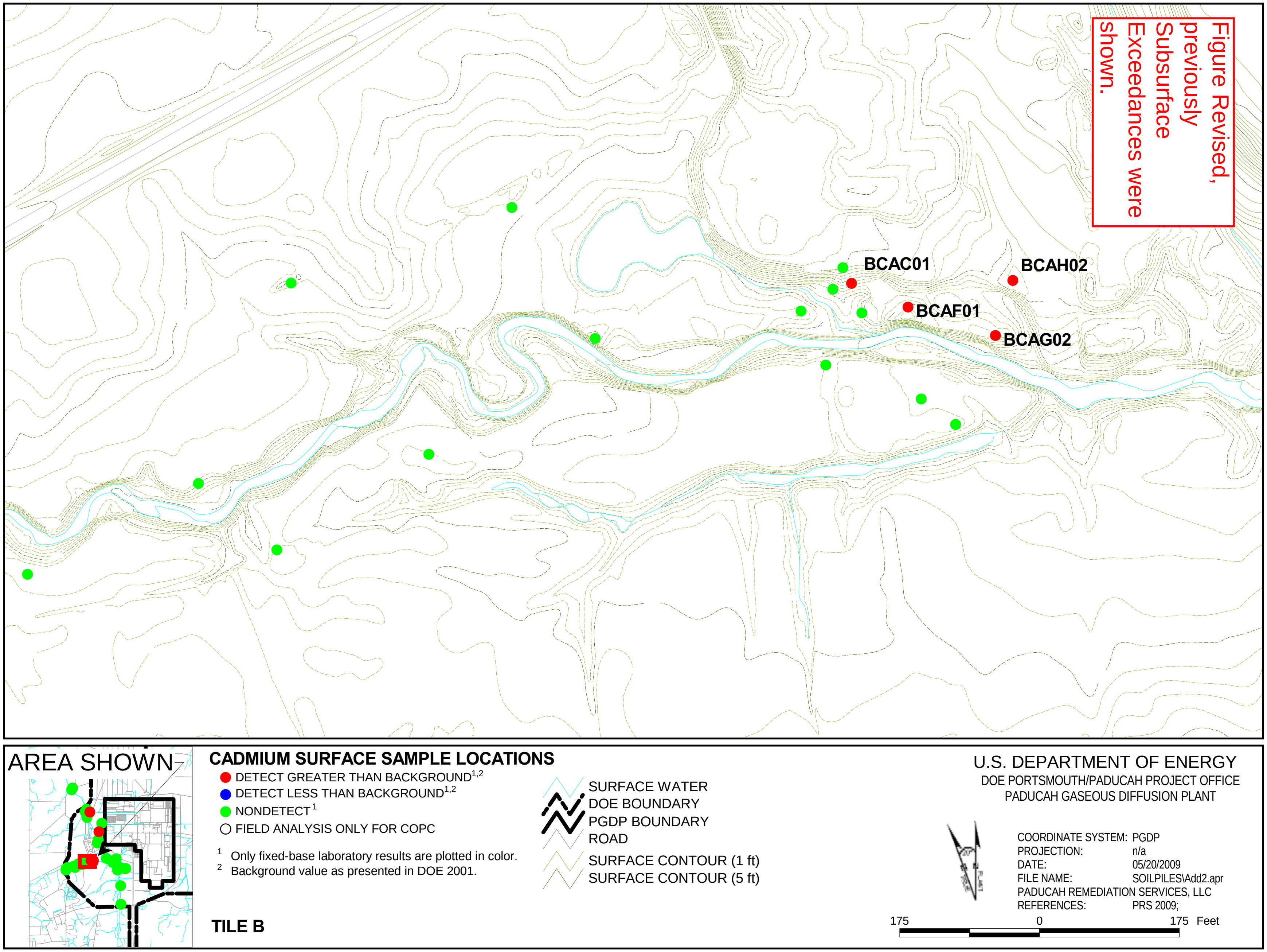


Figure B.8. (Continued)

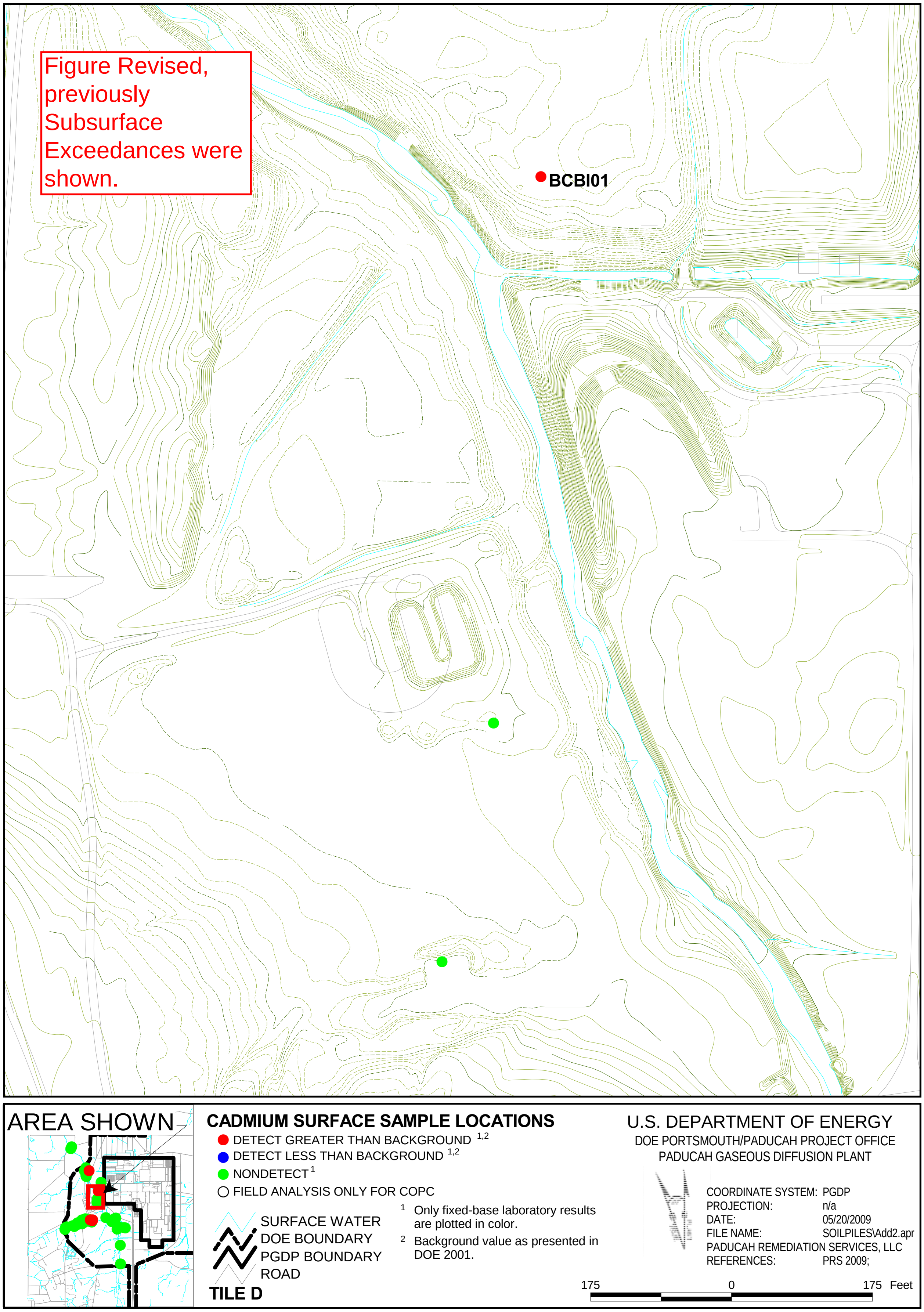
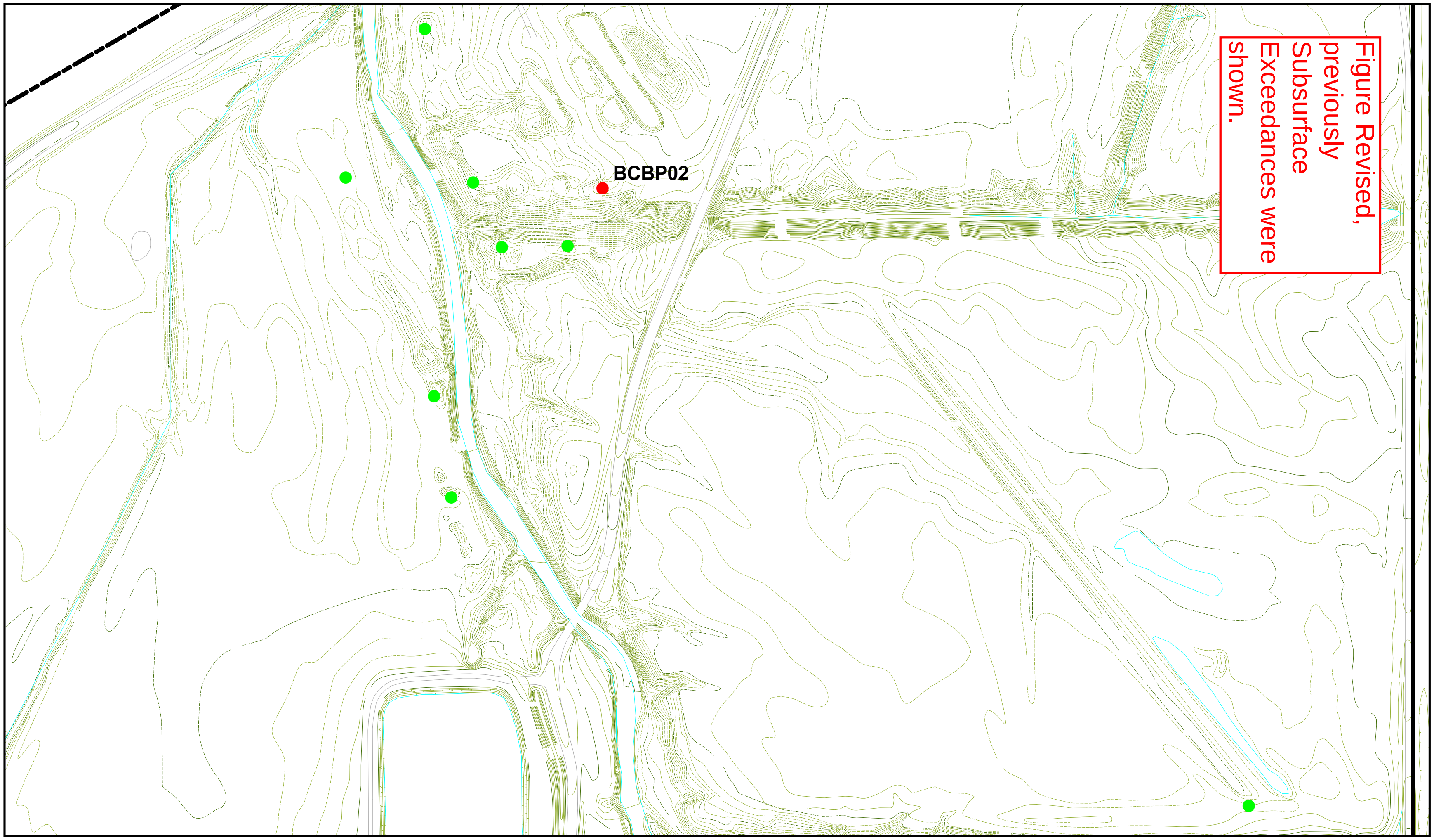


Figure B.8. (Continued)



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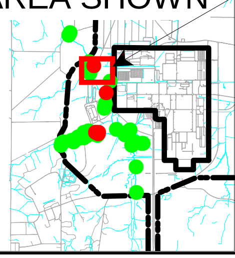

CADMIUM SURFACE SAMPLE LOCATIONS

- DETECT GREATER THAN BACKGROUND[1,2]
- DETECT LESS THAN BACKGROUND[1,2]
- NONDETECT[1]
- FIELD ANALYSIS ONLY FOR COPC

[1] Only fixed-base laboratory results are plotted in color.
[2] Background value as presented in DOE 2001.

SURFACE WATER
DOE BOUNDARY
PGDP BOUNDARY
ROAD
SURFACE CONTOUR (1 ft)
SURFACE CONTOUR (5 ft)

TILE E

U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

COORDINATE SYSTEM:	PGDP
PROJECTION:	n/a
DATE:	05/20/2009
FILE NAME:	SOILPILES\Add2.apr
PADUCAH REMEDIATION SERVICES, LLC	
REFERENCES:	PRS 2009;

250 0 250 Feet

Figure B.8. (Continued)

Cadmium–Subsurface. Cadmium values in subsurface soil samples exceed the background value of 0.21 mg/kg in 8 of 56 samples. The exceeding values were the only detects of cadmium in the subsurface because the background value is lower than the detection limit for cadmium. Detected values in the samples range from 0.466 to 0.655 mg/kg. The criteria for applying ambient background values established by KEEC were met: (1) the mean site concentration (for detects) (0.543 mg/kg) is below the 95% UCL of the mean concentrations of KEEC background (0.78 mg/kg); (2) at least half of the data points are not detected and, therefore, less than the 60th percentile (0.27 mg/kg); and (3) no data points are above the upper bound value (3.9 mg/kg) (KEEC 2004). Figure B.9 graphically shows the results with the background value and other comparison values.

Figure B.10 illustrates the spatial distribution of the sampling locations in which the background value was exceeded. Although 6 of the 8 detected values are primarily located within close proximity, their values (ranging 0.466 to 0.609 mg/kg) are close to the laboratory detection limits (ranging 0.439 to 0.499 mg/kg). These values are all well below the statewide ambient background values and, as such, are not of consequence; therefore, cadmium is not present in the Addendum 2 soil piles as a contaminant in the subsurface.

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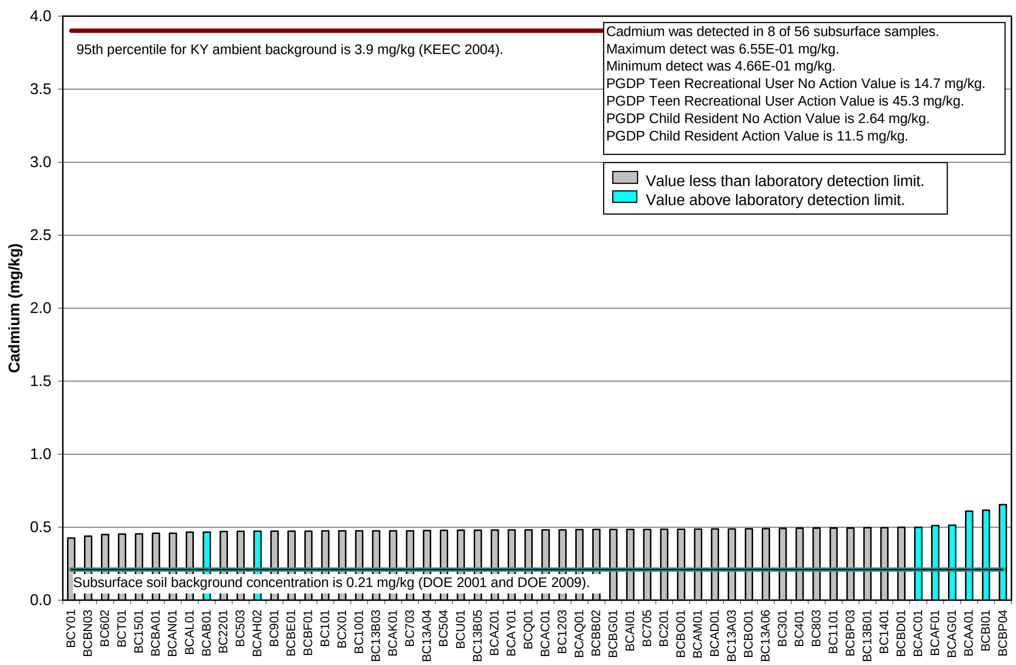
Deleted: Although detected values are primarily located within close proximity, their values are well below the statewide ambient background values and as such, are not of consequence; therefore, cadmium is not present in the Addendum 2 soil piles as a contaminant in the subsurface.¶
¶



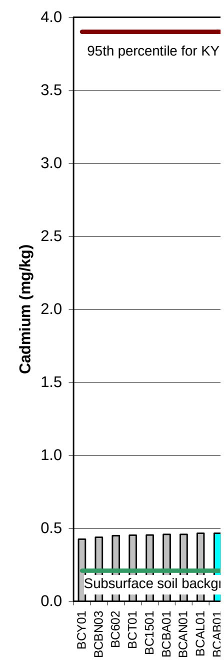


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Figure B.9. Comparison between Cadmium Concentrations in Samples from Soil Piles Addendum 2 and Subsurface Soil Background Concentrations

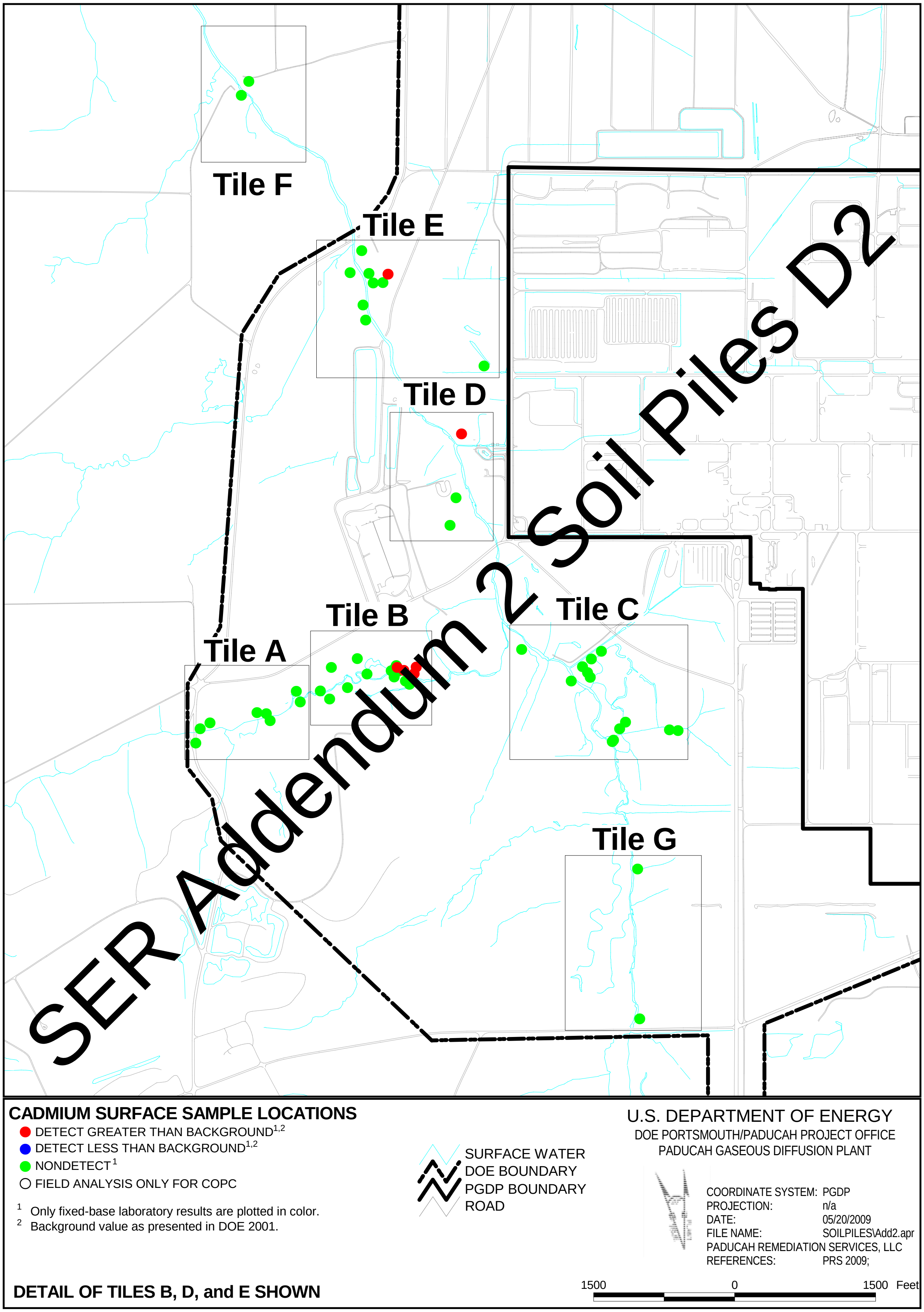
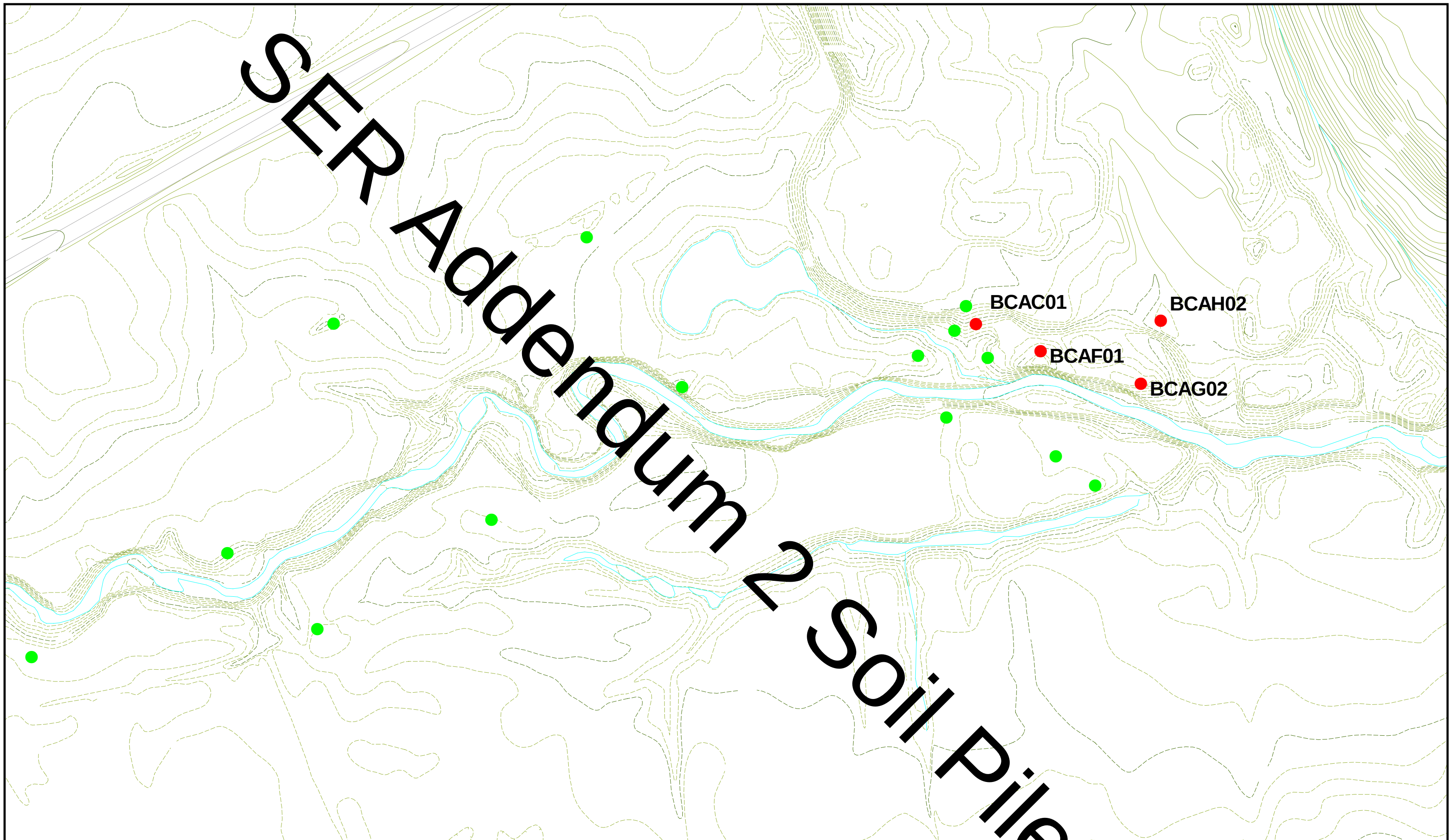


Figure B.10. Location of Sample Stations in Addendum 2 Soil Pile Sampling for Cadmium in the Subsurface



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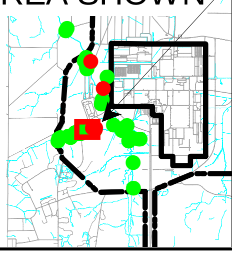


CADMIUM SURFACE SAMPLE LOCATIONS

- DETECT GREATER THAN BACKGROUND[1,2]
- DETECT LESS THAN BACKGROUND[1,2]
- NONDETECT[1]
- FIELD ANALYSIS ONLY FOR COPC

1 Only fixed-base laboratory results are plotted in color.
2 Background value as presented in DOE 2001.

SURFACE WATER
DOE BOUNDARY
PGDP BOUNDARY
ROAD
SURFACE CONTOUR (1 ft)
SURFACE CONTOUR (5 ft)

TILE B

U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

COORDINATE SYSTEM: PGDP
PROJECTION: n/a
DATE: 05/20/2009
FILE NAME: SOILPILES\Add2.apr
PADUCAH REMEDIATION SERVICES, LLC
REFERENCES: PRS 2009;

175 0 175 Feet

Figure B.10. (Continued)

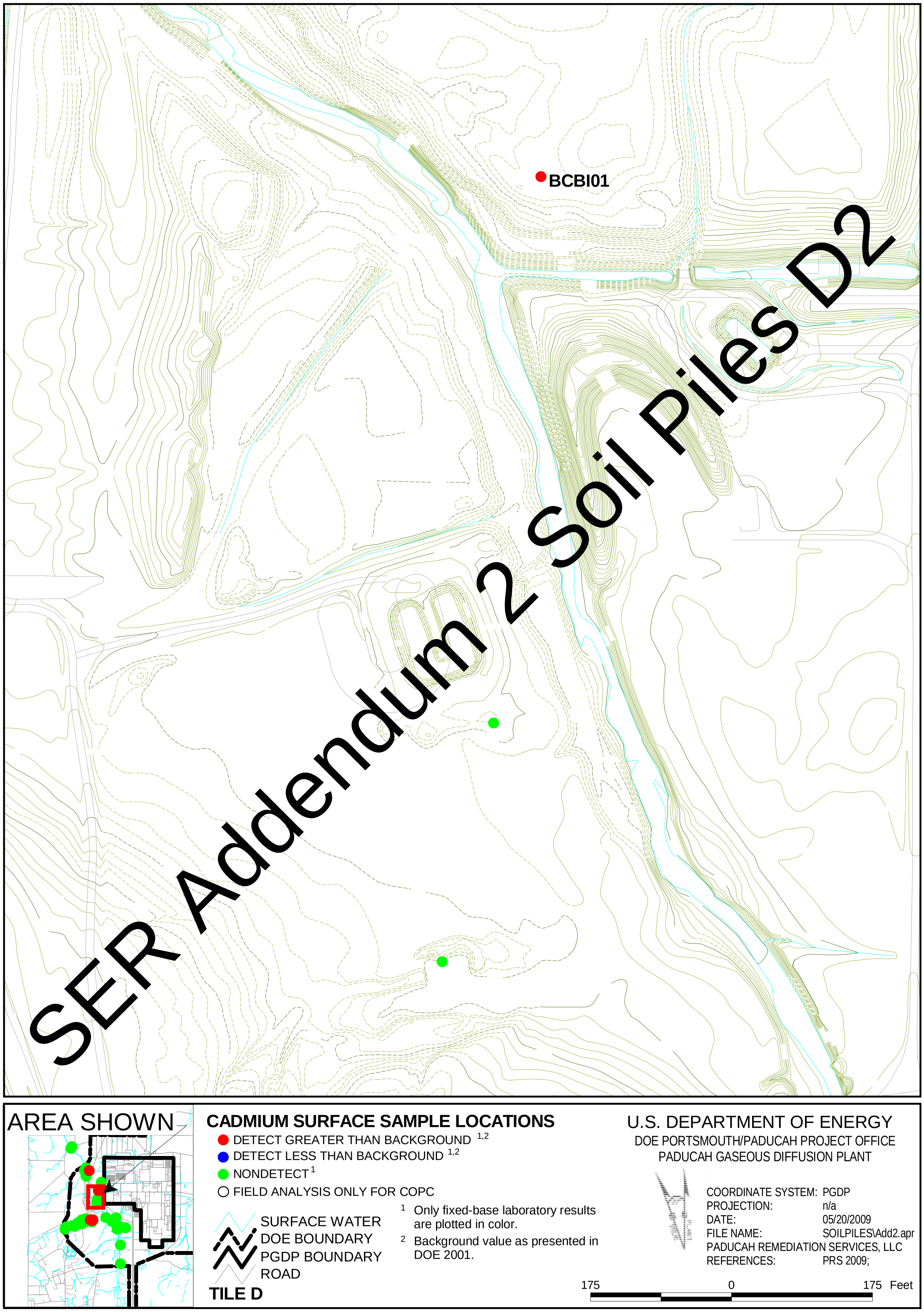
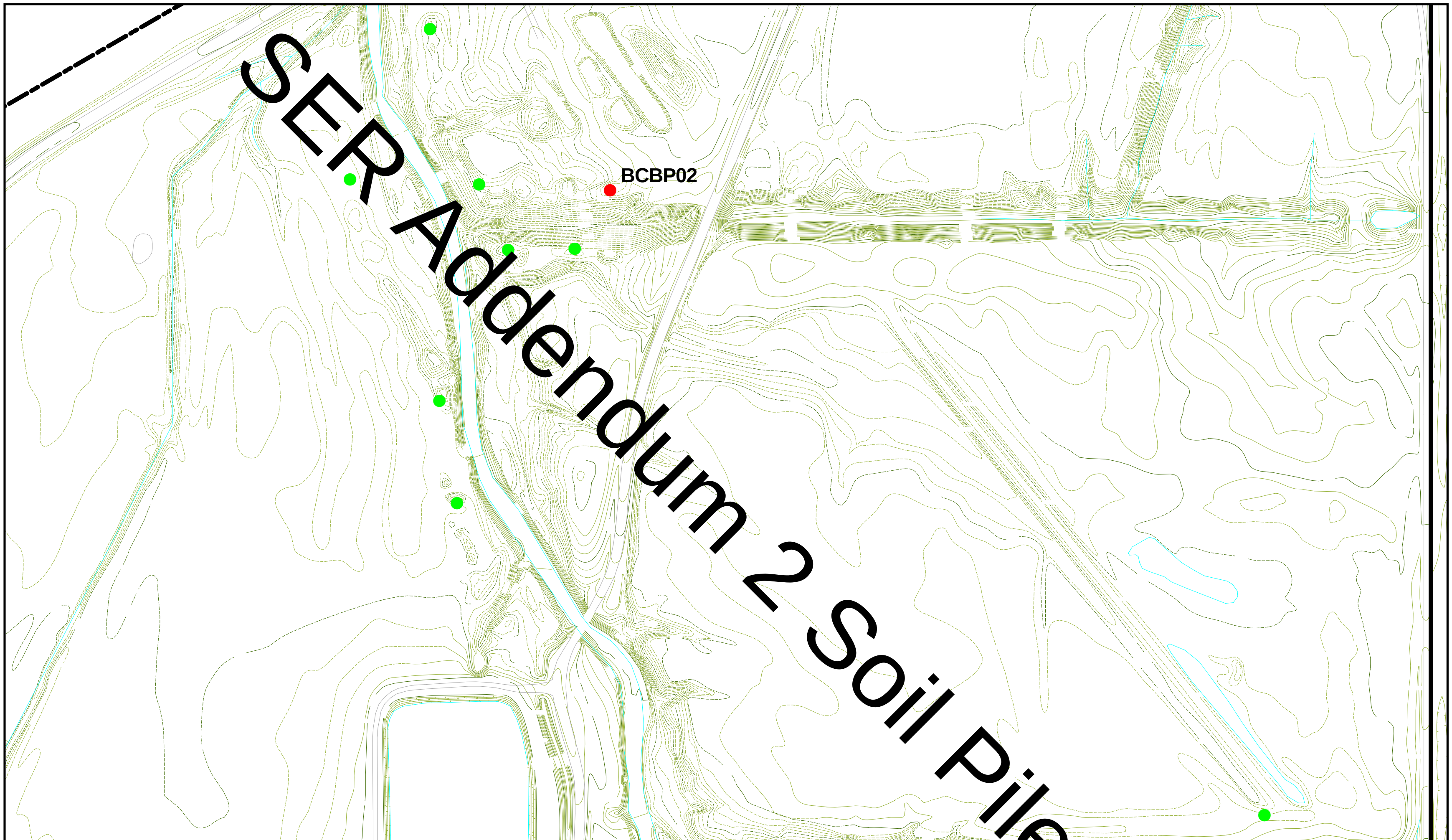


Figure B.10. (Continued)



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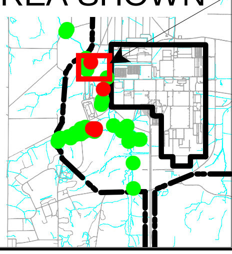


CADMIUM SUBSURFACE SAMPLE LOCATIONS

- DETECT GREATER THAN BACKGROUND[1,2]
- DETECT LESS THAN BACKGROUND[1,2]
- NONDETECT[1]
- FIELD ANALYSIS ONLY FOR COPC

[1] Only fixed-base laboratory results are plotted in color.
[2] Background value as presented in DOE 2001.

SURFACE WATER
DOE BOUNDARY
PGDP BOUNDARY
ROAD
SURFACE CONTOUR (1 ft)
SURFACE CONTOUR (5 ft)

TILE E

U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

COORDINATE SYSTEM: PGDP
PROJECTION: n/a
DATE: 05/20/2009
FILE NAME: SOILPILES\Add2.apr
PADUCAH REMEDIATION SERVICES, LLC
REFERENCES: PRS 2009;

250 0 250 Feet

Figure B.10. (Continued)

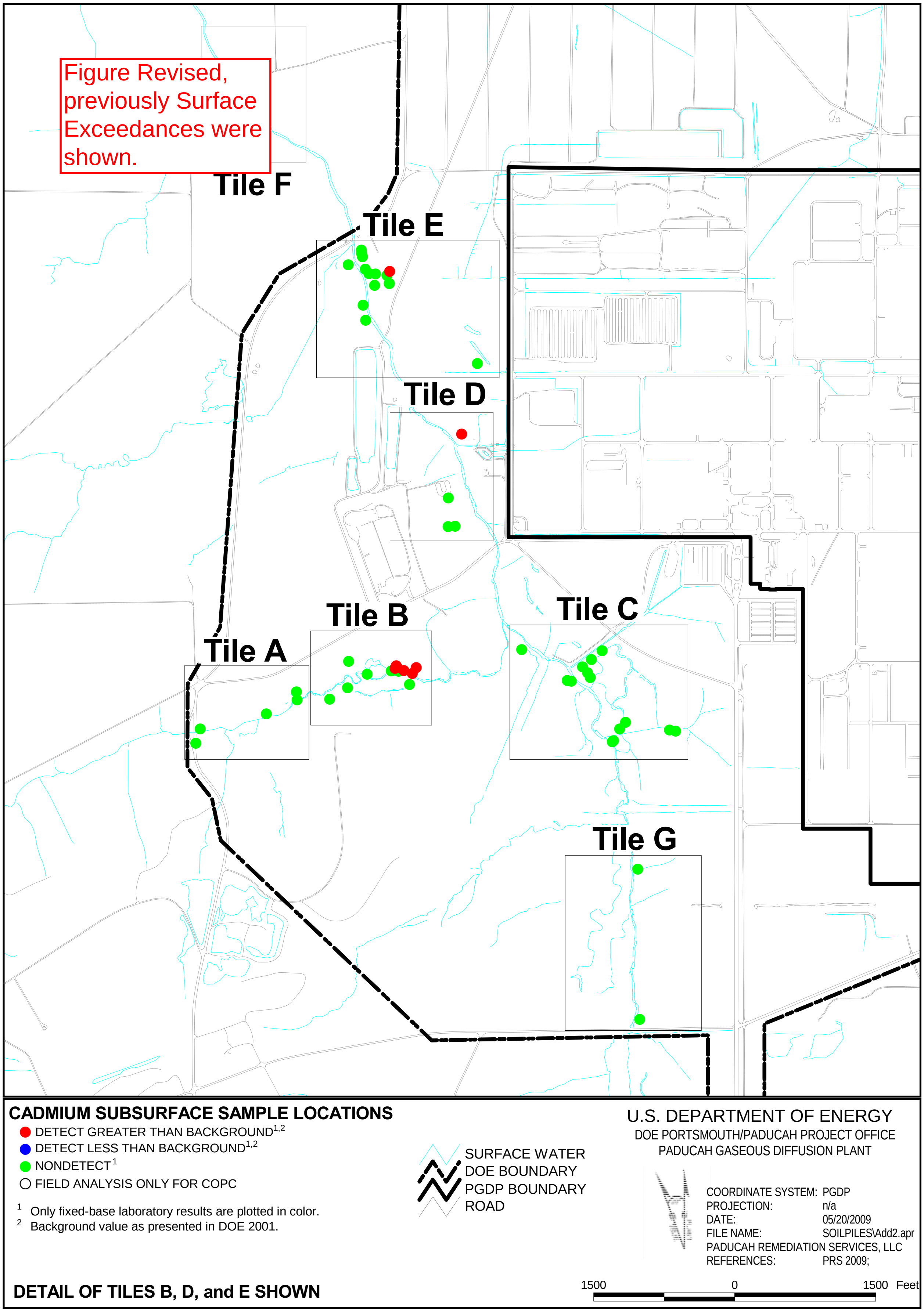


Figure B.10. Location of Sample Stations in Addendum 2 Soil Pile Sampling for Cadmium in the Subsurface

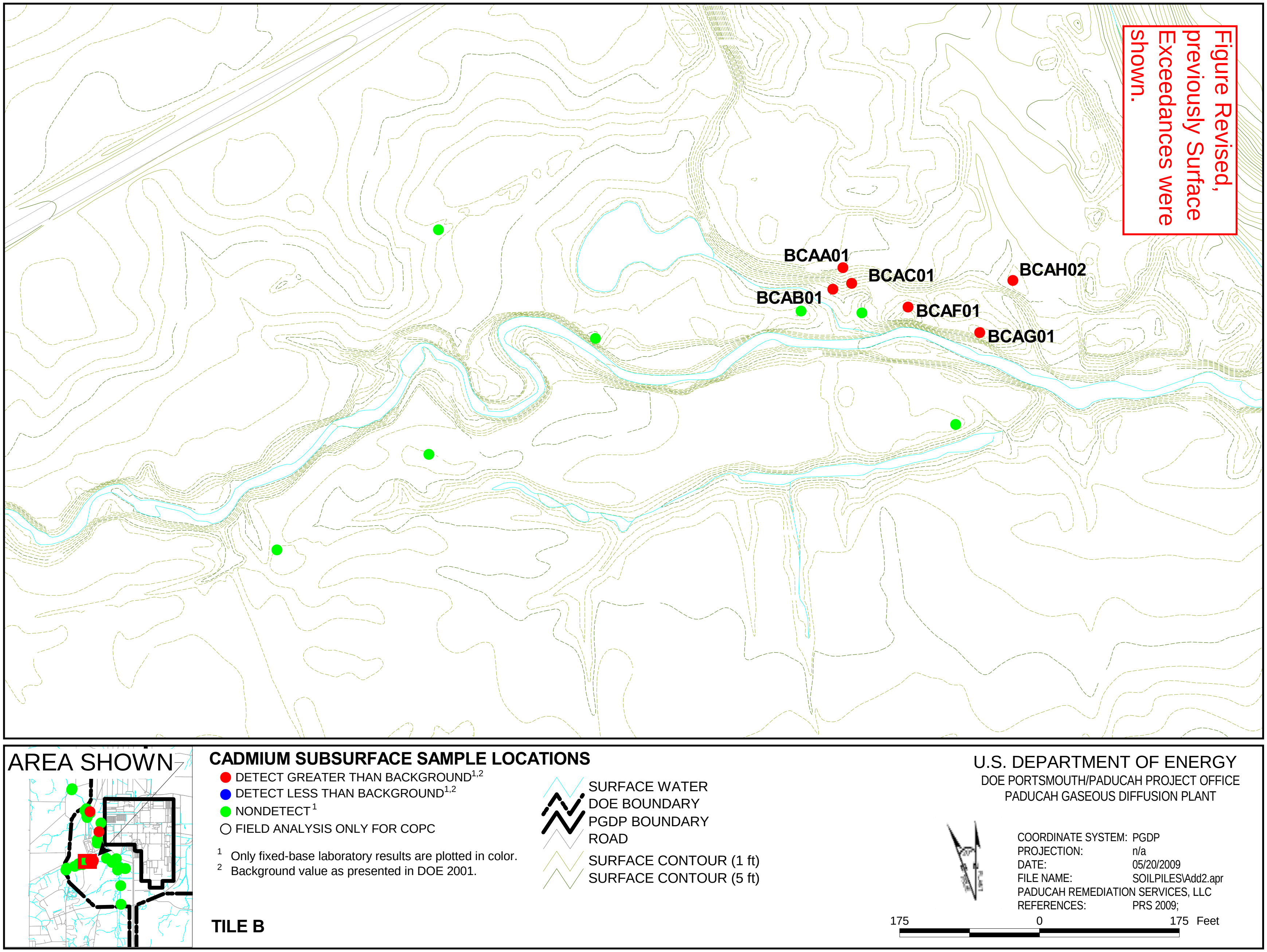


Figure B.10. (Continued)

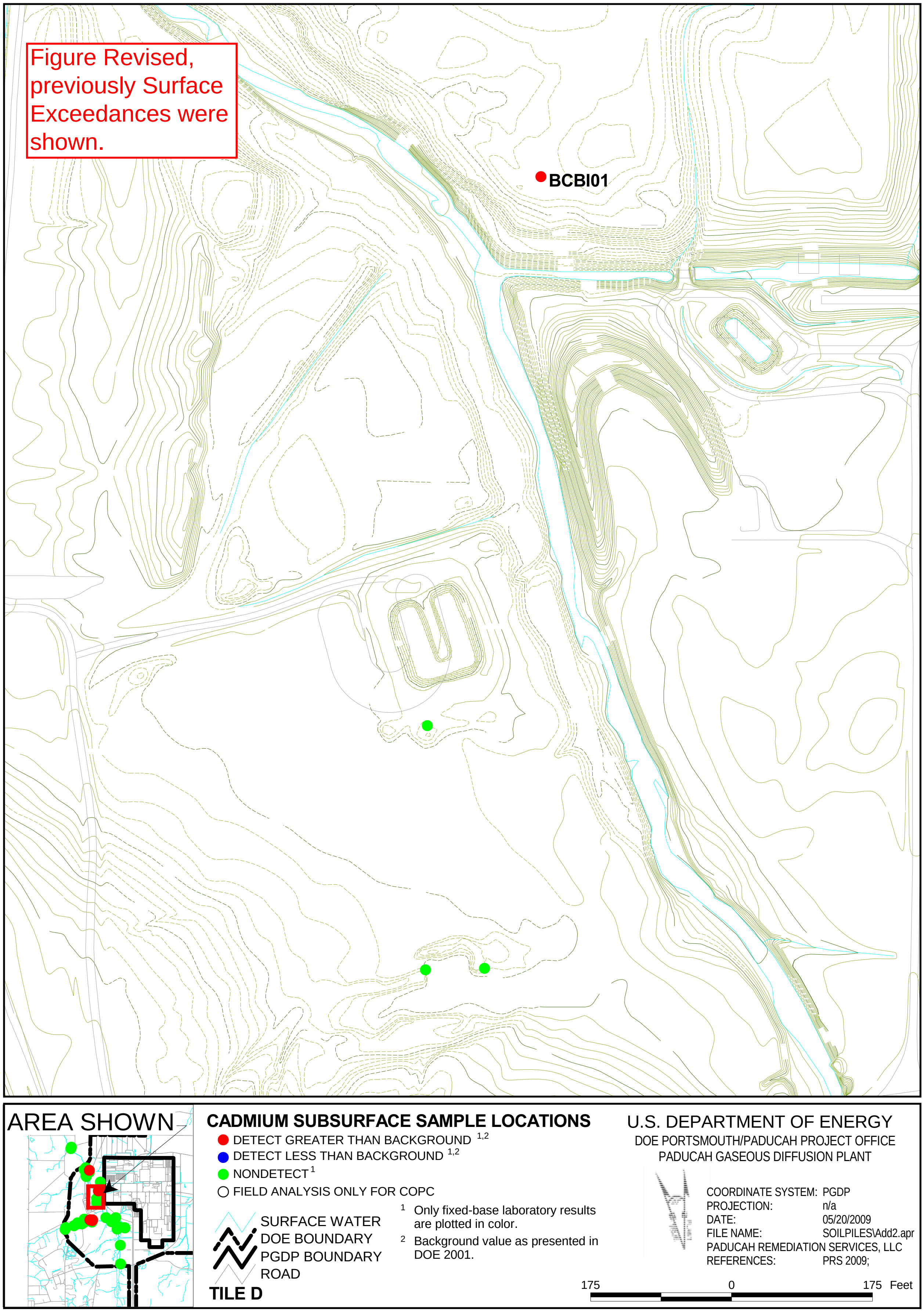


Figure B.10. (Continued)

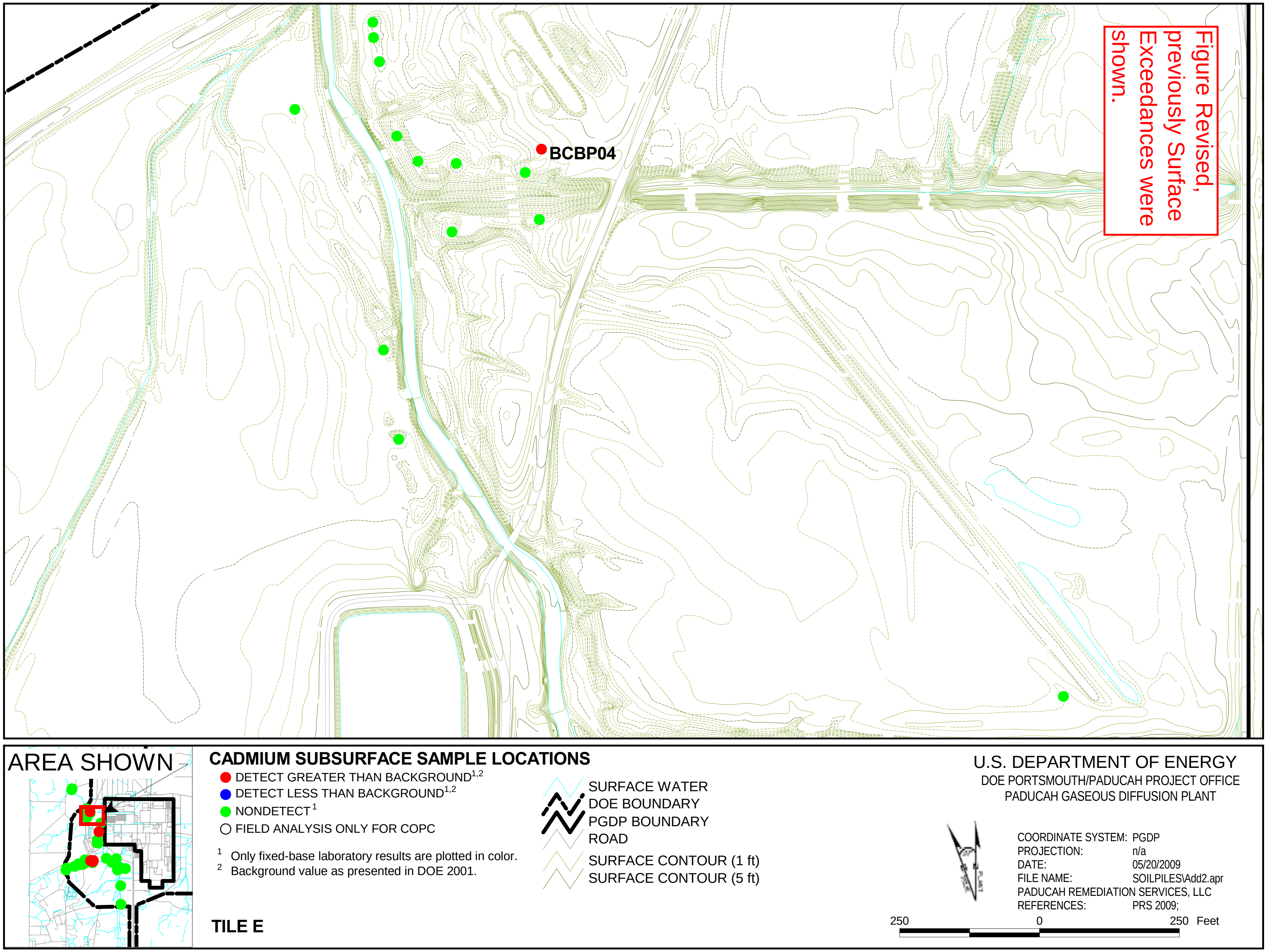
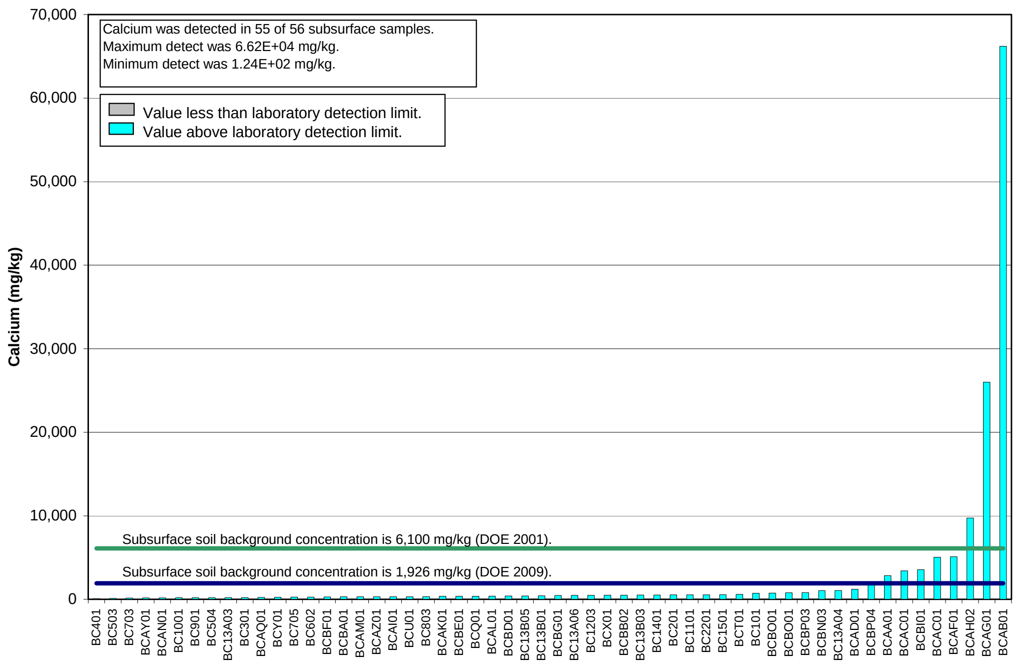


Figure B.10. (Continued)

Calcium–Subsurface. Calcium values in subsurface soil samples exceed the background value of 6,100 mg/kg in 3 of 56 samples. The three exceeding values are 9,750; 26,000; and 66,200 mg/kg. The locations from which the exceeding samples were collected are from the same area; however, several other samples were collected near these three locations that did not exceed background. Calcium is not listed with a generic statewide ambient background value, nor does the chemical have risk-based action and no-action levels because calcium is an essential element (DOE 2001); therefore, though calcium is present in the Addendum 2 soil piles above background, it is not considered a contaminant.

Figure B.11 graphically shows the results with the background value and other comparison values. Figure B.12 illustrates the spatial distribution of the sampling locations in which the background value was exceeded.



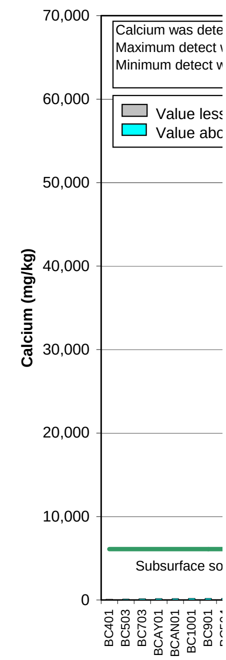


Figure B.11. Comparison between Calcium Concentrations in Samples from Soil Piles Addendum 2 and Subsurface Soil Background Concentrations

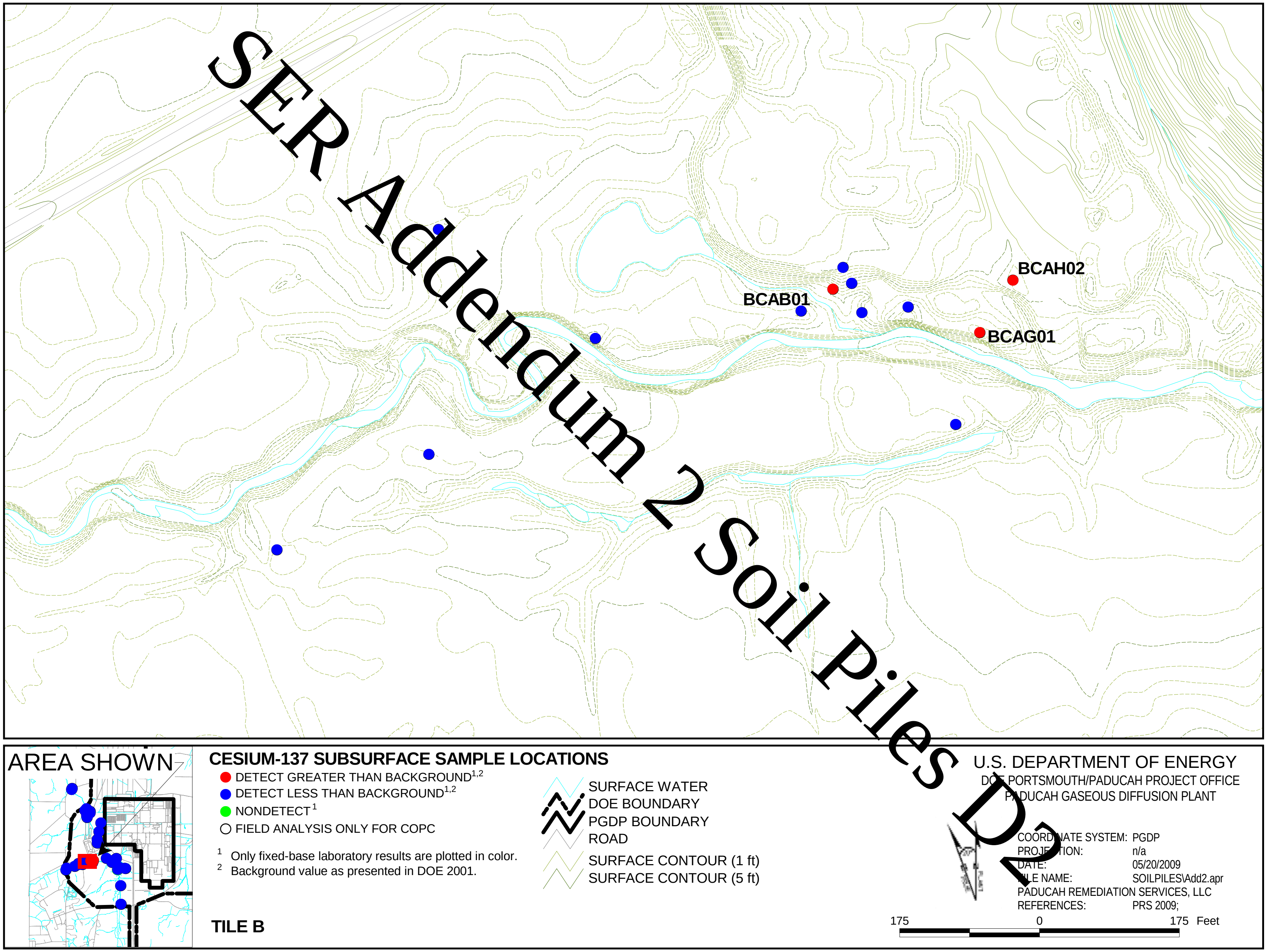


Figure B.12. (Continued)

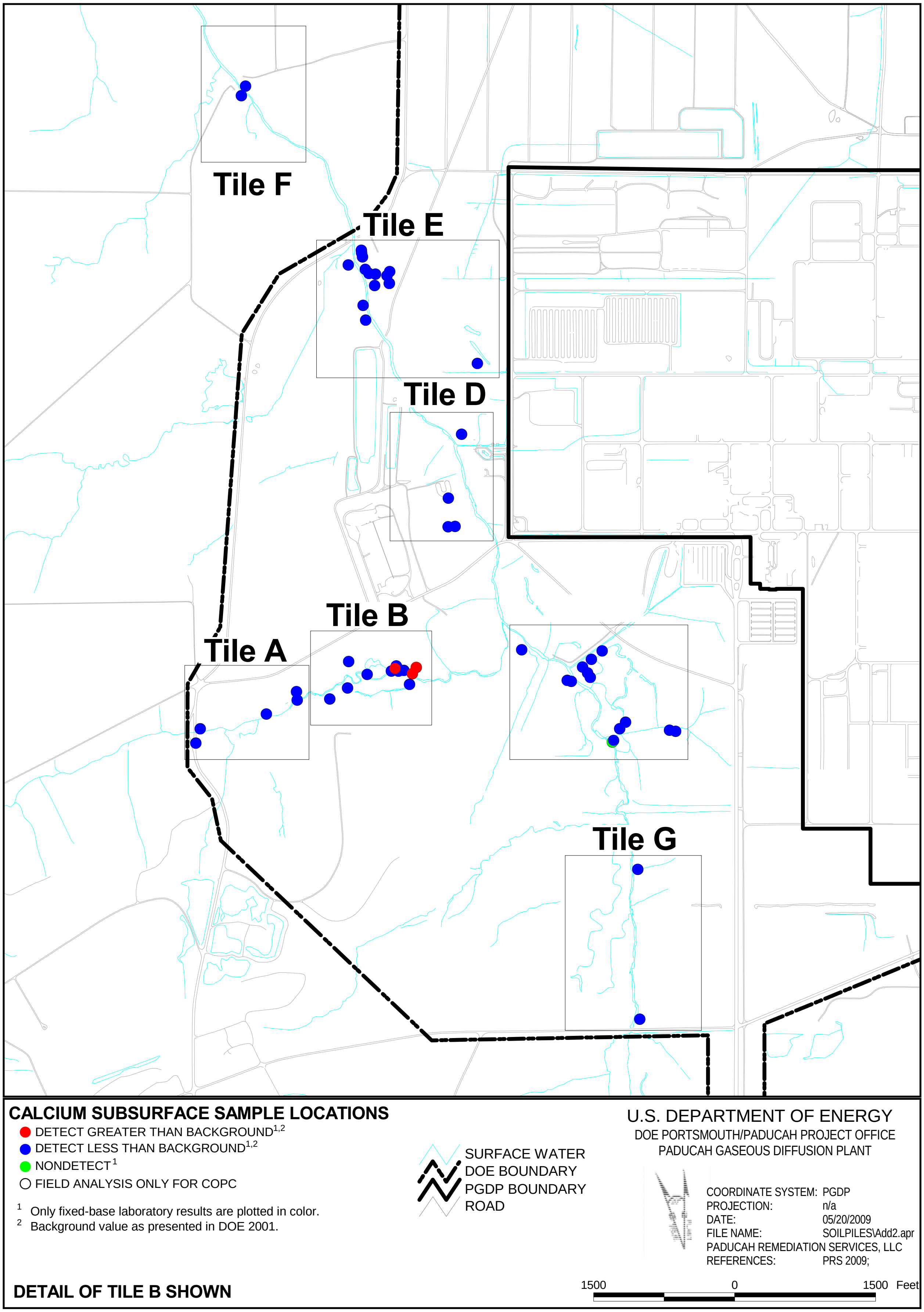


Figure B.12. Location of Sample Stations in Addendum 2 Soil Pile Sampling for Calcium in the Subsurface

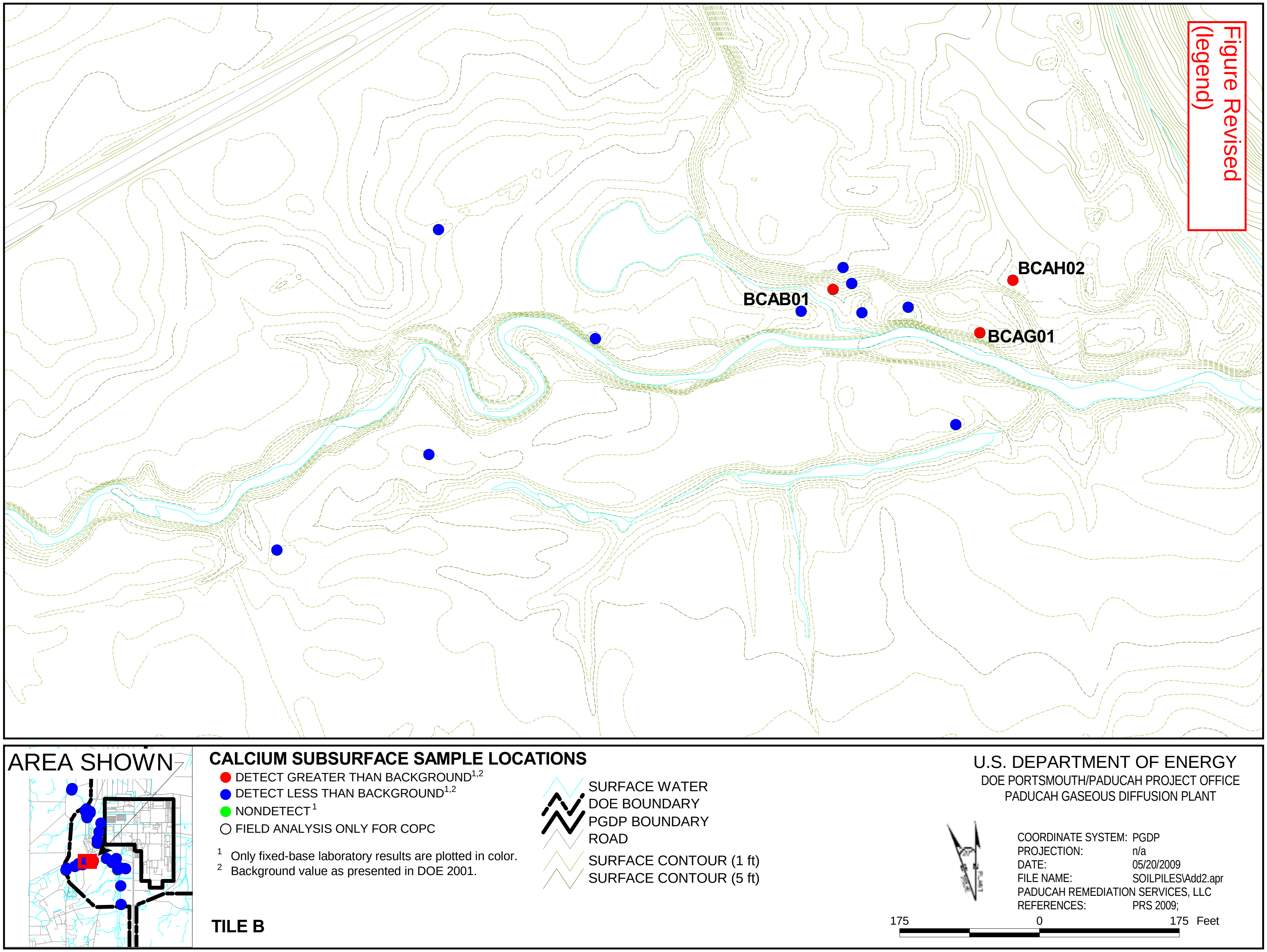


Figure B.12. (Continued)

Chromium–Surface. Chromium values in surface soil samples exceed the background value of 16 mg/kg in 5 of 54 samples. The samples exceeding background ranged from 16.7 to 29.7 mg/kg. Only 1 of the 54 samples exceeded the revised background value of 25 mg/kg established by the revised Risk Methods Document (DOE 2009). The criteria for applying ambient background values established by KEEC were met: (1) the mean site concentration (11.8 mg/kg) is below the 95% UCL of the mean concentrations of KEEC background (21.3 mg/kg); (2) at least half of the data points are less than the 60th percentile (19.3 mg/kg); and (3) no data points are above the upper bound value (40 mg/kg) (KEEC 2004); therefore, chromium is not present in the Addendum 2 soil piles as a contaminant in the surface. Figure B.13 graphically shows the results with the background value and other comparison values.

Figure B.14 illustrates the spatial distribution of the sampling locations in which the background value was exceeded.

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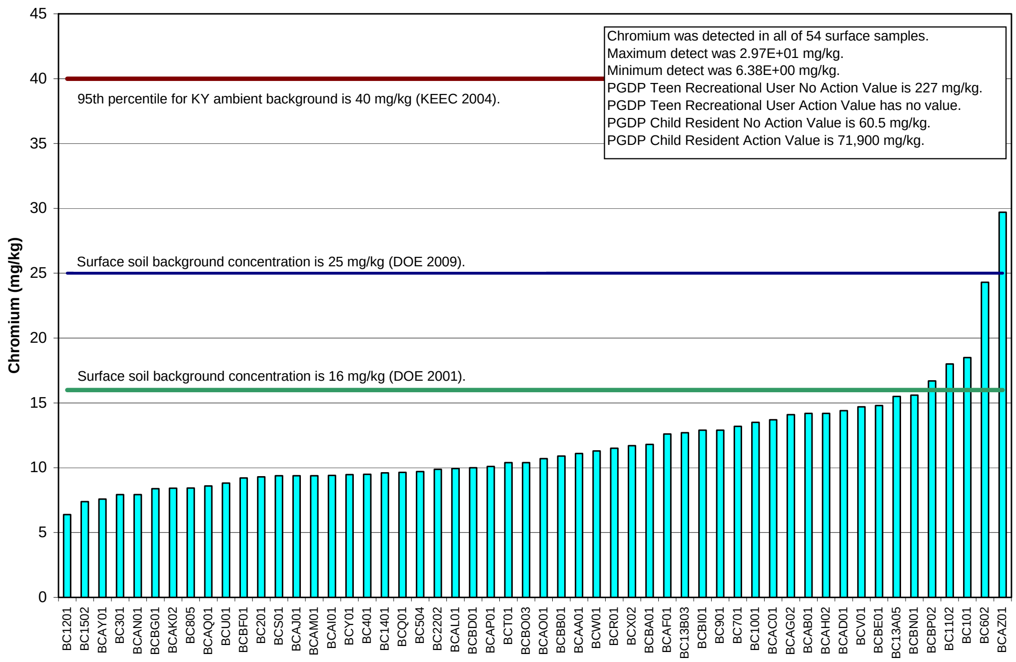

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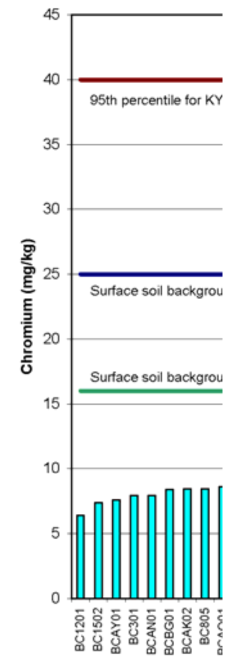


Figure B.13. Comparison between Chromium Concentrations in Samples from Soil Piles Addendum 2 and Surface Soil Background Concentrations

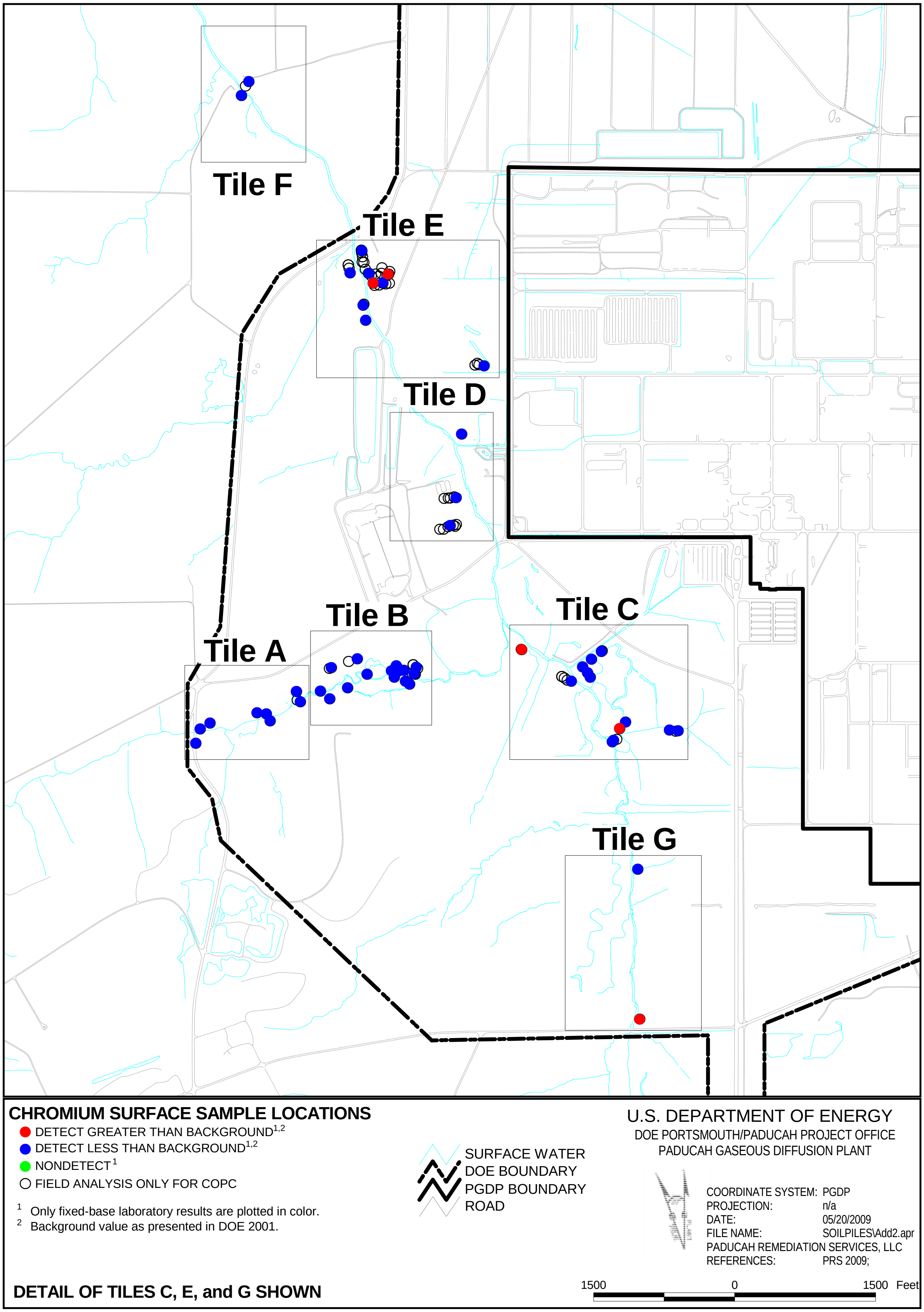
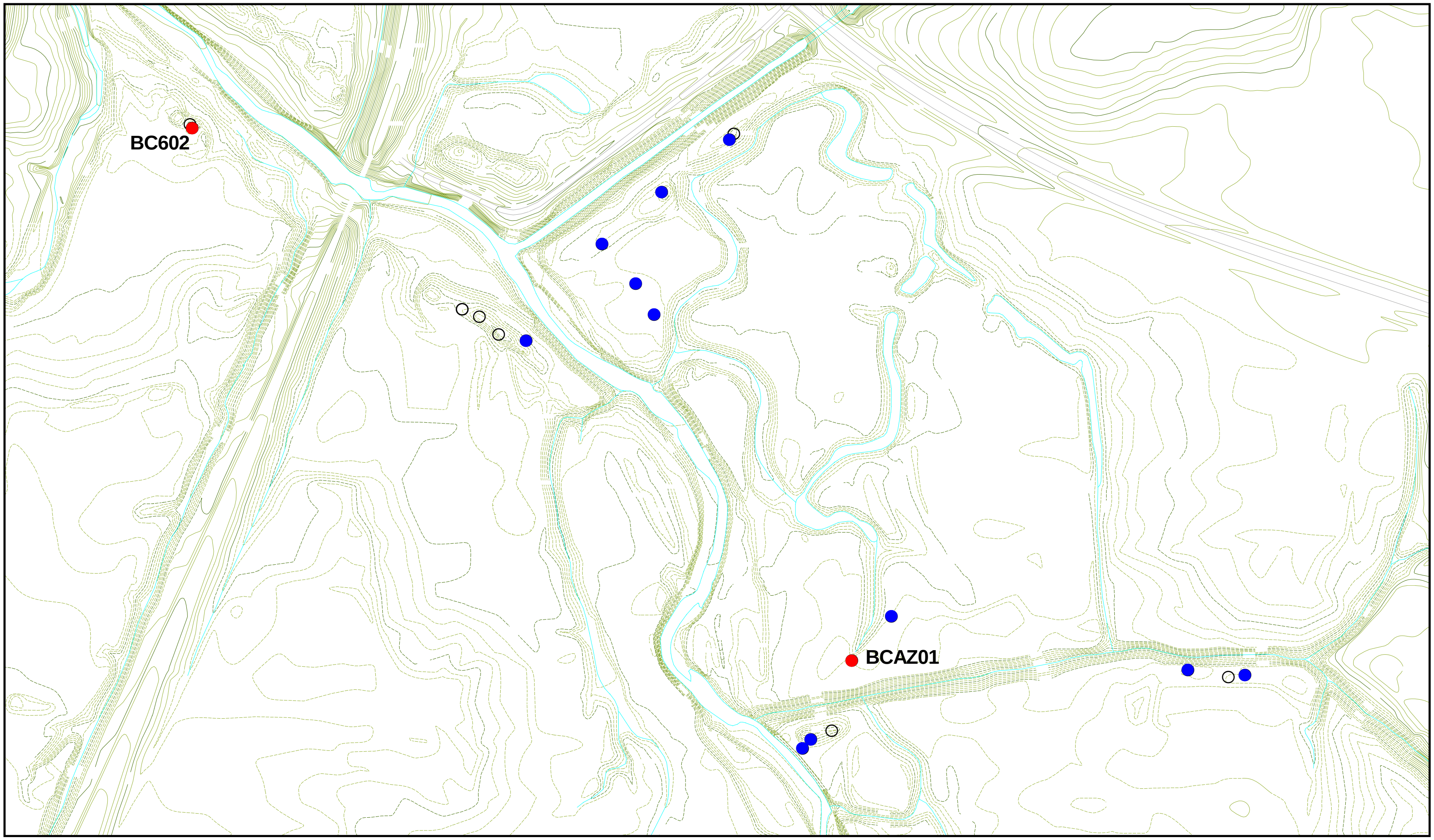
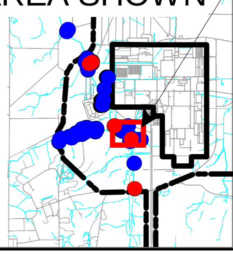


Figure B.14. Location of Sample Stations in Addendum 2 Soil Pile Sampling for Chromium in the Surface



AREA SHOWN



CHROMIUM SURFACE SAMPLE LOCATIONS

- DETECT GREATER THAN BACKGROUND[1,2]
- DETECT LESS THAN BACKGROUND[1,2]
- NONDETECT[1]
- FIELD ANALYSIS ONLY FOR COPC

[1] Only fixed-base laboratory results are plotted in color.
[2] Background value as presented in DOE 2001.

- SURFACE WATER
- DOE BOUNDARY
- PGDP BOUNDARY
- ROAD
- SURFACE CONTOUR (1 ft)
- SURFACE CONTOUR (5 ft)

TILE C

U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

COORDINATE SYSTEM:	PGDP
PROJECTION:	n/a
DATE:	05/20/2009
FILE NAME:	SOILPILES\Add2.apr
PADUCAH REMEDIATION SERVICES, LLC	
REFERENCES:	PRS 2009;

250 0 250 Feet

Figure B.14. (Continued)

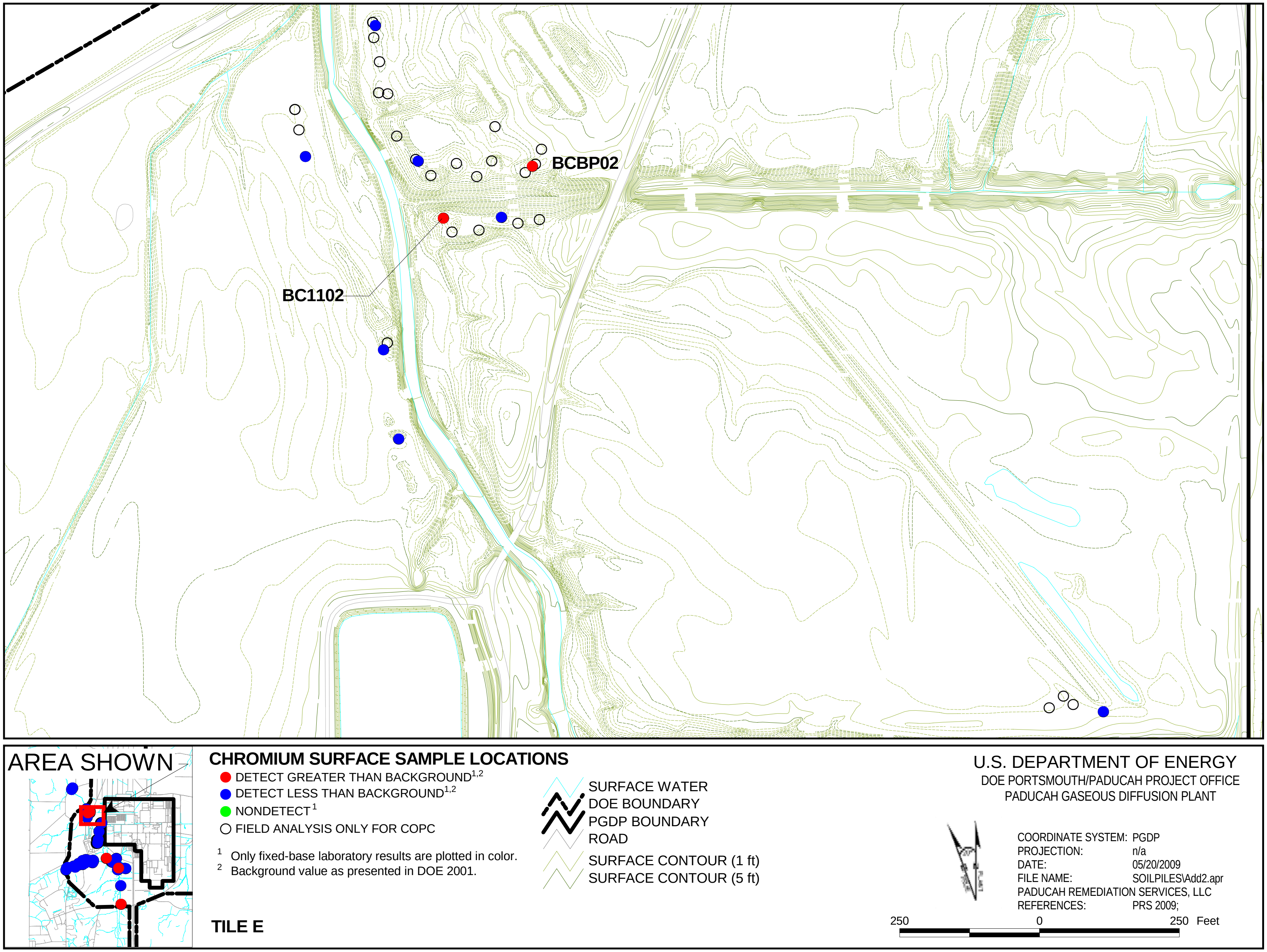
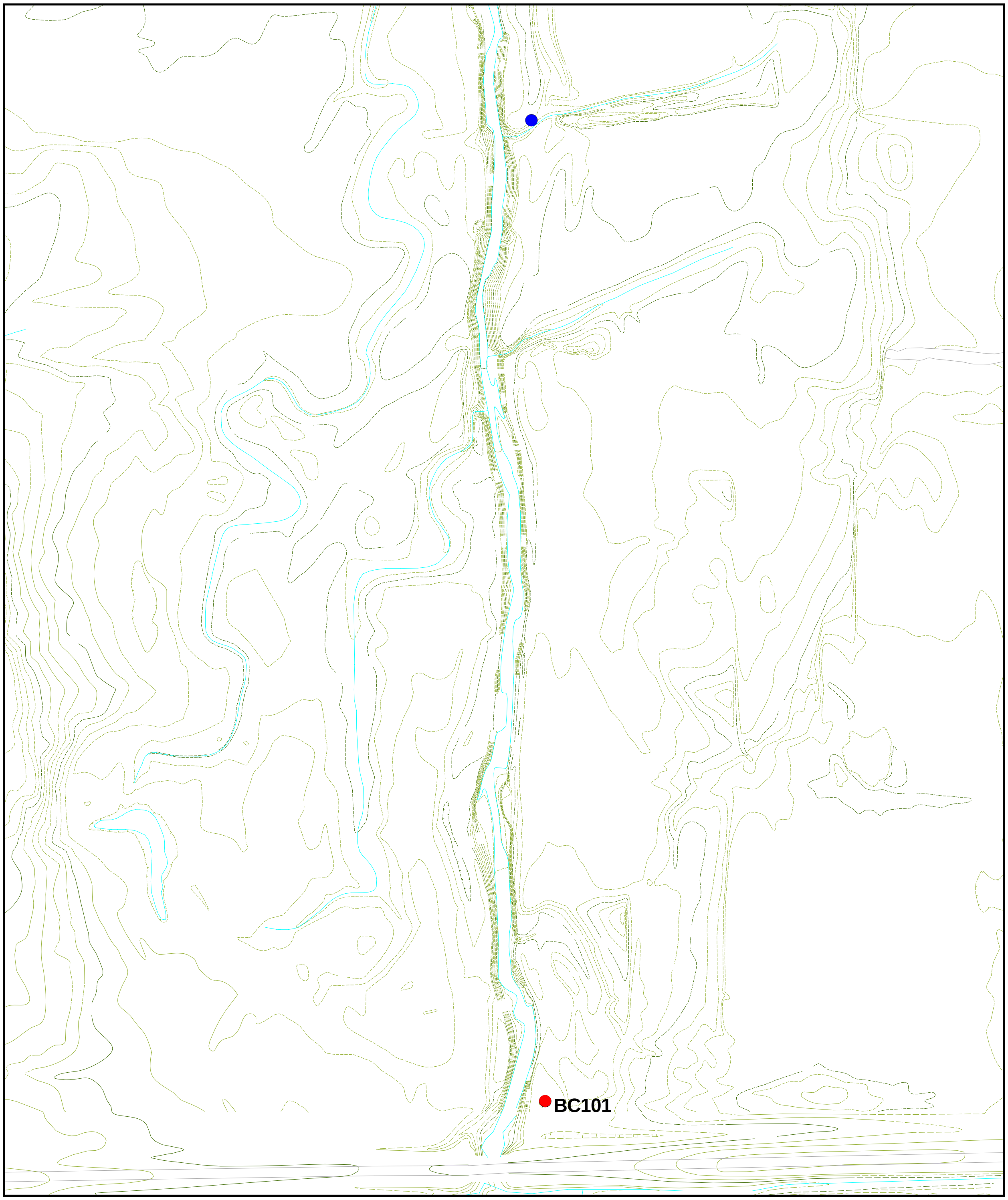


Figure B.14. (Continued)



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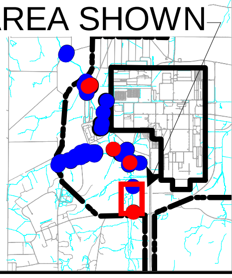

CHROMIUM SURFACE SAMPLE LOCATIONS

- DETECT GREATER THAN BACKGROUND [1,2]
- DETECT LESS THAN BACKGROUND [1,2]
- NONDETECT [1]
- FIELD ANALYSIS ONLY FOR COPC

SURFACE WATER
DOE BOUNDARY
PGDP BOUNDARY
ROAD

[1] Only fixed-base laboratory results are plotted in color.

[2] Background value as presented in DOE 2001.

TILE G

U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

COORDINATE SYSTEM:	PGDP
PROJECTION:	n/a
DATE:	05/20/2009
FILE NAME:	SOILPILES\Add2.apr
PADUCAH REMEDIATION SERVICES, LLC	
REFERENCES:	PRS 2009;

1500 0 1500 Feet

Figure B.14. (Continued)

Chromium–Subsurface. Chromium values in subsurface soil samples exceed the background value of 43 mg/kg in only 1 of 56 samples (54.6 mg/kg). This value is near other subsurface samples that are below the background value. Additionally, though this sample exceeds background, it is well below the screening criteria established for the soil piles. The teen recreational user no-action level for chromium is 227 mg/kg, and the child resident no-action level for chromium is 60.5. Although chromium is present in the Addendum 2 soil piles above background, it should not be considered a contaminant since it is well below the screening criteria.

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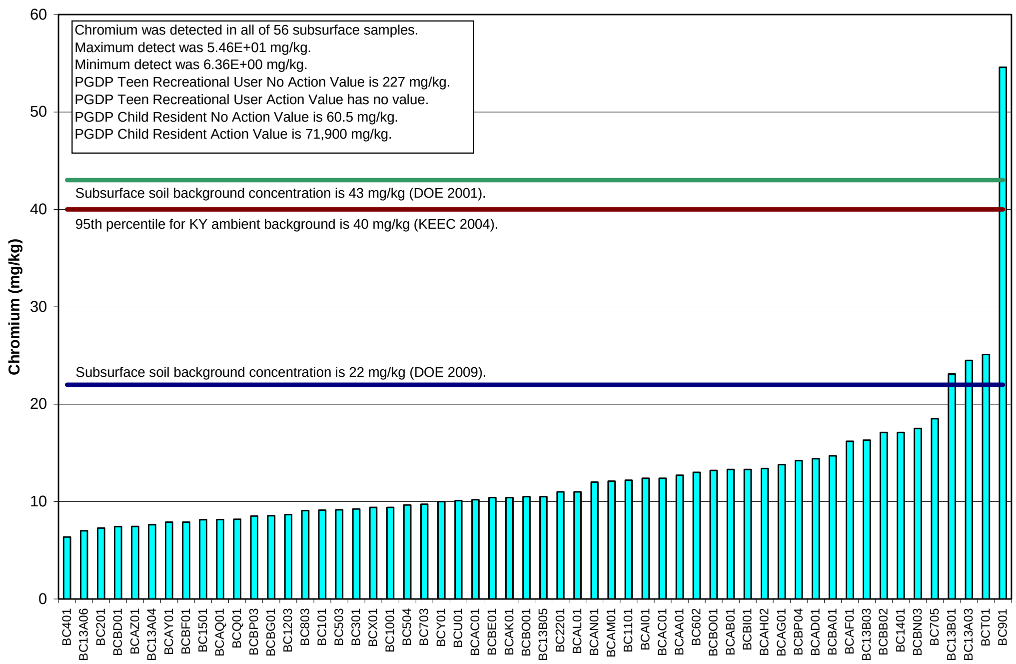
Figure B.15 graphically shows the results with the background value and other comparison values. Figure B.16 illustrates the spatial distribution of the sampling locations in which the background value was exceeded.



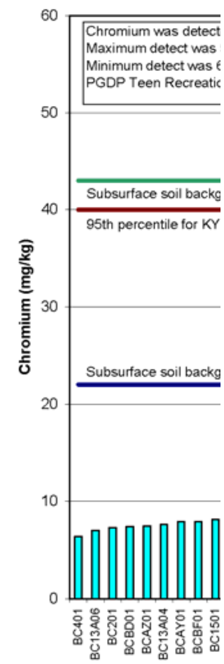


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Figure B.15. Comparison between Chromium Concentrations in Samples from Soil Piles Addendum 2 and Subsurface Soil Background Concentrations

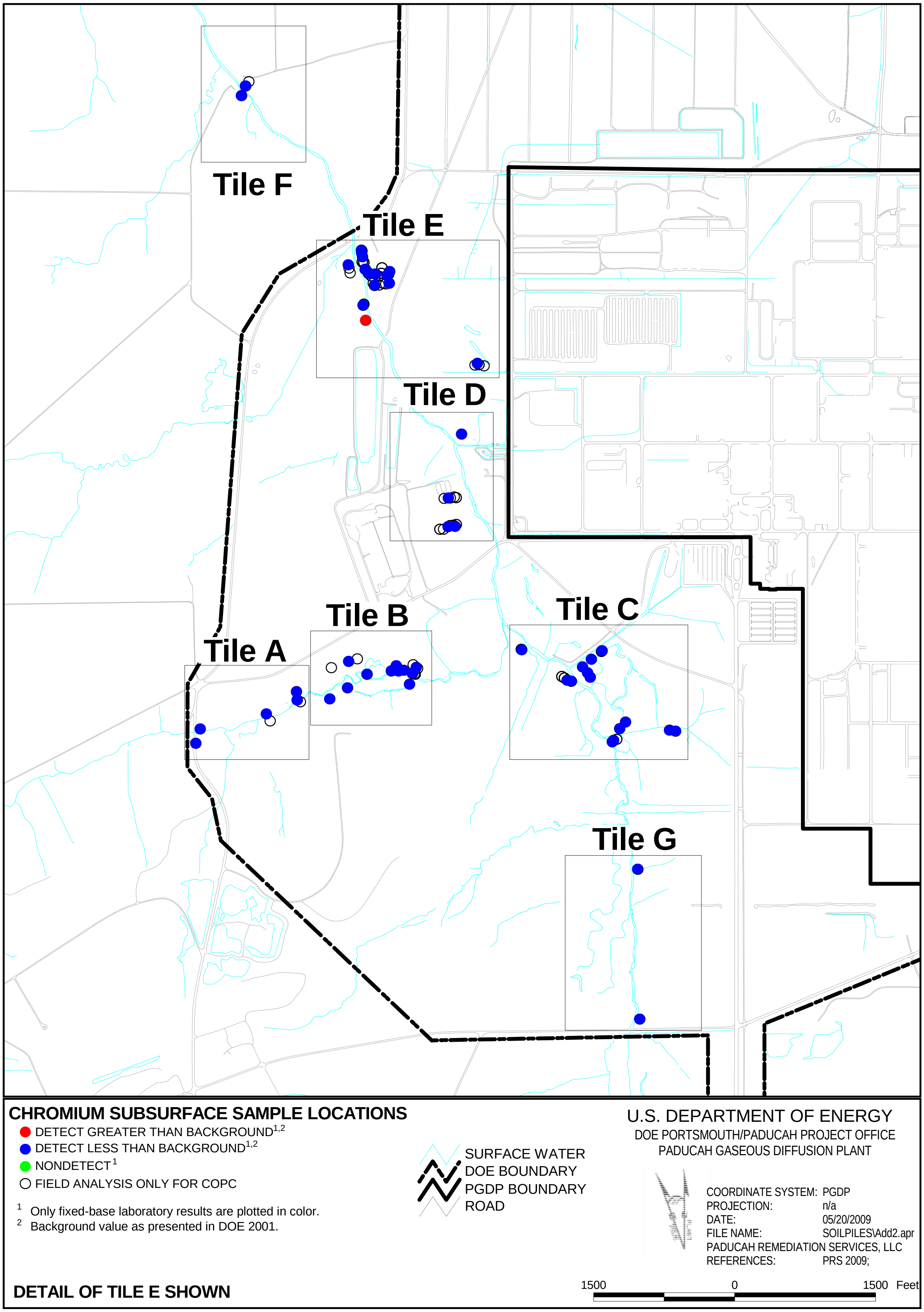
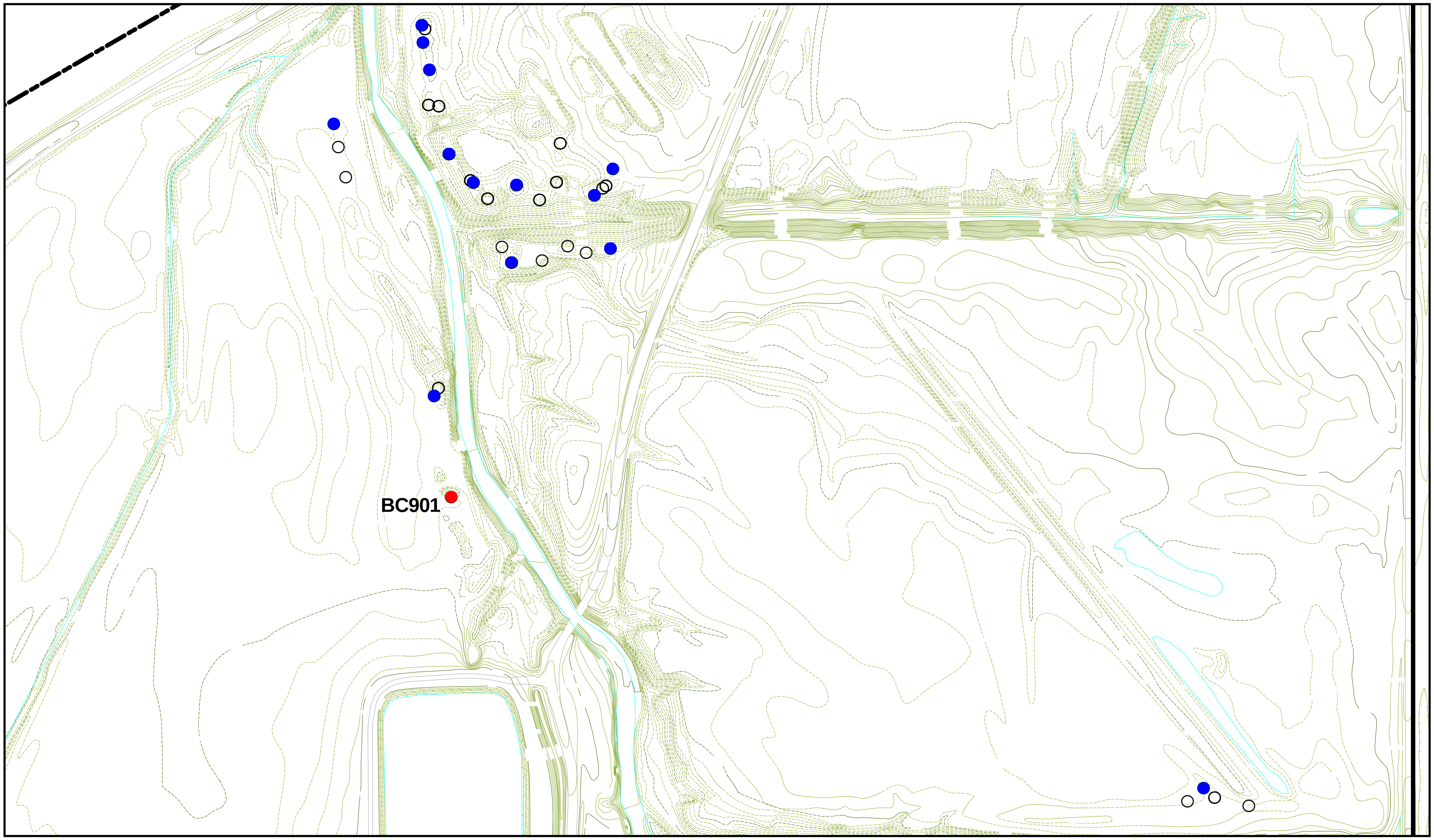


Figure B.16. Location of Sample Stations in Addendum 2 Soil Pile Sampling for Chromium in the Subsurface



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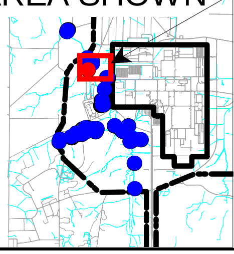

CHROMIUM SUBSURFACE SAMPLE LOCATIONS

- DETECT GREATER THAN BACKGROUND[1,2]
- DETECT LESS THAN BACKGROUND[1,2]
- NONDETECT[1]
- FIELD ANALYSIS ONLY FOR COPC

[1] Only fixed-base laboratory results are plotted in color.
[2] Background value as presented in DOE 2001.

- SURFACE WATER
- DOE BOUNDARY
- PGDP BOUNDARY
- ROAD
- SURFACE CONTOUR (1 ft)
- SURFACE CONTOUR (5 ft)

TILE E

U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

COORDINATE SYSTEM:	PGDP
PROJECTION:	n/a
DATE:	05/20/2009
FILE NAME:	SOILPILES\Add2.apr
PADUCAH REMEDIATION SERVICES, LLC	
REFERENCES:	PRS 2009;

250 0 250 Feet

Figure B.16. (Continued)

Lead–Subsurface. Lead values in subsurface soil samples exceed the background value of 23 mg/kg in 1 of 56 samples (28.8 mg/kg). The criteria for applying ambient background values established by KEEC were met: (1) the mean site concentration (9.89 mg/kg) is below the 95% UCL of the mean concentrations of KEEC background (33 mg/kg); (2) at least half of the data points are less than the 60th percentile (20.9 mg/kg); and (3) no data points are above the upper bound value (84.6 mg/kg) (KEEC 2004); therefore, lead is not present in the Addendum 2 soil piles as a contaminant.

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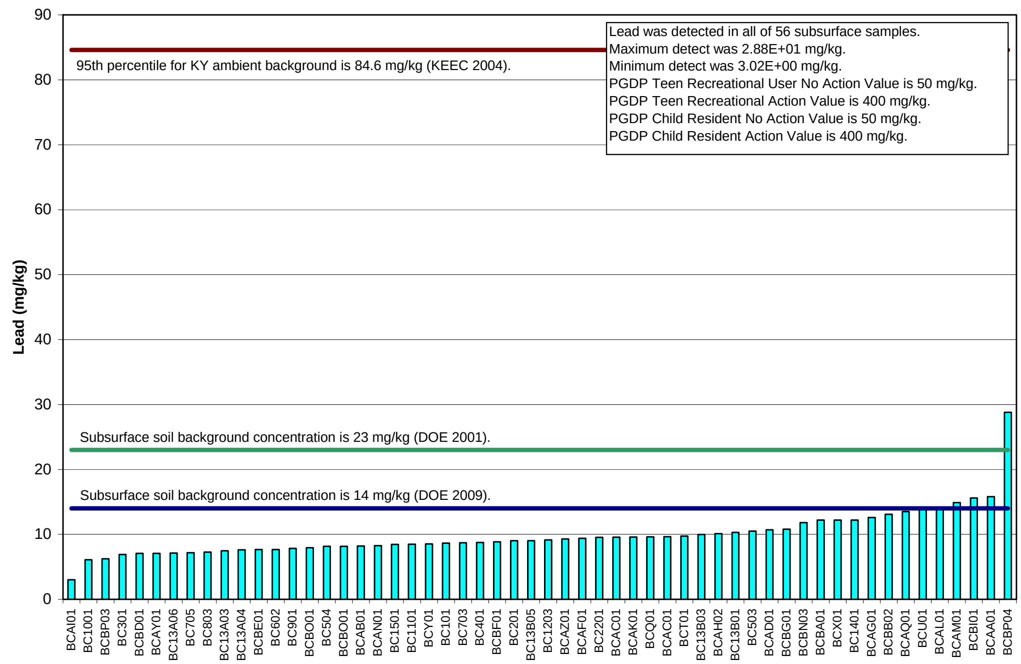
Figure B.17 graphically shows the results with the background value and other comparison values. Figure B.18 illustrates the spatial distribution of the sampling locations in which the background value was exceeded.



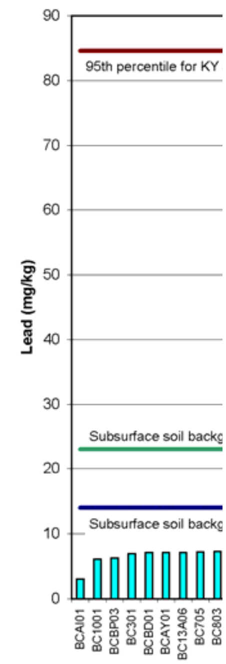


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Figure B.17. Comparison between Lead Concentrations in Samples from Soil Piles Addendum 2 and Subsurface Soil Background Concentrations

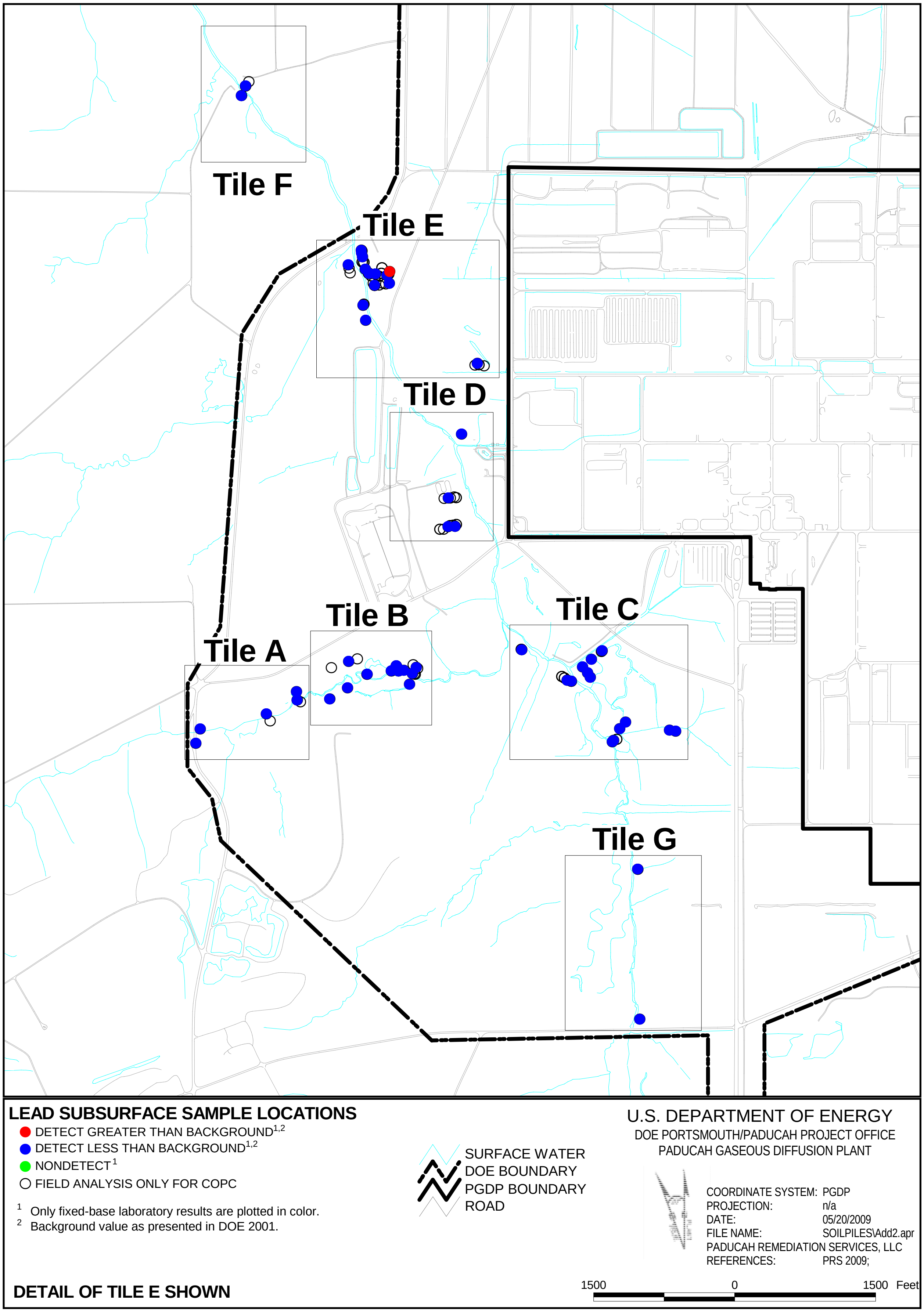
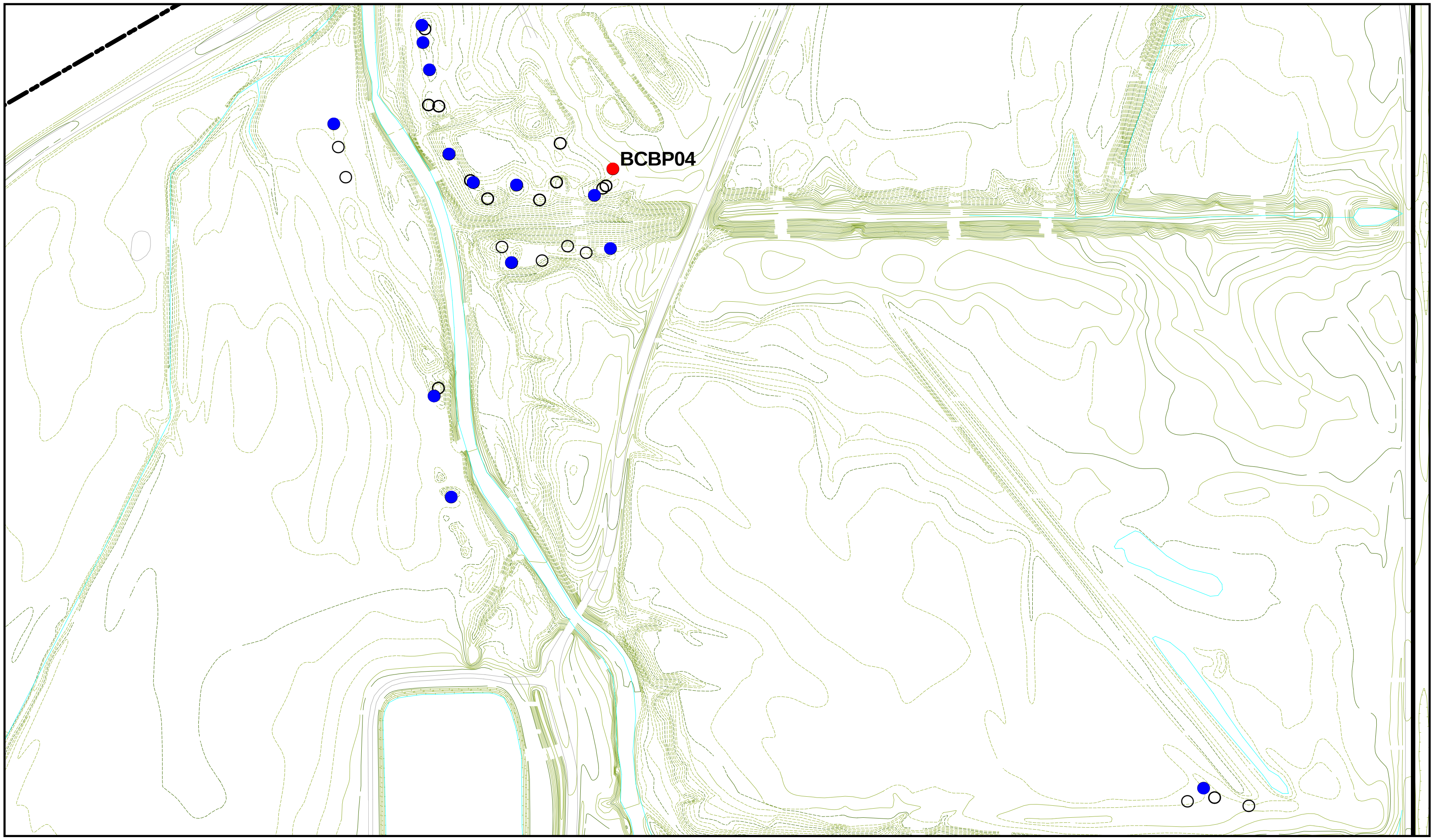
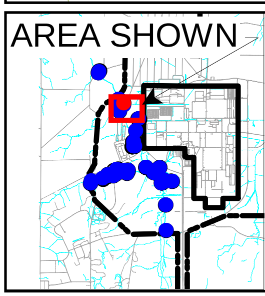


Figure B.18. Location of Sample Stations in Addendum 2 Soil Pile Sampling for Lead in the Subsurface





LEAD SUBSURFACE SAMPLE LOCATIONS

- DETECT GREATER THAN BACKGROUND[1,2]
- DETECT LESS THAN BACKGROUND[1,2]
- NONDETECT[1]
- FIELD ANALYSIS ONLY FOR COPC

[1] Only fixed-base laboratory results are plotted in color.
[2] Background value as presented in DOE 2001.

SURFACE WATER
DOE BOUNDARY
PGDP BOUNDARY
ROAD
SURFACE CONTOUR (1 ft)
SURFACE CONTOUR (5 ft)

TILE E

U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

COORDINATE SYSTEM:	PGDP
PROJECTION:	n/a
DATE:	05/20/2009
FILE NAME:	SOILPILES\Add2.apr
PADUCAH REMEDIATION SERVICES, LLC	
REFERENCES:	PRS 2009;

250 0 250 Feet

Figure B.18. (Continued)

Manganese–Surface. Manganese values in surface soil samples exceed the background value of 1,500 mg/kg in only 1 of 54 samples (1,580 mg/kg). The criteria for applying ambient background values established by KEEC were met: (1) the mean site concentration (532 mg/kg) is below the 95% UCL of the mean concentrations of KEEC background (1,071 mg/kg); (2) at least half of the data points are less than the 60th percentile (948 mg/kg); and (3) no data points are above the upper bound value (2,620 mg/kg) (KEEC 2004); therefore, manganese is not present in the Addendum 2 soil piles as a contaminant.

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Figure B.19 graphically shows the results with the background value and other comparison values. Figure B.20 illustrates the spatial distribution of the sampling locations in which the background value was exceeded.

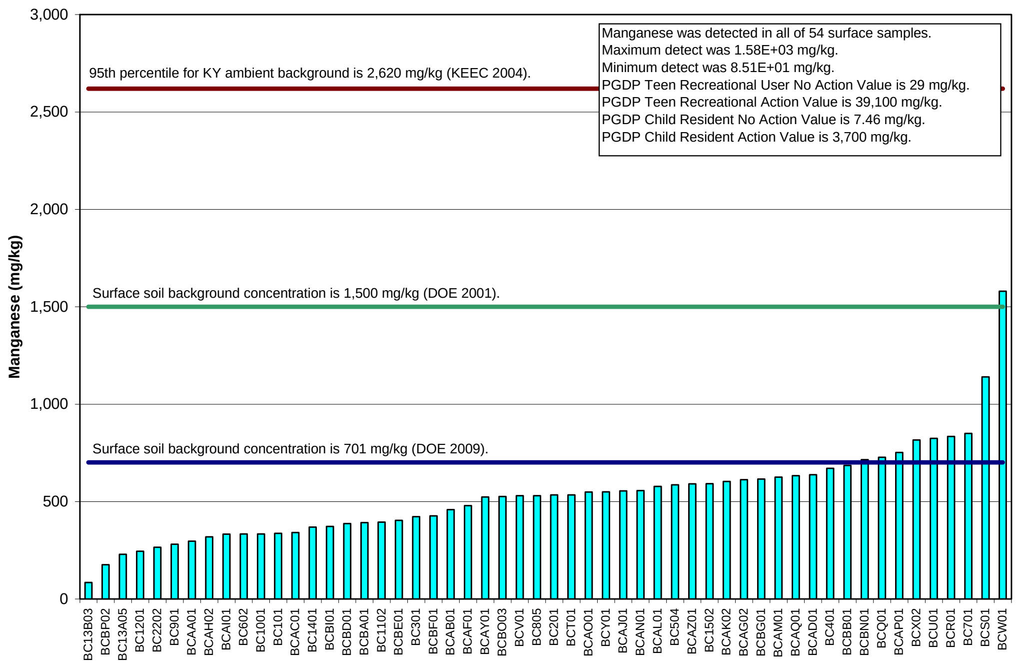
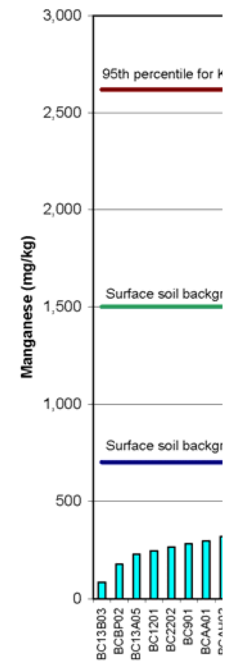


Figure B.19. Comparison between Manganese Concentrations in Samples from Soil Piles Addendum 2 and Surface Soil Background Concentrations



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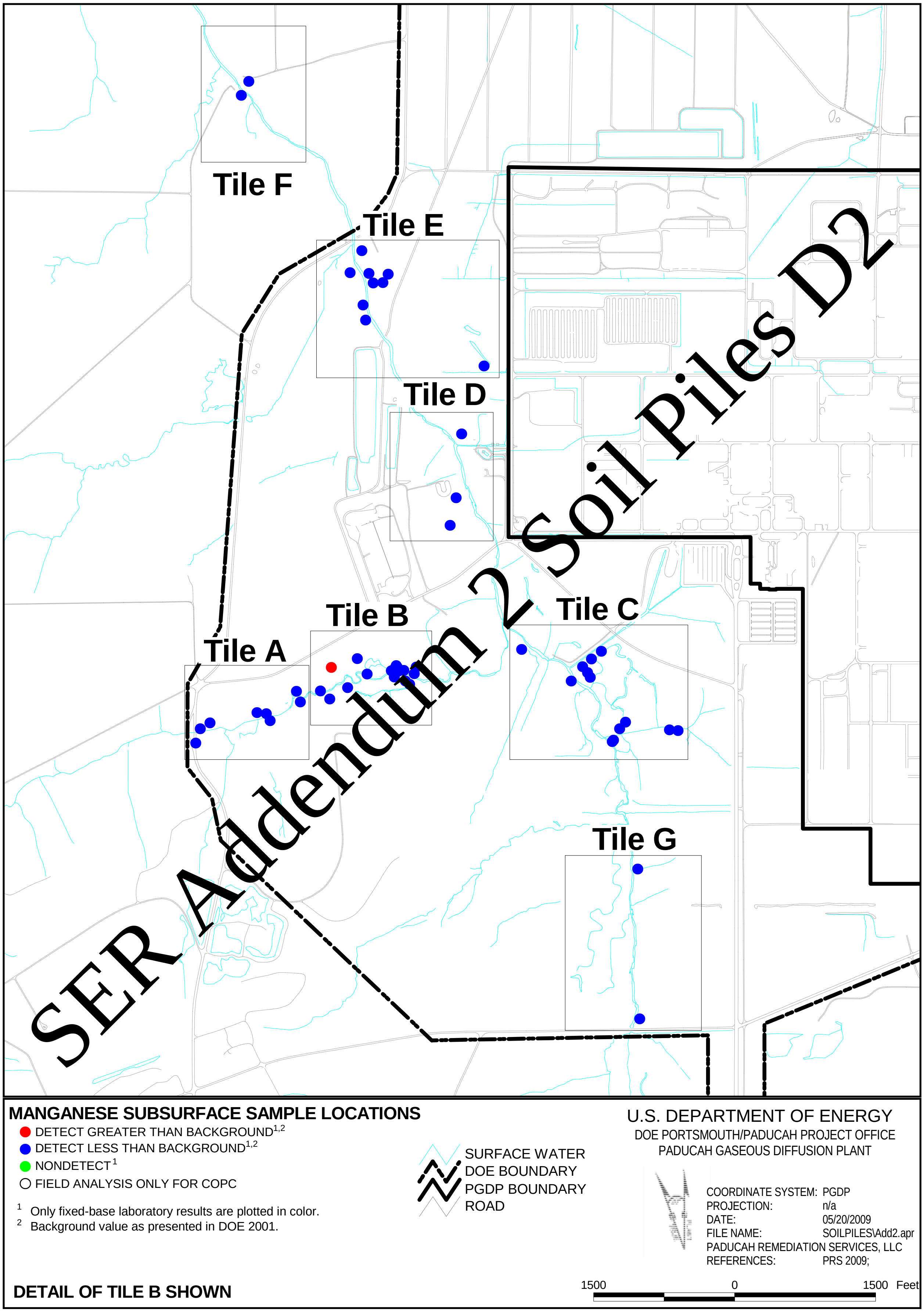


Figure B.20. Location of Sample Stations in Addendum 2 Soil Pile Sampling for Manganese in the Surface

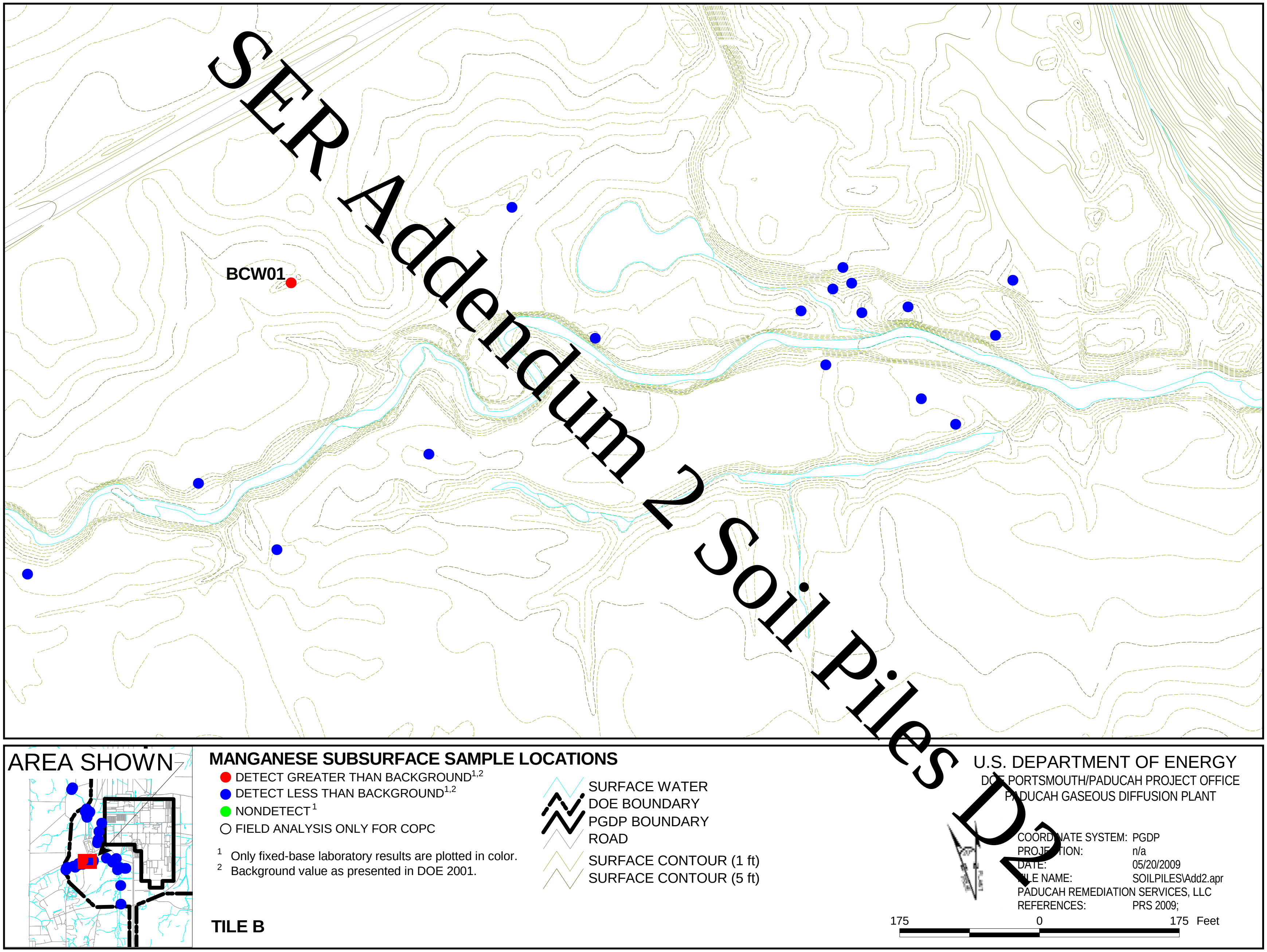


Figure B.20. (Continued)

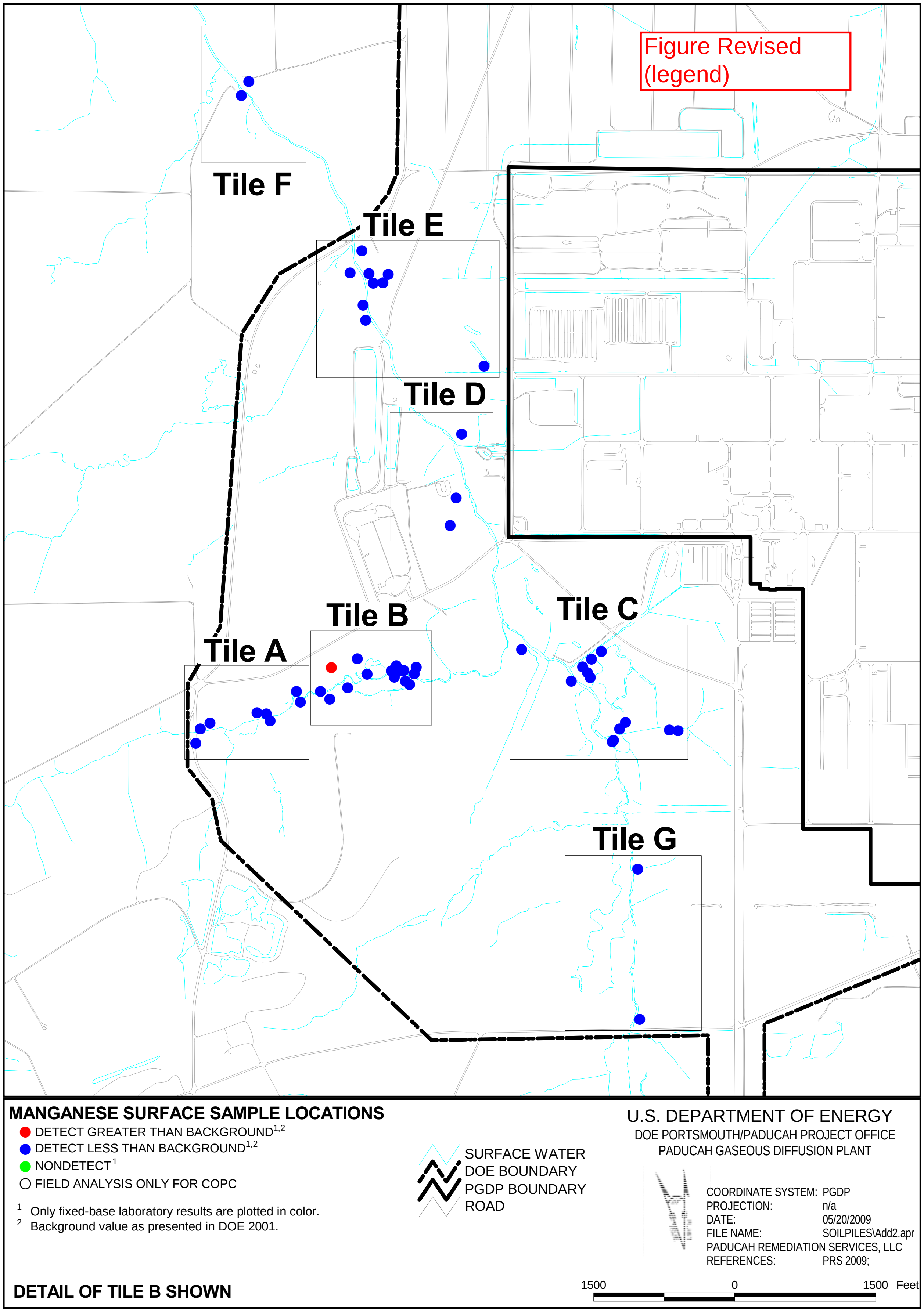
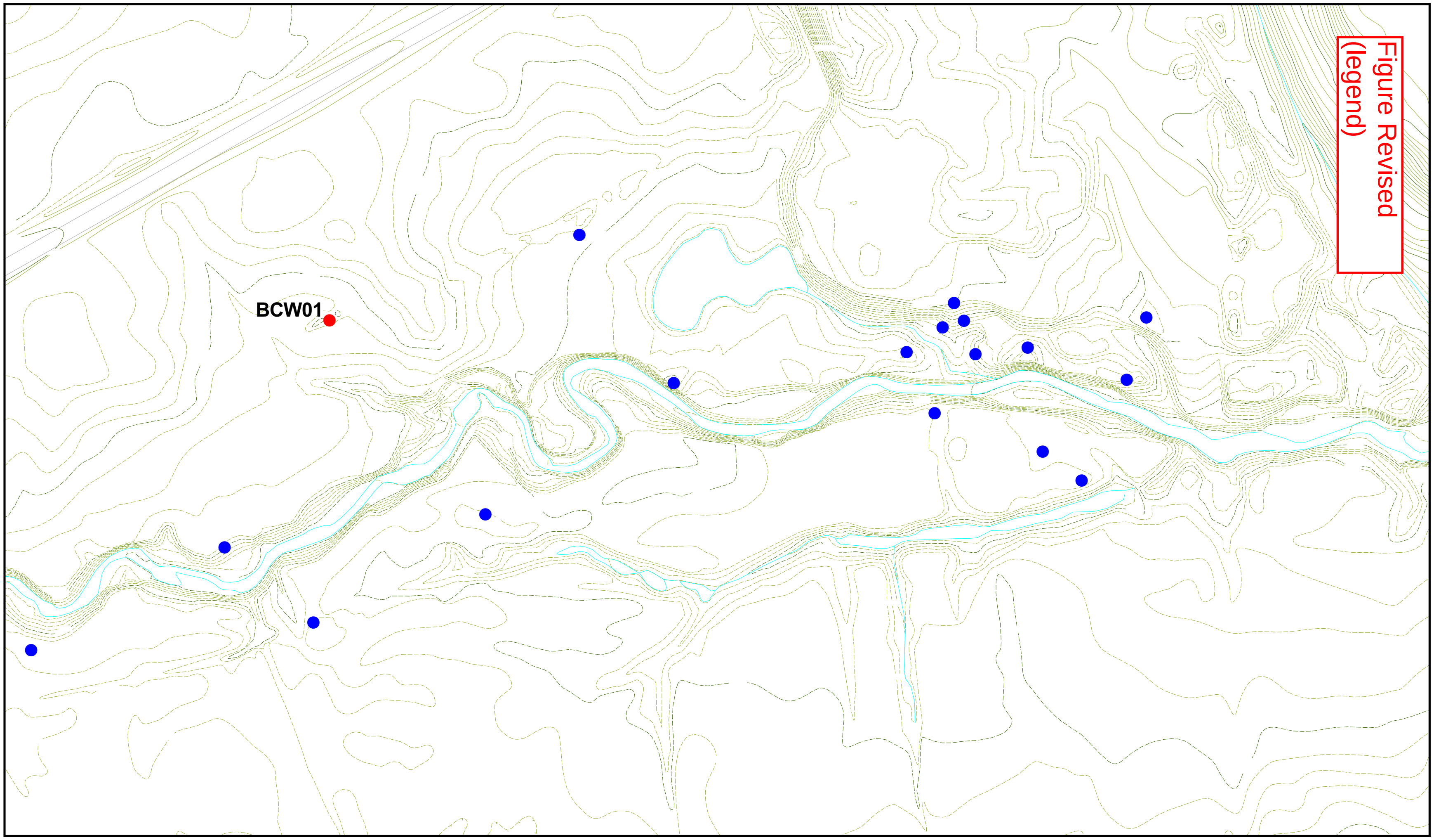


Figure B.20. Location of Sample Stations in Addendum 2 Soil Pile Sampling for Manganese in the Surface



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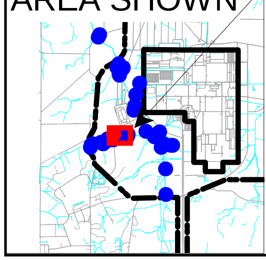

MANGANESE SURFACE SAMPLE LOCATIONS

- DETECT GREATER THAN BACKGROUND[1,2]
- DETECT LESS THAN BACKGROUND[1,2]
- NONDETECT[1]
- FIELD ANALYSIS ONLY FOR COPC

[1] Only fixed-base laboratory results are plotted in color.
[2] Background value as presented in DOE 2001.

SURFACE WATER
DOE BOUNDARY
PGDP BOUNDARY
ROAD
SURFACE CONTOUR (1 ft)
SURFACE CONTOUR (5 ft)

TILE B

U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

COORDINATE SYSTEM: PGDP
PROJECTION: n/a
DATE: 05/20/2009
FILE NAME: SOILPILES\Add2.apr
PADUCAH REMEDIATION SERVICES, LLC
REFERENCES: PRS 2009;

175 0 175 Feet

Figure B.20. (Continued)

Vanadium–Subsurface. Vanadium values in subsurface soil samples exceed the background value of 37 mg/kg in 1 of 56 samples (37.7 mg/kg). The criteria for applying ambient background values established by KEEC were met: (1) the mean site concentration (17.8 mg/kg) is below the 95% UCL of the mean concentrations of KEEC background (27.7 mg/kg); (2) at least half of the data points are less than the 60th percentile (27.3 mg/kg); and (3) no data points are above the upper bound value (48.6 mg/kg) (KEEC 2004); therefore, vanadium is not present in the Addendum 2 soil piles as a contaminant.

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Figure B.21 graphically shows the results with the background value and other comparison values. Figure B.22 illustrates the spatial distribution of the sampling locations in which the background value was exceeded.

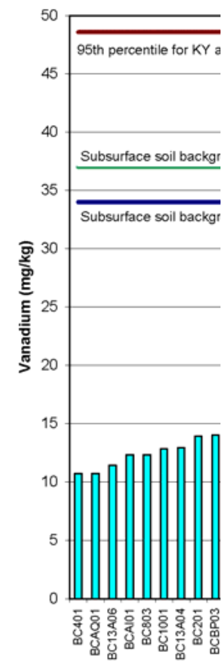

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Figure B.21. Comparison between Vanadium Concentrations in Samples from Soil Piles Addendum 2 and Subsurface Soil Background Concentrations

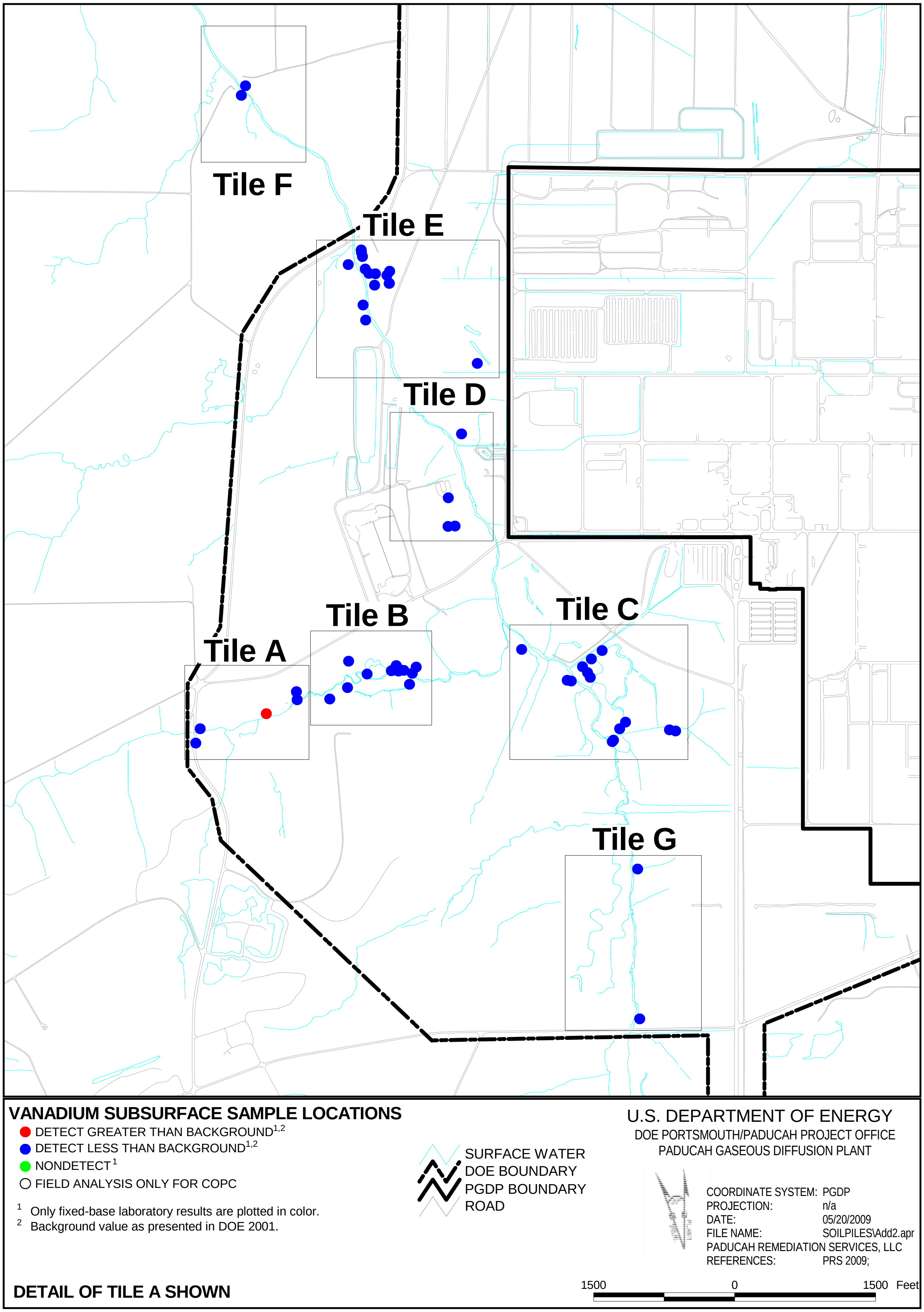
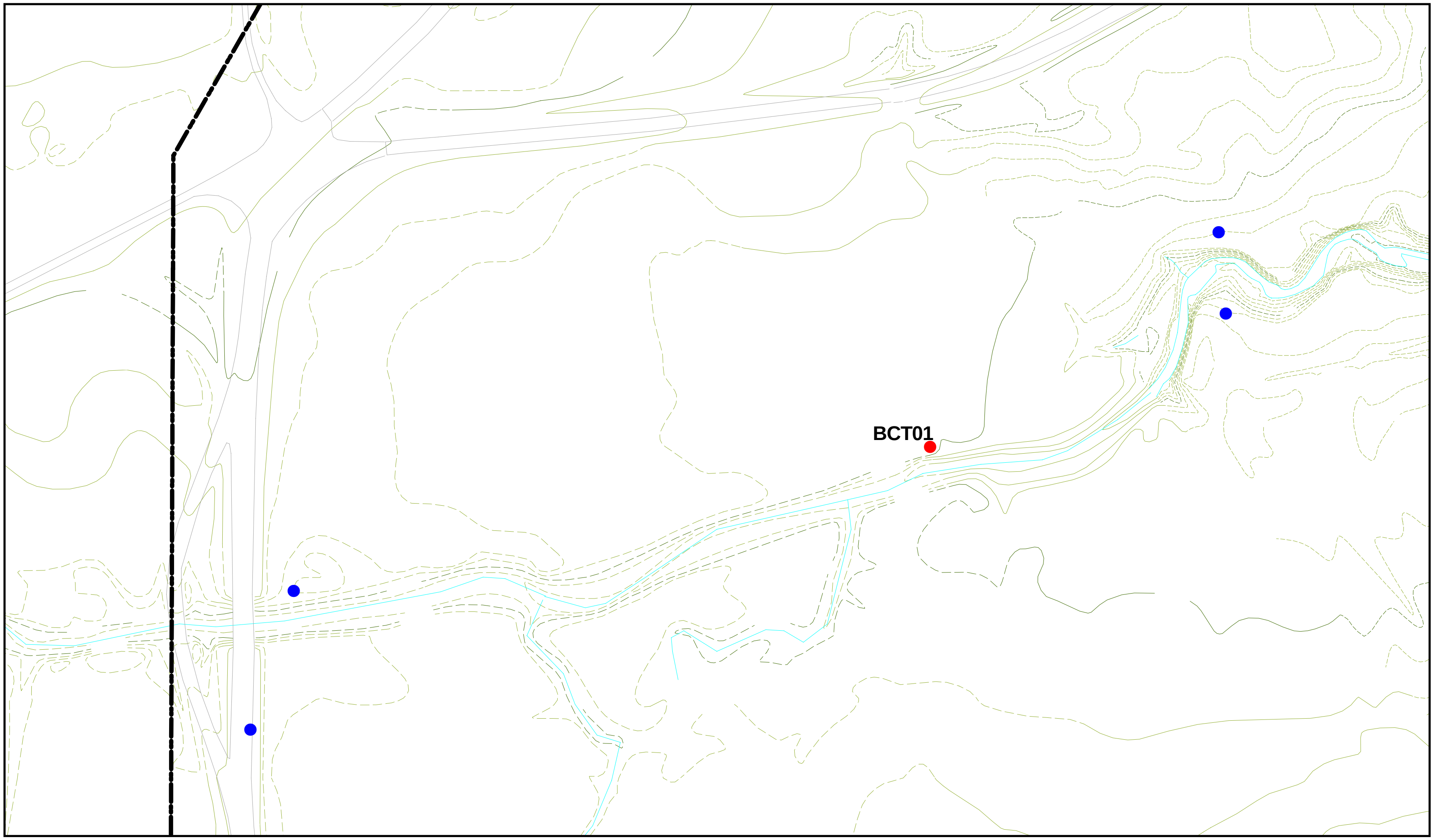


Figure B.22. Location of Sample Stations in Addendum 2 Soil Pile Sampling for Vanadium in the Subsurface



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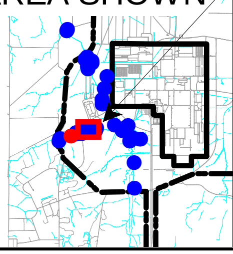

VANADIUM SUBSURFACE SAMPLE LOCATIONS

- DETECT GREATER THAN BACKGROUND[1,2]
- DETECT LESS THAN BACKGROUND[1,2]
- NONDETECT[1]
- FIELD ANALYSIS ONLY FOR COPC

[1] Only fixed-base laboratory results are plotted in color.
[2] Background value as presented in DOE 2001.

SURFACE WATER
DOE BOUNDARY
PGDP BOUNDARY
ROAD
SURFACE CONTOUR (1 ft)
SURFACE CONTOUR (5 ft)

TILE A

U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

COORDINATE SYSTEM:	PGDP
PROJECTION:	n/a
DATE:	05/20/2009
FILE NAME:	SOILPILES\Add2.apr
PADUCAH REMEDIATION SERVICES, LLC	
REFERENCES:	PRS 2009;

200 0 200 Feet

Figure B.22. (Continued)

Cesium-137–Surface. Cesium-137 values in surface soil samples exceed the background value of 0.49 pCi/g in 6 of 54 samples. The samples exceeding background ranged from 0.724 to 0.883 pCi/g. Figure B.23 graphically shows the results with the background value and other comparison values. Although the cesium-137 concentration exceeds the site-specific background for PGDP, the concentration of cesium-137 in samples exceeding background is below levels seen in 1988 to 1993 monitoring studies at PGDP. Cesium-137 levels in these studies ranged from 0.11 to 4.0 pCi/g (DOE 1997). The highest result is reported in the 1990 Annual Site Environmental Report from a location 13 kilometers south of PGDP (MMES 1991).

In all cases from Addendum 2 soil piles, the locations from which surface samples exceed site-specific PGDP background are from soil piles along the banks of the Unnamed Tributary, which is upstream of PGDP operations. Specifically, these Soil Piles are W, X, AL, AO, AP, and AQ. Figure B.24 illustrates the direction of surface water flow and the spatial distribution of the sampling locations in which the background value was exceeded.

Cesium-137 is a major contributor to global fall-out due to atmospheric testing of nuclear weapons in the 1950s to the early 1960s. A summary from Argonne National Lab (ANL 2007) states that concentrations up to 1 pCi/g are expected from fall-out.

Although cesium-137 is detected in 6 of 54 samples at levels greater than the benchmark background value, cesium-137 is below the range of background and global fallout presented and should not be considered in the Addendum 2 soil piles as a contaminant.

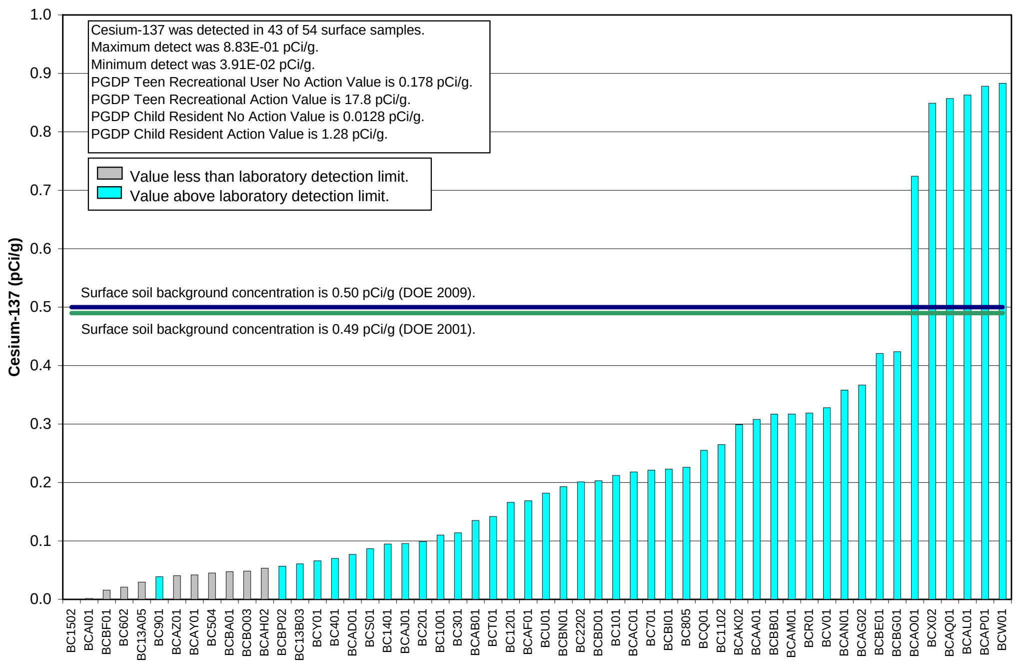

Figure B.23. Comparison between Cesium-137 Concentrations in Samples from Soil Piles Addendum 2 and Surface Soil Background Concentrations

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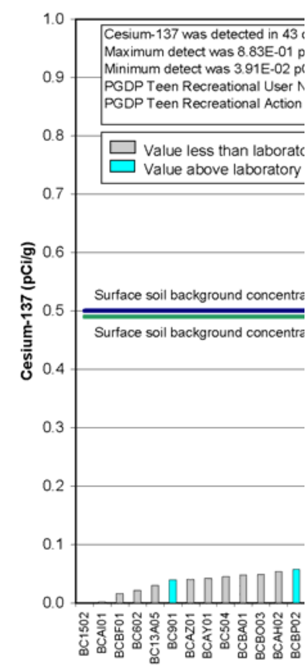


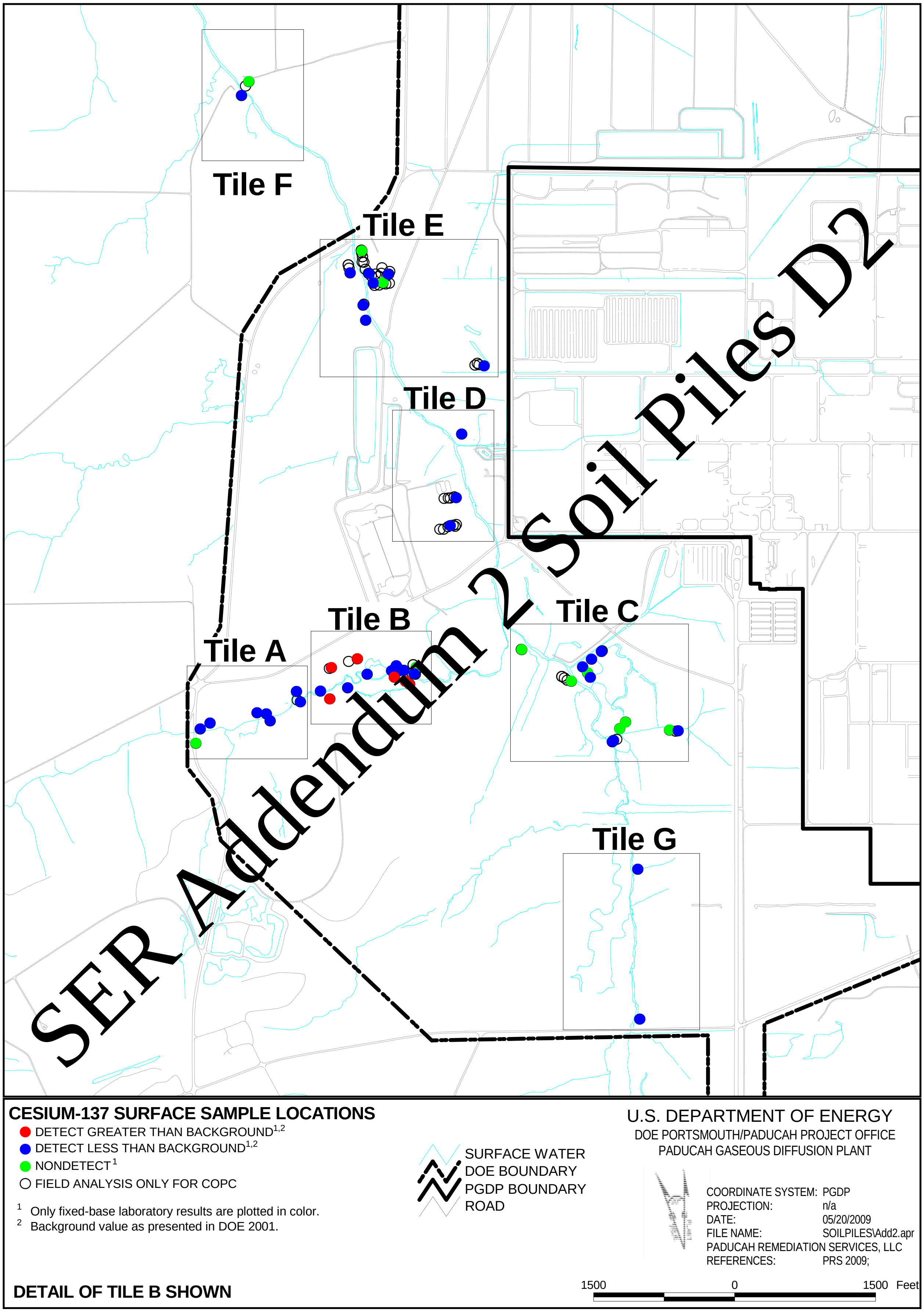
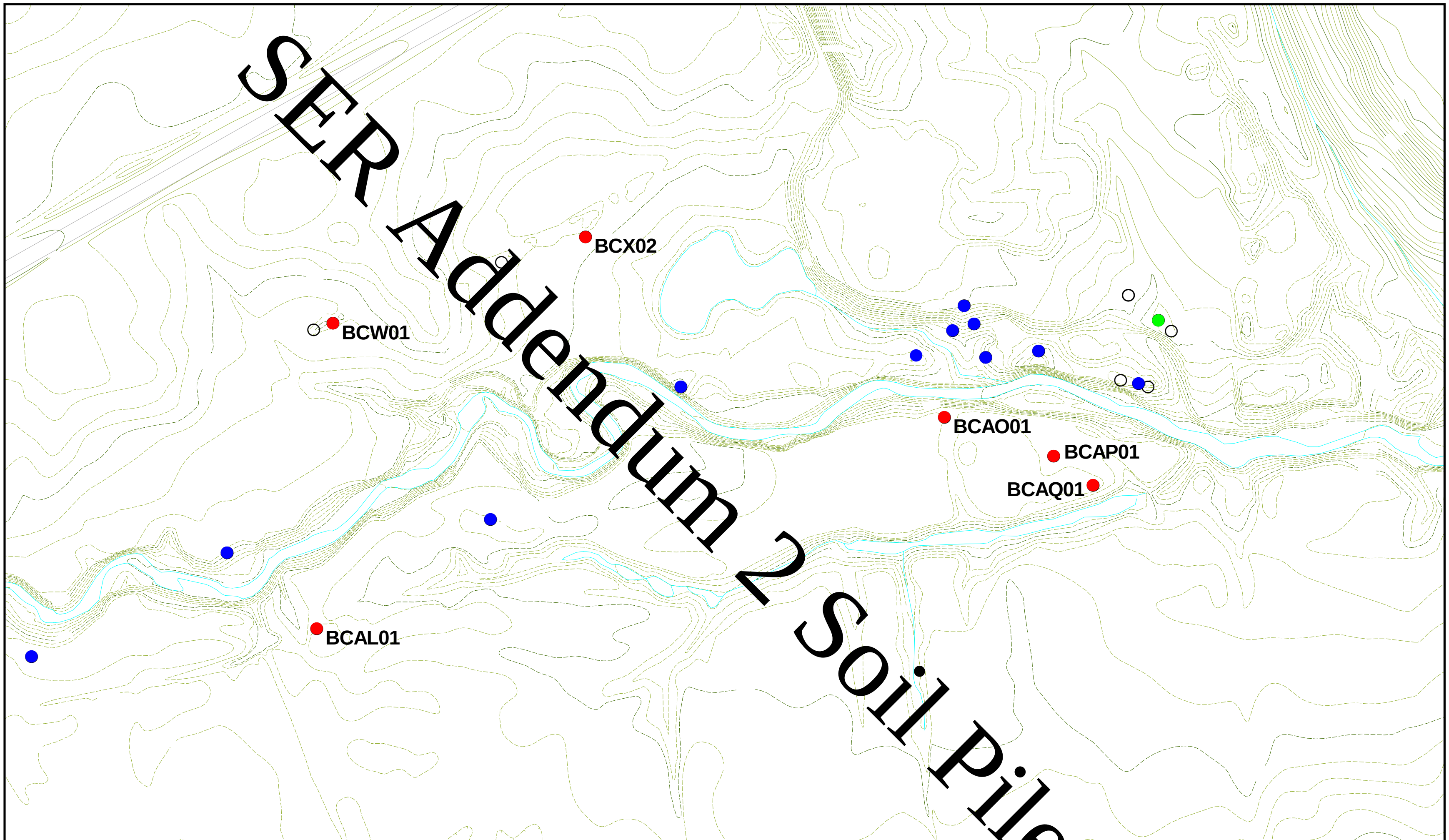


Figure B.24. Location of Sample Stations in Addendum 2 Soil Pile Sampling for Cesium-137 in the Surface



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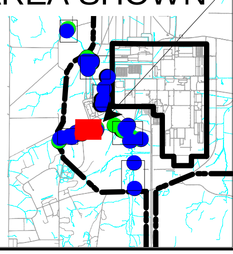

CESIUM-137 SURFACE SAMPLE LOCATIONS

- DETECT GREATER THAN BACKGROUND[1,2]
- DETECT LESS THAN BACKGROUND[1,2]
- NONDETECT[1]
- FIELD ANALYSIS ONLY FOR COPC

1 Only fixed-base laboratory results are plotted in color.
2 Background value as presented in DOE 2001.

SURFACE WATER
DOE BOUNDARY
PGDP BOUNDARY
ROAD
SURFACE CONTOUR (1 ft)
SURFACE CONTOUR (5 ft)

TILE B

U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

COORDINATE SYSTEM: PGDP
PROJECTION: n/a
DATE: 05/20/2009
FILE NAME: SOILPILES\Add2.apr
PADUCAH REMEDIATION SERVICES, LLC
REFERENCES: PRS 2009;

175 0 175 Feet

Figure B.24. (Continued)

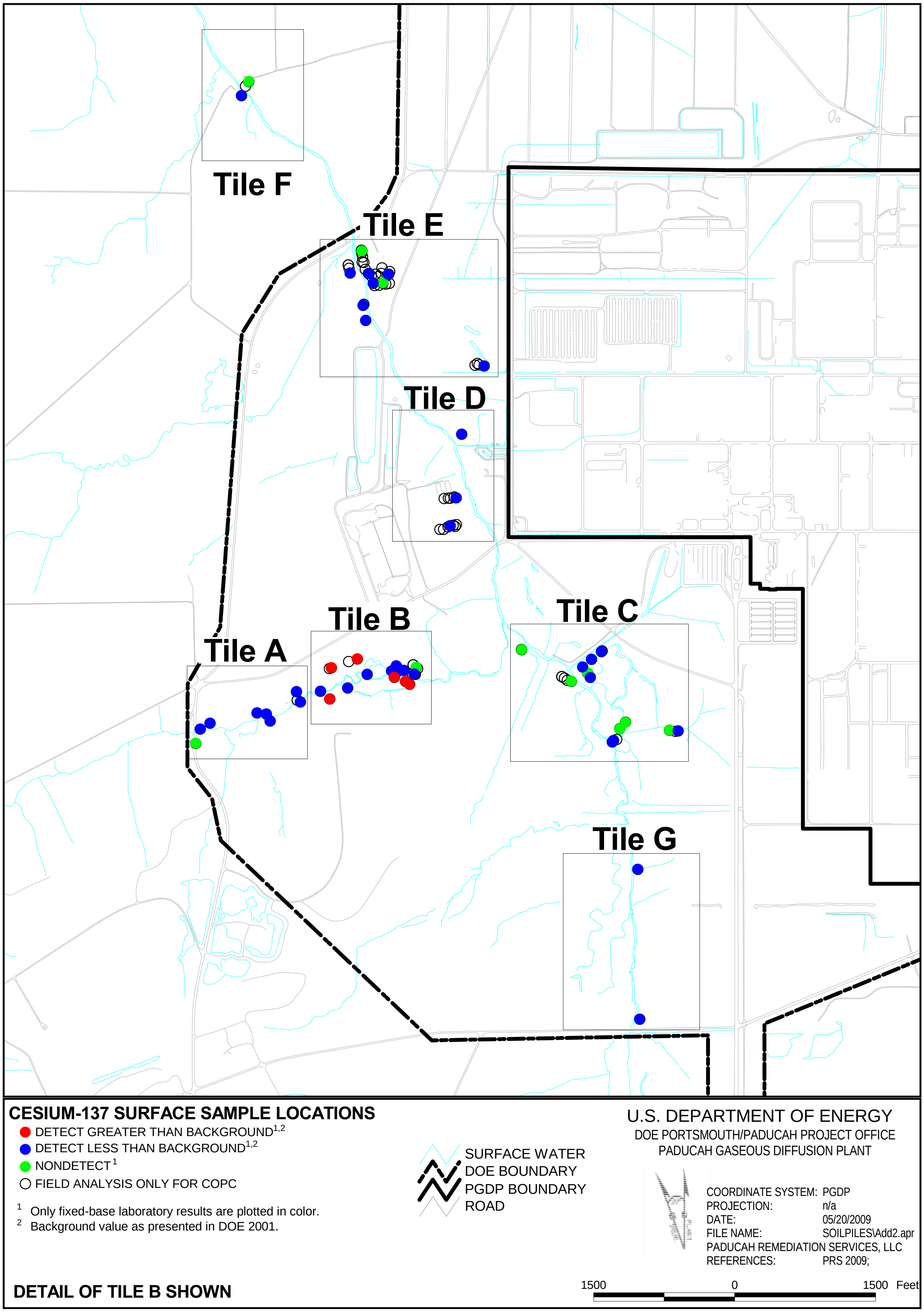

Figure B.24. Location of Sample Stations in Addendum 2 Soil Pile Sampling for Cesium-137 in the Surface

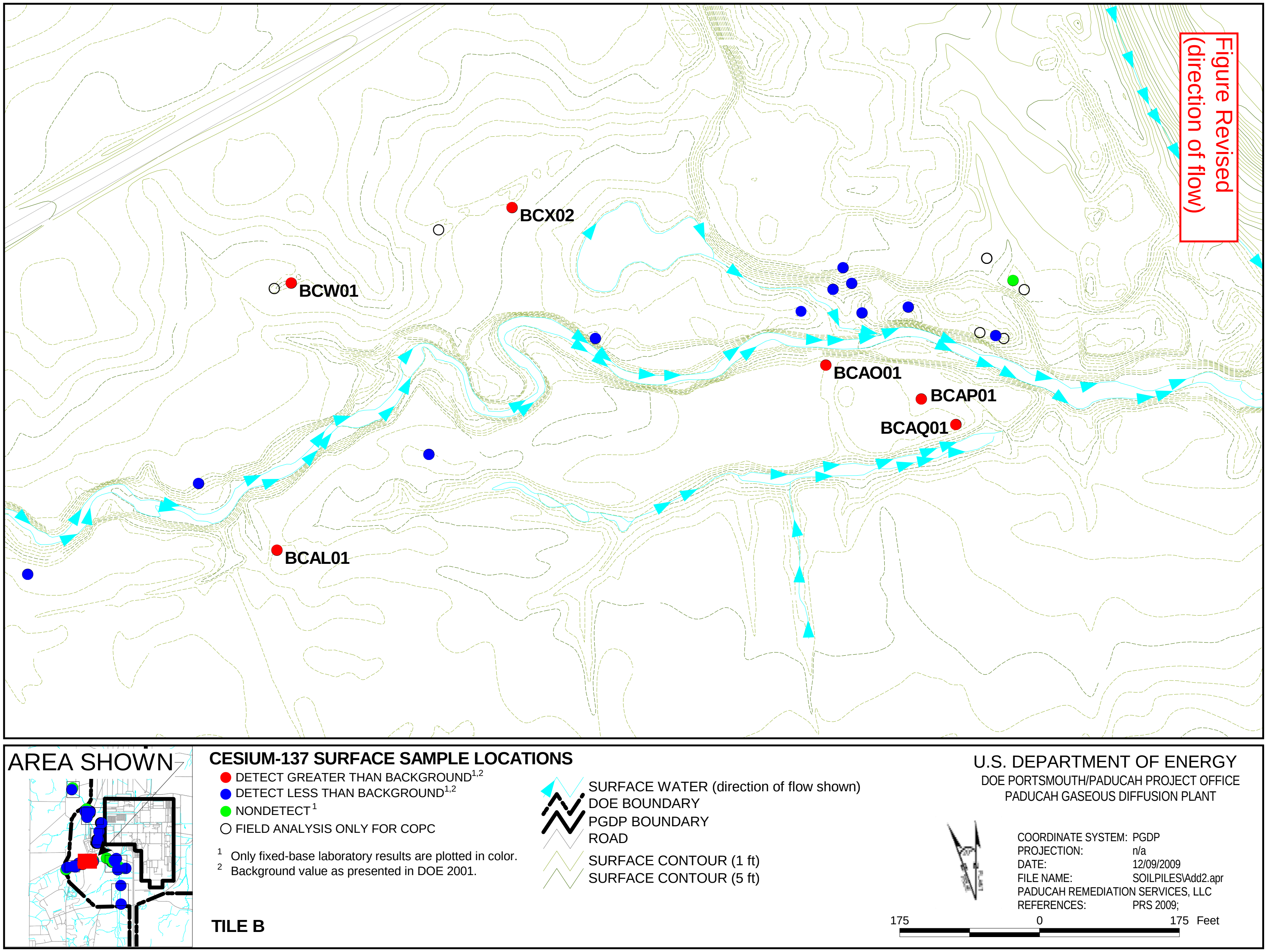

Figure B.24. (Continued)

Cesium-137–Subsurface. Cesium-137 values in subsurface soil samples exceed the background value of 0.28 pCi/g in 9 of 56 samples (ranging 0.342 to 0.979 pCi/g). In many of the cases, the locations from which subsurface samples exceed site-specific PGDP background are from soil piles along the banks upstream of PGDP operations. Specifically, these soil piles are X, AL, AM, and AQ along the Unnamed Tributary. Of these piles, three (Soil Piles X, AL, and AQ) had results above the background value in surface soil samples as well. Figure B.25 depicts the distribution of detected cesium-137 activities within these soil piles. Other soil piles exceeding the site-specific PGDP background in subsurface samples are 22, BE, and BG near Outfall K009; BI near Outfall K008; BP near Outfall K001.

Although the cesium-137 concentration exceeds the site-specific background for PGDP, the concentration of cesium-137 in samples exceeding background is below levels seen in 1988 to 1993 monitoring studies at PGDP. Cesium-137 levels in these studies ranged from 0.11 to 4.0 pCi/g (DOE 1997). The highest result is reported in the 1990 Annual Site Environmental Report from a location 13 kilometers south of PGDP (MMES 1991).

Deleted: One possible explanation for these cesium-137 results is the association with fall-out.

Cesium-137 is a major contributor to global fall-out due to atmospheric testing of nuclear weapons in the 1950s to the early 1960s. A summary from Argonne National Lab (ANL 2007) states that concentrations up to 1 pCi/g are expected from fall-out. Although cesium-137 as a result of fall-out would not be expected to be found at depth, the material from the soil piles is thought once to have been surface soil or sediment and could have been subject to the results of global fall-out at that time.

Figure B.26 graphically shows the results with the background value and other comparison values. Figure B.27 illustrates the spatial distribution of the sampling locations in which the background value was exceeded. Although cesium-137 is detected in 9 of 56 samples at levels greater than the benchmark background value, cesium-137 is below the range of background and global fallout presented and should not be considered in the Addendum 2 soil piles as a contaminant.

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¶

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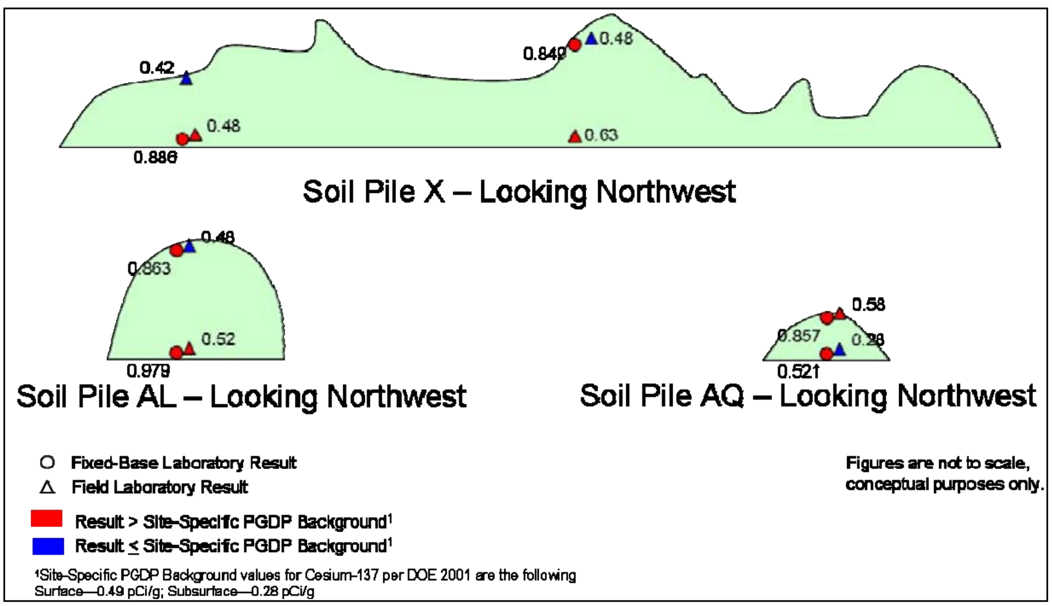
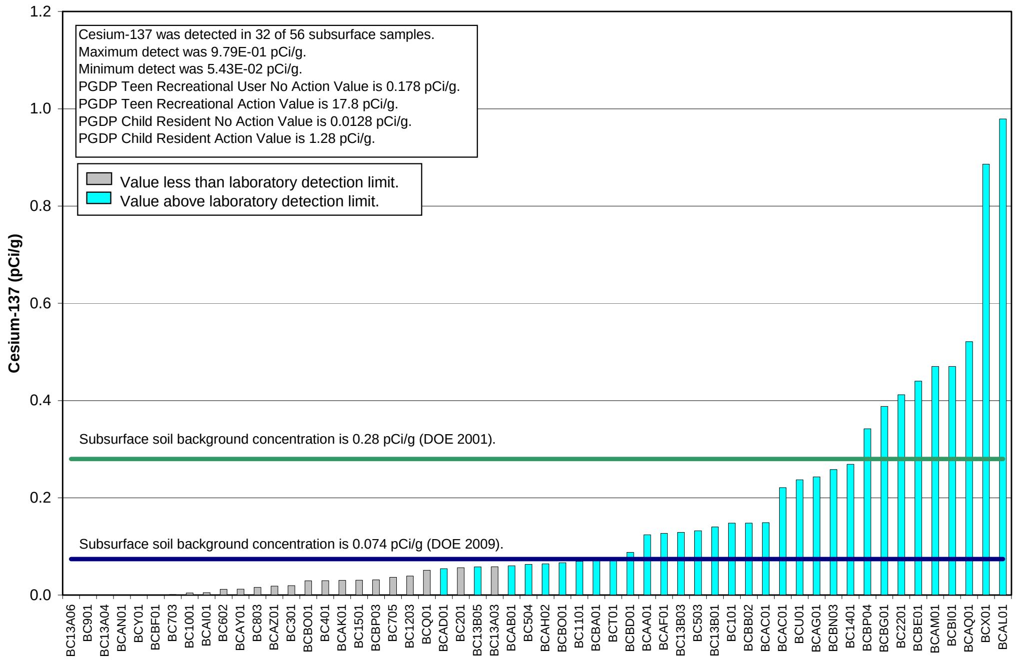


Figure B.25 Detected Cesium-137 within Soil Piles X, AL, and AQ



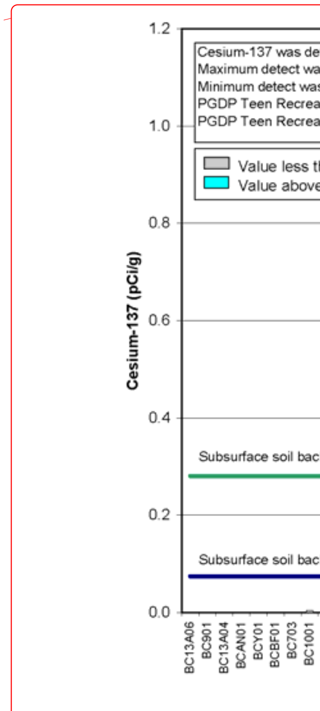


Figure B.26. Comparison between Cesium-137 Concentrations in Samples from Soil Piles Addendum 2 and Subsurface Soil Background Concentrations

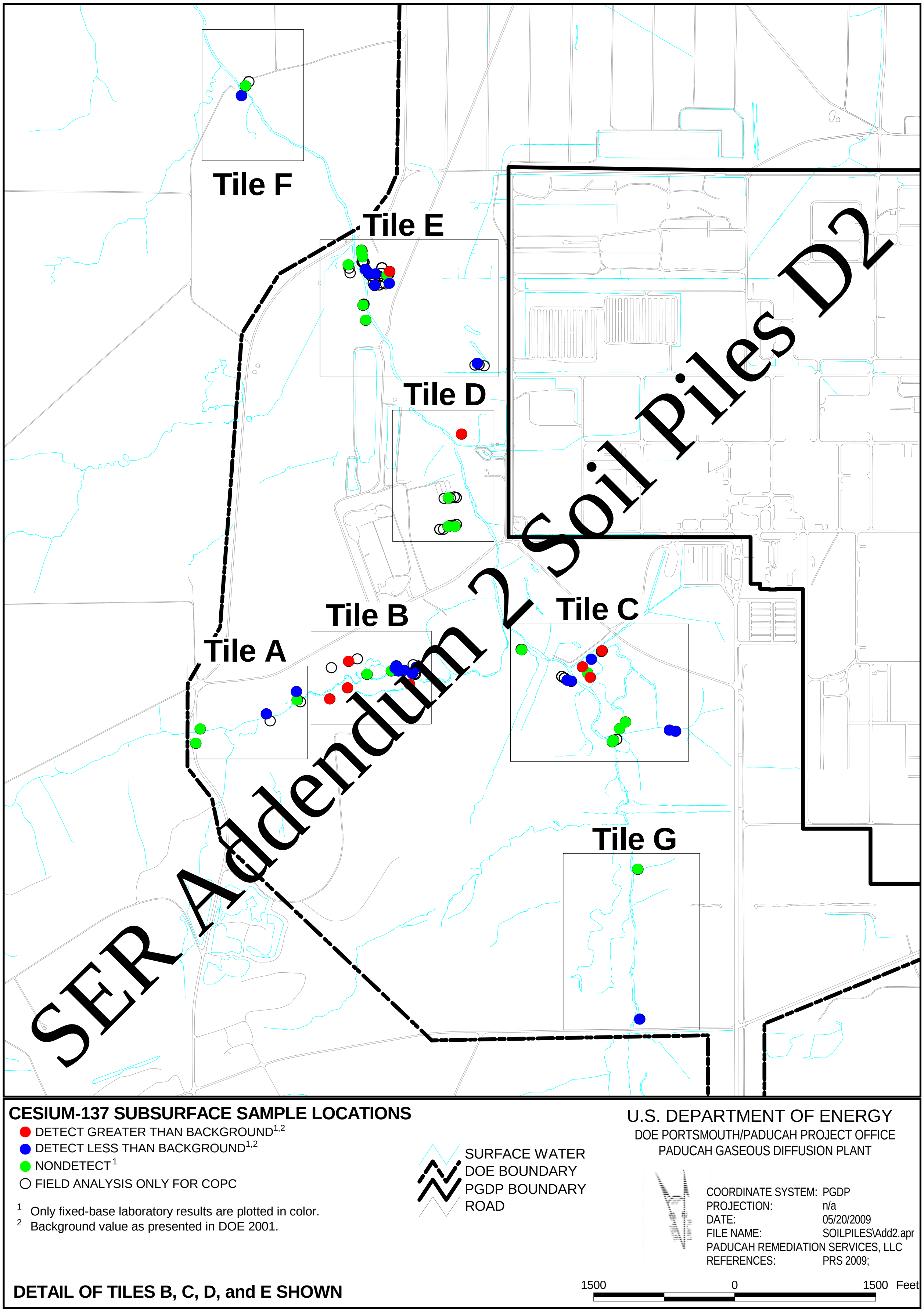
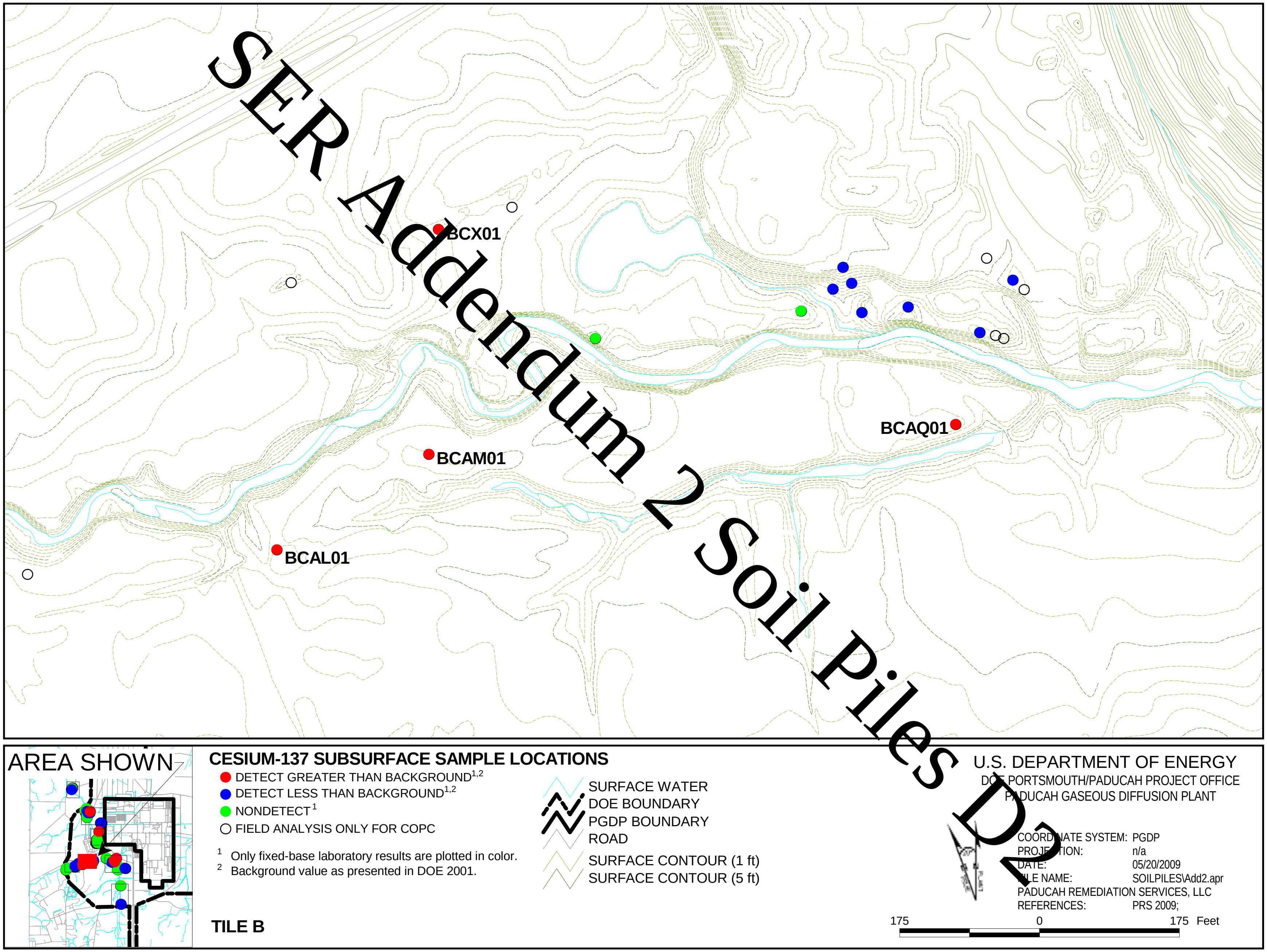


Figure B.27. Location of Sample Stations in Addendum 2 Soil Pile Sampling for Cesium-137 in the Subsurface



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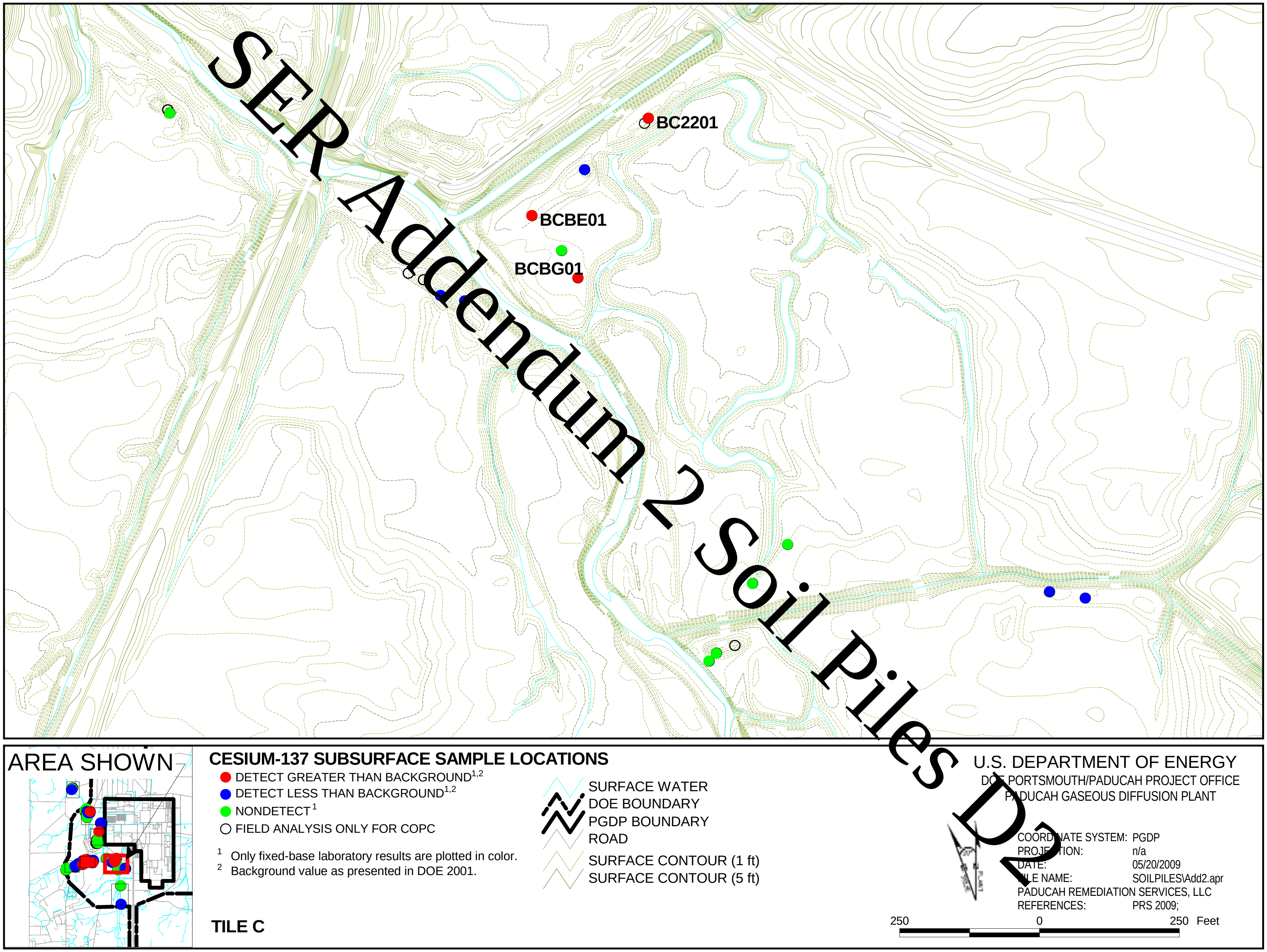


Figure B.27. (Continued)

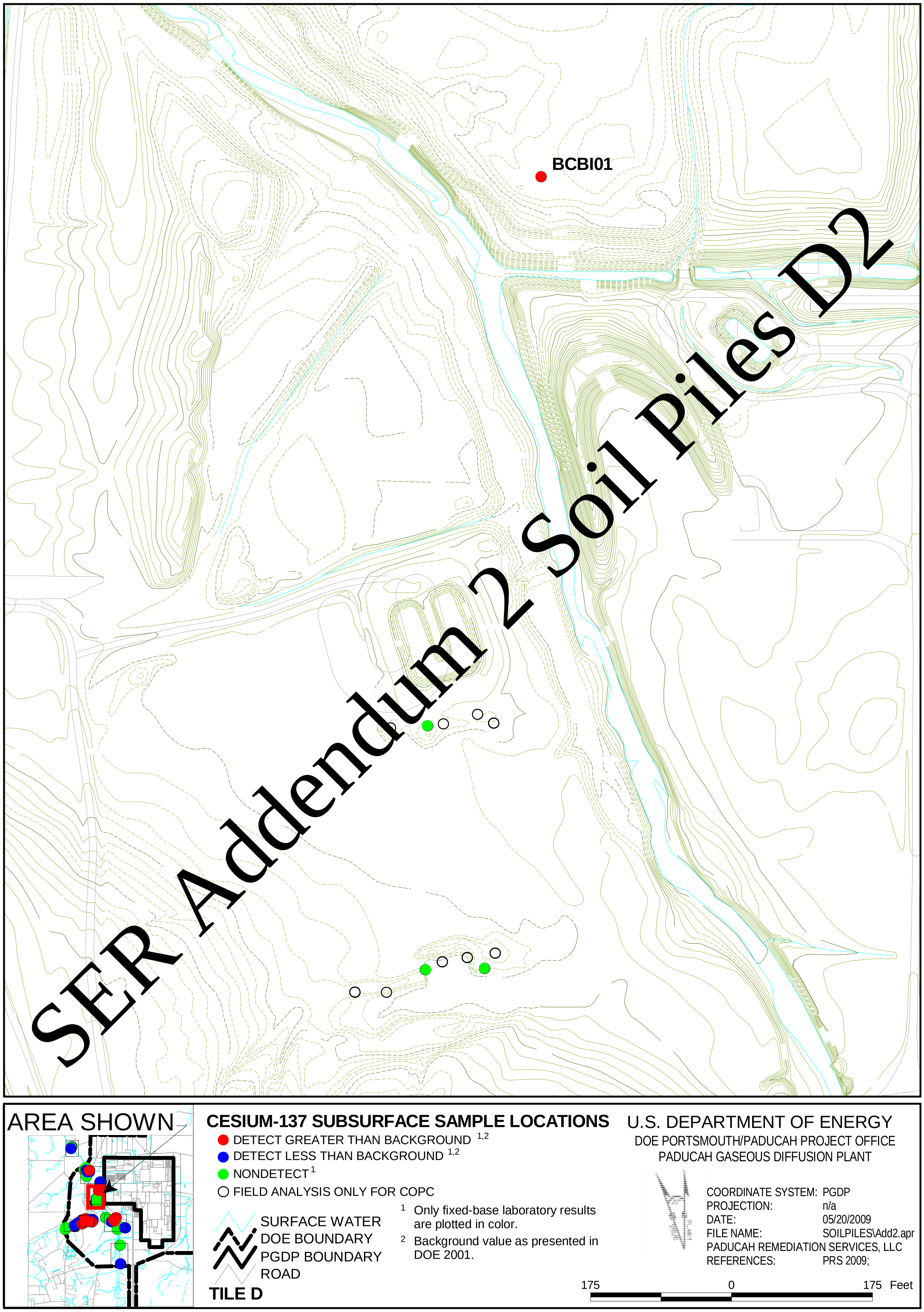


Figure B.27. (Continued)

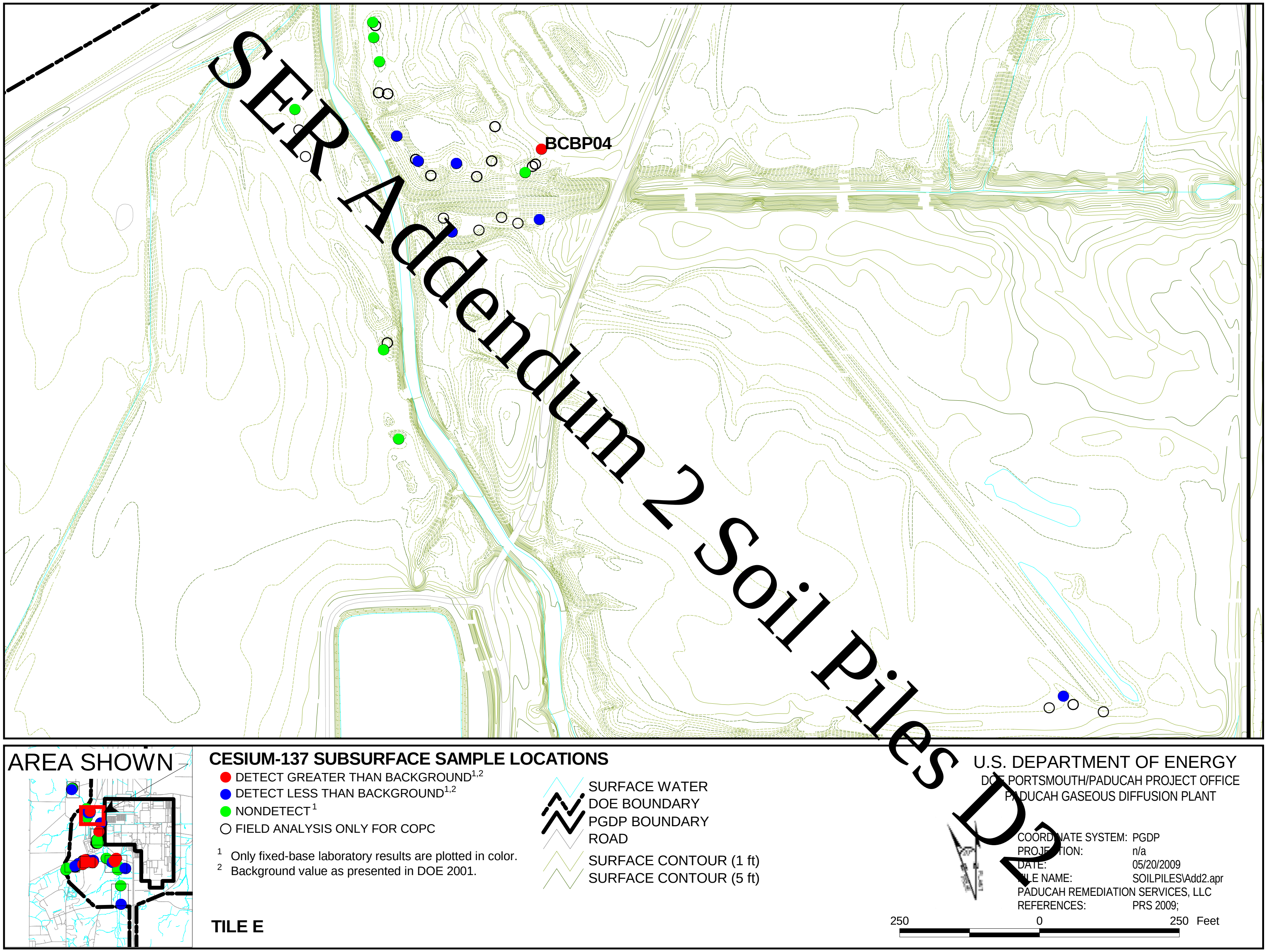


Figure B.27. (Continued)

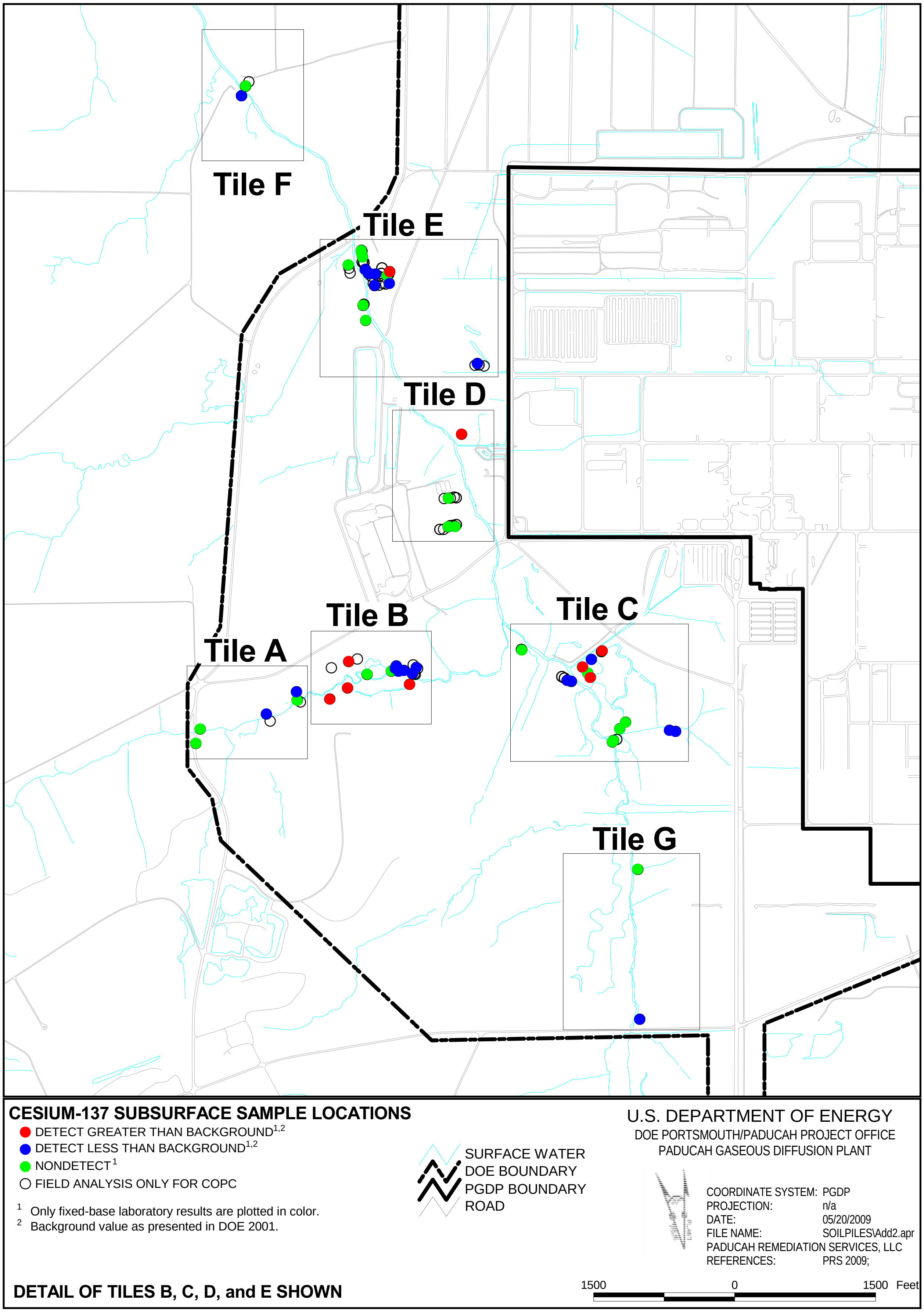


Figure B.27. Location of Sample Stations in Addendum 2 Soil Pile Sampling for Cesium-137 in the Subsurface

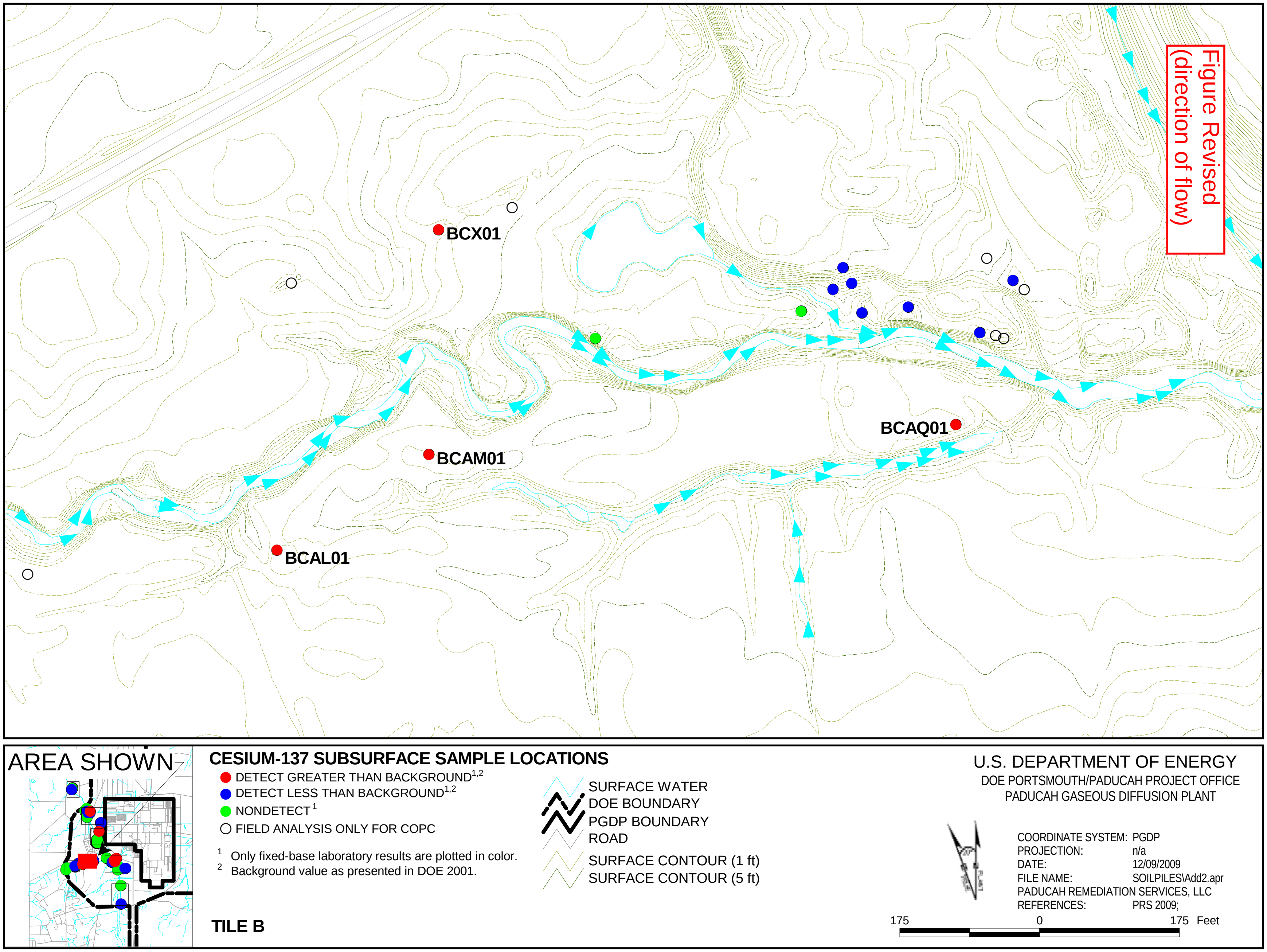
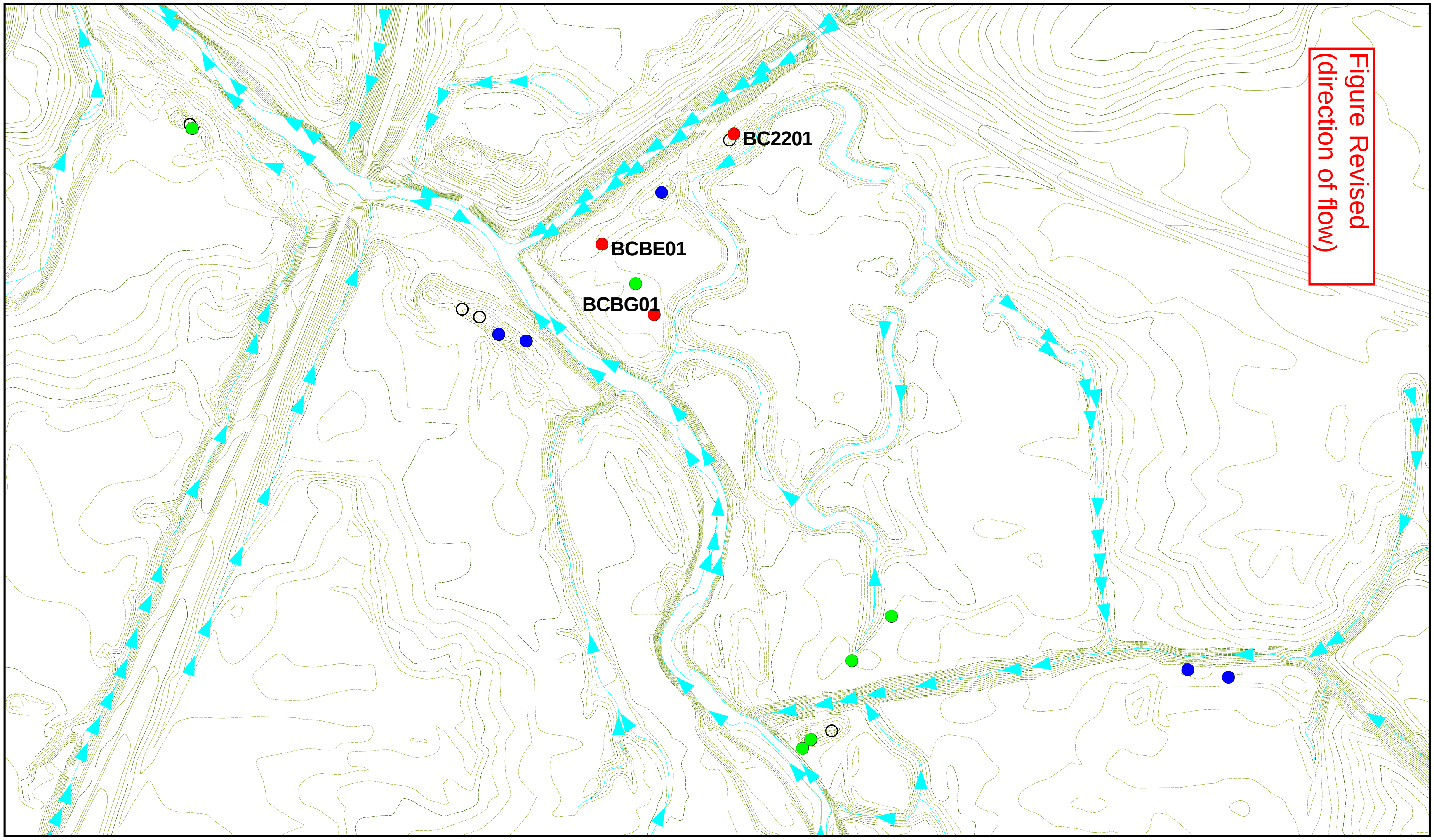
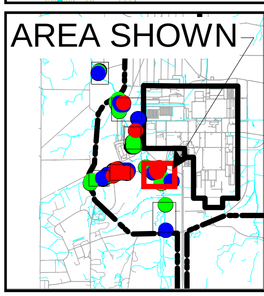


Figure B.27. (Continued)





CESIUM-137 SUBSURFACE SAMPLE LOCATIONS

- DETECT GREATER THAN BACKGROUND[1,2]
- DETECT LESS THAN BACKGROUND[1,2]
- NONDETECT[1]
- FIELD ANALYSIS ONLY FOR COPC

[1] Only fixed-base laboratory results are plotted in color.
[2] Background value as presented in DOE 2001.

- SURFACE WATER (direction of flow shown)
- DOE BOUNDARY
- PGDP BOUNDARY
- ROAD
- SURFACE CONTOUR (1 ft)
- SURFACE CONTOUR (5 ft)

TILE C

U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

COORDINATE SYSTEM: PGDP
PROJECTION: n/a
DATE: 12/09/2009
FILE NAME: SOILPILES\Add2.apr
PADUCAH REMEDIATION SERVICES, LLC
REFERENCES: PRS 2009;

250 0 250 Feet

Figure B.27. (Continued)

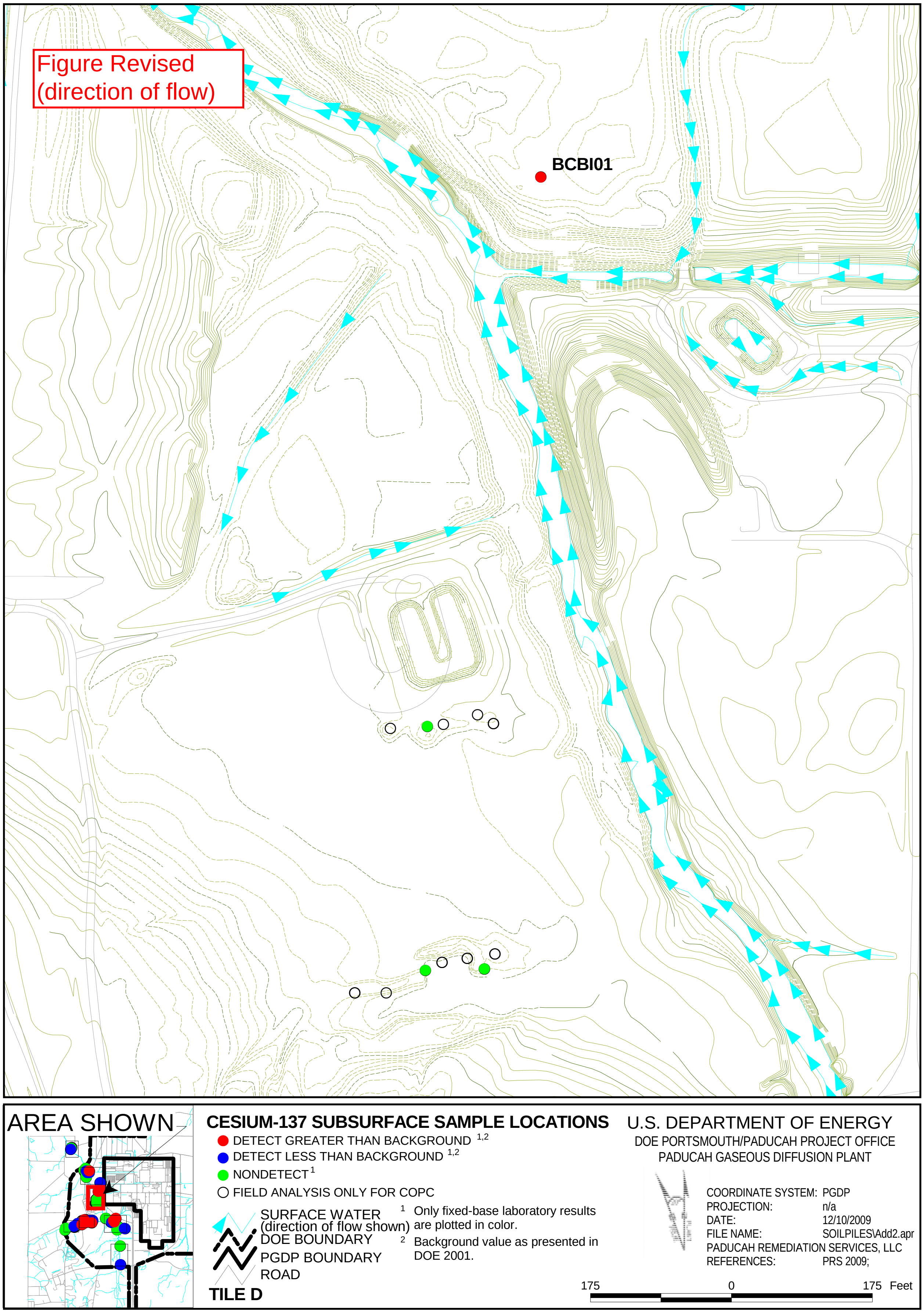
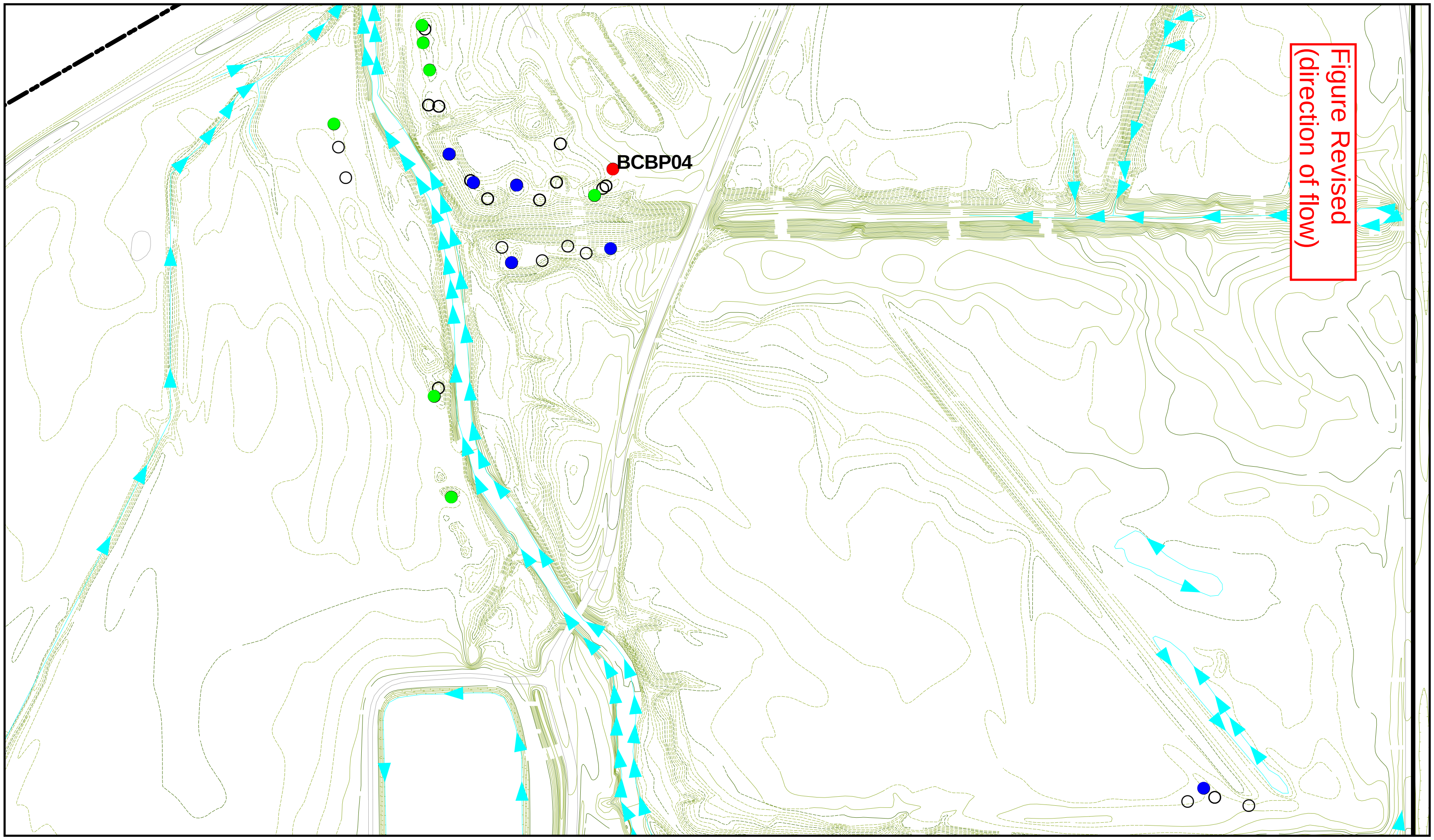
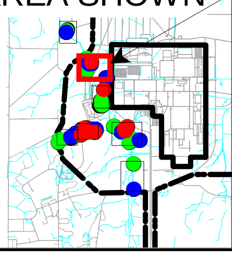


Figure B.27. (Continued)



AREA SHOWN



CESIUM-137 SUBSURFACE SAMPLE LOCATIONS

- DETECT GREATER THAN BACKGROUND[1,2]
- DETECT LESS THAN BACKGROUND[1,2]
- NONDETECT[1]
- FIELD ANALYSIS ONLY FOR COPC

SURFACE WATER (direction of flow shown)
DOE BOUNDARY
PGDP BOUNDARY
ROAD
SURFACE CONTOUR (1 ft)
SURFACE CONTOUR (5 ft)

[1] Only fixed-base laboratory results are plotted in color.
[2] Background value as presented in DOE 2001.

TILE E

U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

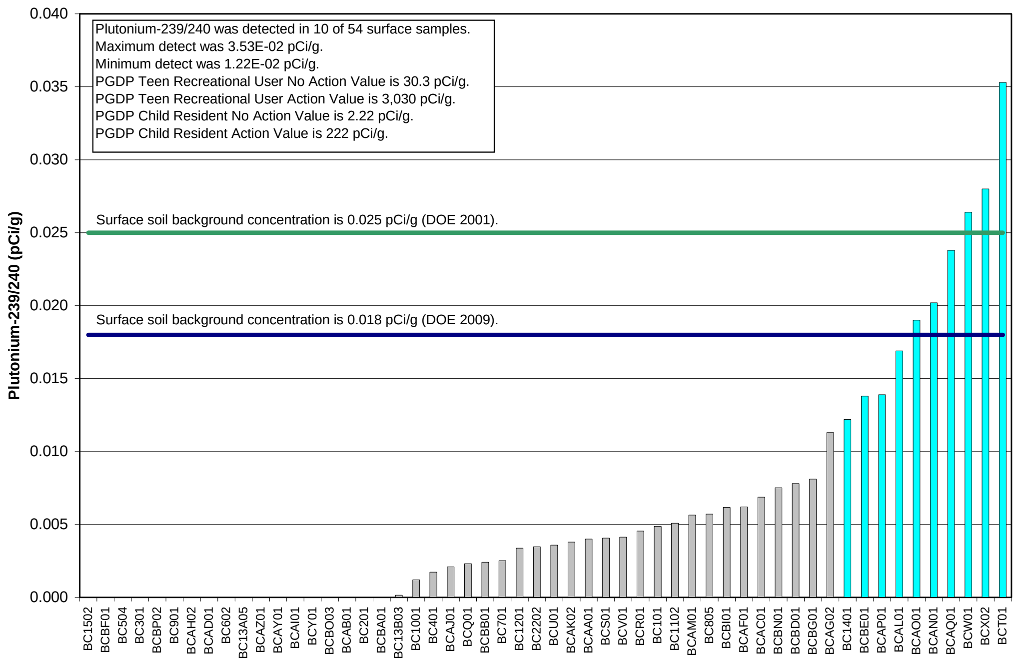
COORDINATE SYSTEM: PGDP
PROJECTION: n/a
DATE: 12/10/2009
FILE NAME: SOILPILES\Add2.apr
PADUCAH REMEDIATION SERVICES, LLC
REFERENCES: PRS 2009;

250 0 250 Feet

Figure B.27. (Continued)

Plutonium-239/240–Surface. Plutonium-239/240 values in surface soil samples exceed the background value of 0.025 pCi/g in 3 of 54 samples. The three exceeding values are 0.0264, 0.028, and 0.0353 pCi/g. Although the plutonium-239/240 concentration exceeds the site-specific background for PGDP, the concentration of plutonium-239/240 in samples exceeding background are below the concentrations associated with fall-out. Plutonium-239/240 is a major contributor to global fall-out due to atmospheric testing of nuclear weapons in the 1950s to the early 1960s. A summary from Argonne National Lab (ANL 2007) states that concentrations up to 0.1 pCi/g are expected from fall-out; therefore, plutonium-239/240 should not be considered in the Addendum 2 soil piles as a contaminant.

Figure B.28 graphically shows the results with the background value and other comparison values. Figure B.29 illustrates the spatial distribution of the sampling locations in which the background value was exceeded.



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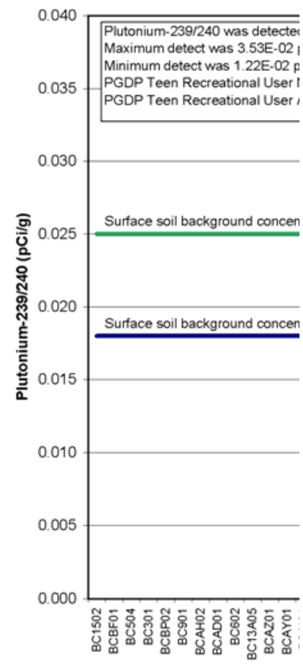

Figure B.28. Comparison between Plutonium-239/240 Concentrations in Samples from Soil Piles Addendum 2 and Surface Soil Background Concentrations

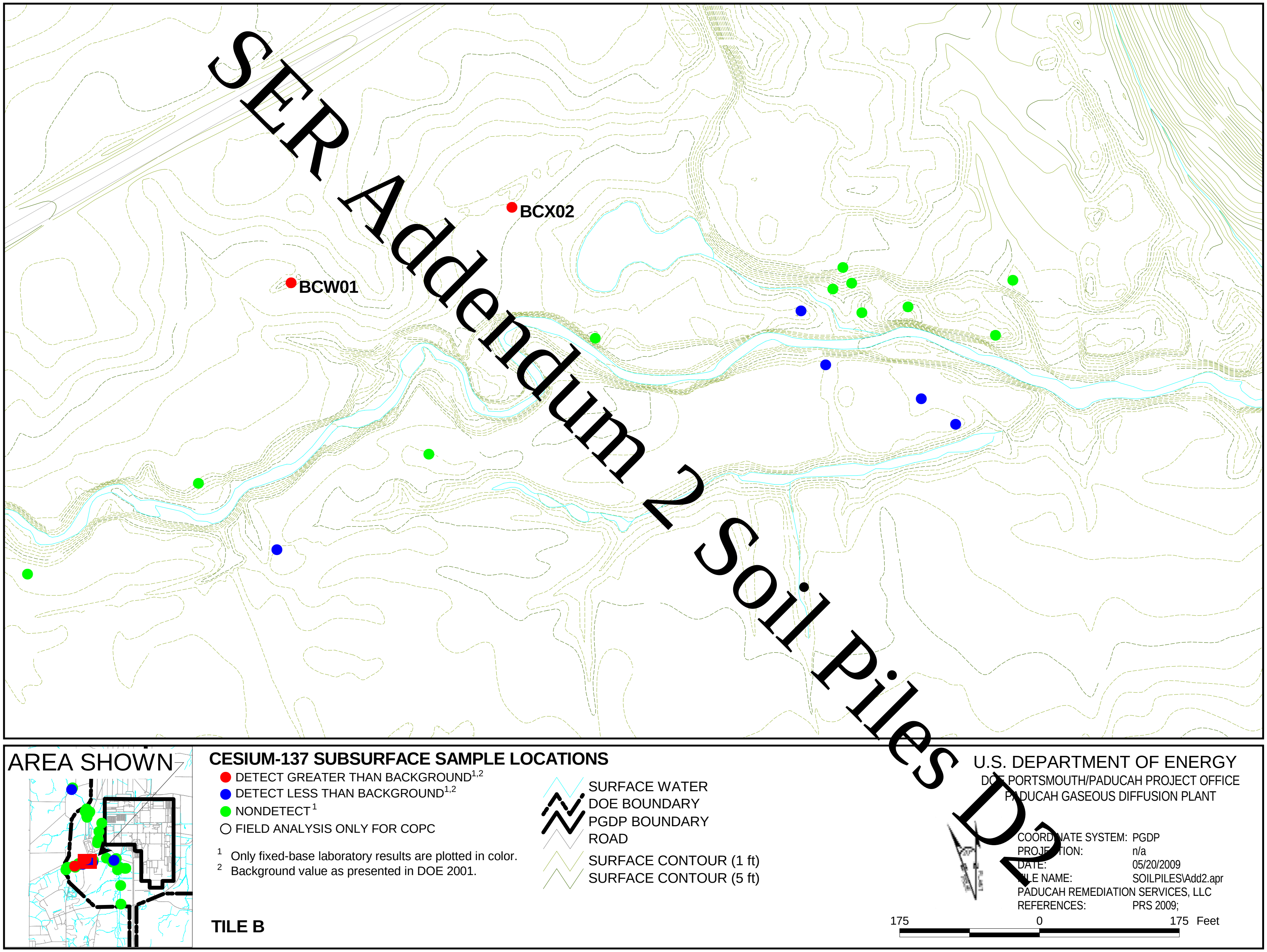

Figure B.29. (Continued)

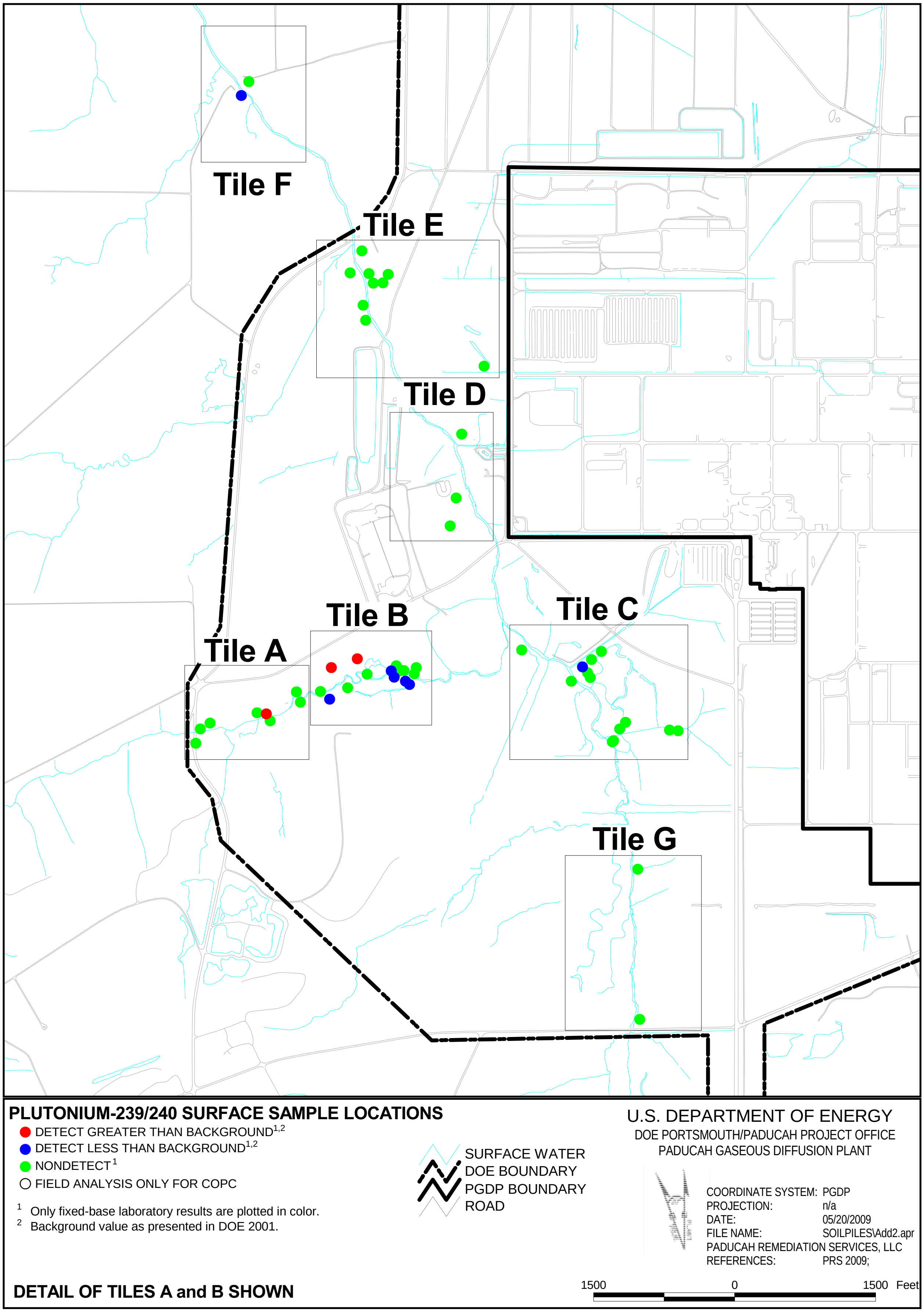

Figure B.29. Location of Sample Stations in Addendum 2 Soil Pile Sampling for Plutonium-239/240 on the Surface

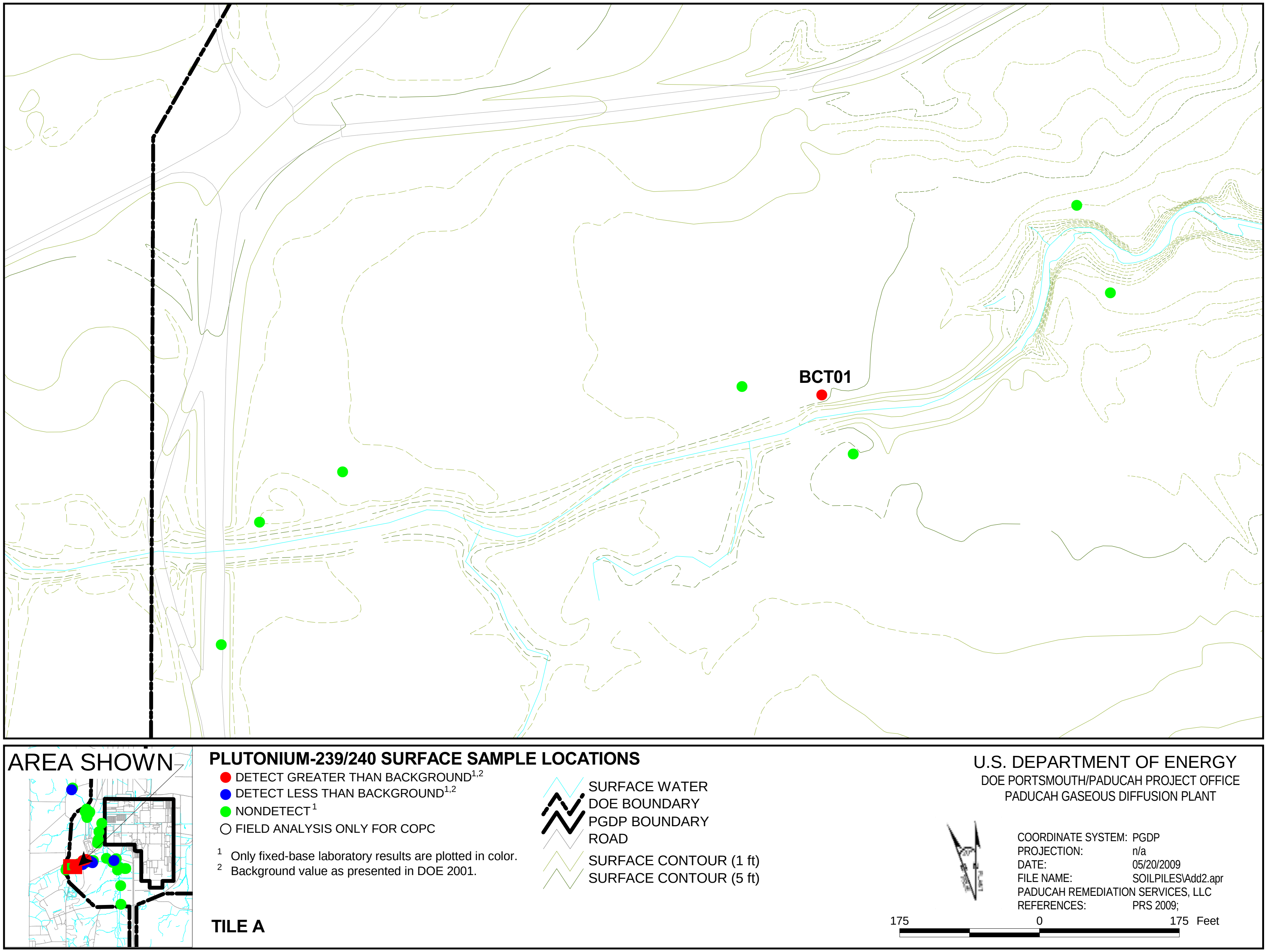

Figure B.29. (Continued)

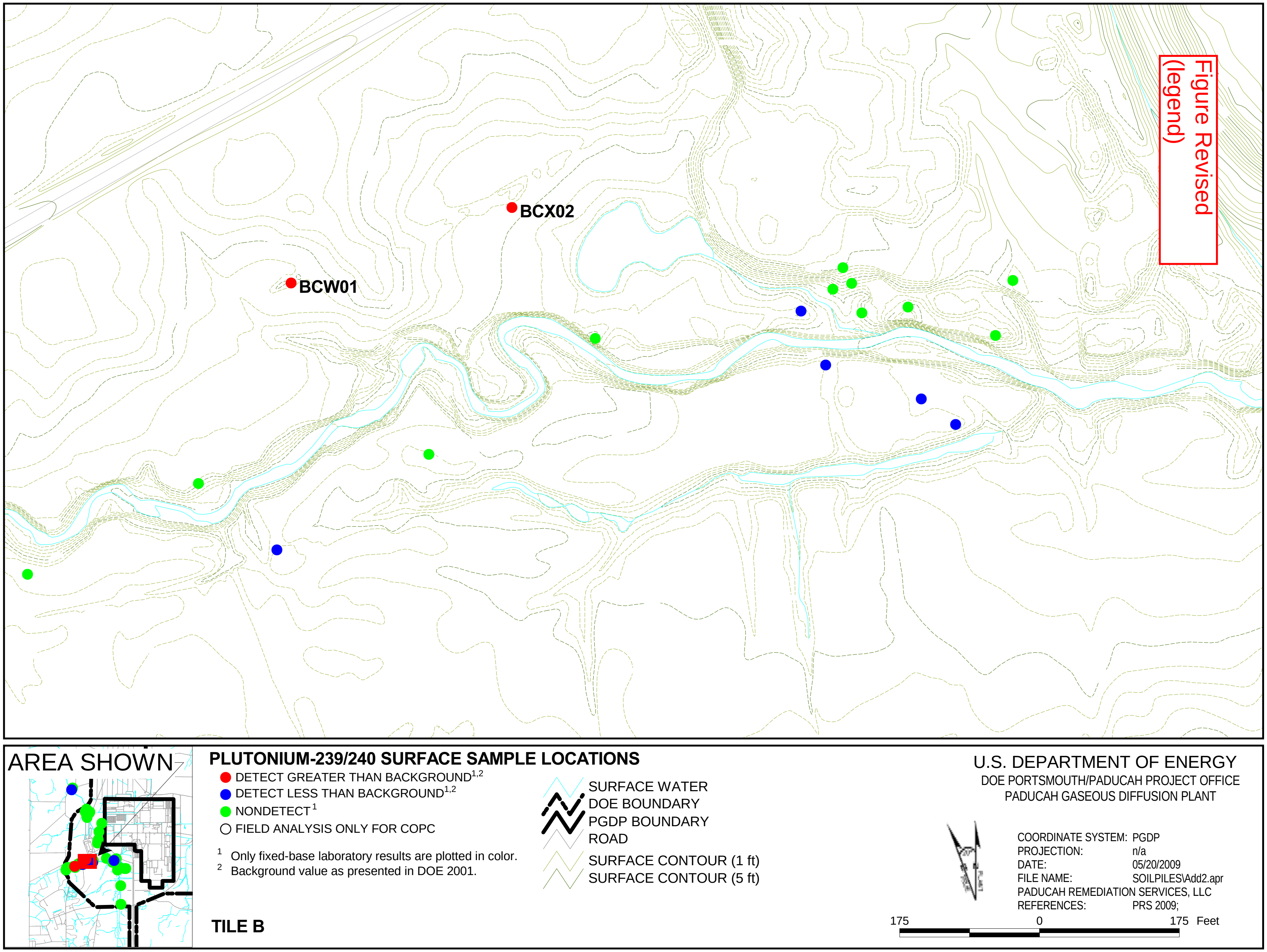

Figure B.29. (Continued)

Uranium-238–Surface. Due to the method by which uranium isotopes were analyzed by the laboratory, an incremental adjustment was applied in order to compare these results with screening values.[2] Incrementally adjusted uranium-238 values in surface soil samples exceed the background value of 1.2 pCi/g (1.205, 1.282, and 1.493) in three of the 54 samples. The exceeding values are the following: 0.405, 0.482, and 0.693 pCi/g. Prior to the incremental adjustment, uranium-238 values in surface soil samples did not exceed background. The revised background value, which is derived using two times the log-transformed mean, is 1.9 pCi/g (DOE 2009). Comparing the surface uranium-238 values to the adjusted, revised background value, there are no surface soil samples exceeding background.

Deleted: Incrementally-adjusted

Deleted: which adjusts to 0.4 pCi/g

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Figure B.30 graphically shows the results with the background value and other comparison values. Figure B.31 illustrates the spatial distribution of the sampling locations in which the background value was exceeded.

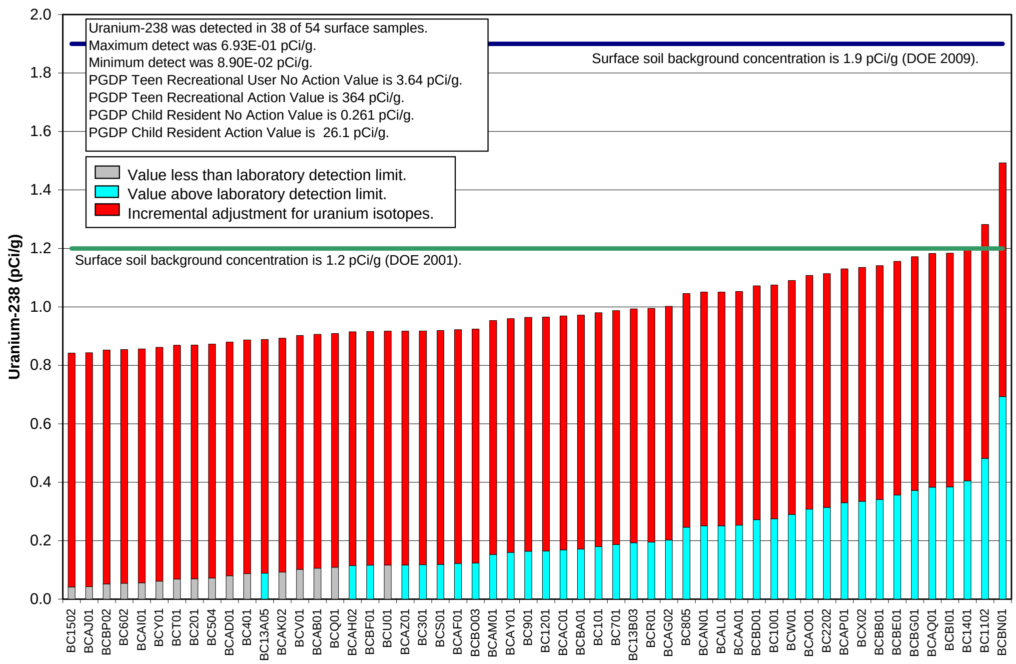

Figure B.30. Comparison between Uranium-238 Concentrations in Samples from Soil Piles Addendum 2 and Surface Soil Background Concentrations

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[2] The laboratory reported results for uranium isotopes near background values may be low based on the laboratory's extraction method. Due to this method, an incremental adjustment is necessary prior to comparison of the data to screening values. To simplify the comparison, the adjustment was made to the data results and not the screening values themselves. The incremental adjustments (0.77 pCi/g, 0.04 pCi/g, and 0.8 pCi/g for uranium-234, uranium-235, and uranium-238, respectively) were applied to results less than 10 pCi/g within the dataset. Screening is conducted upon detected values only; thus, the incremental adjustment did not affect results qualified by the laboratory as not detected.

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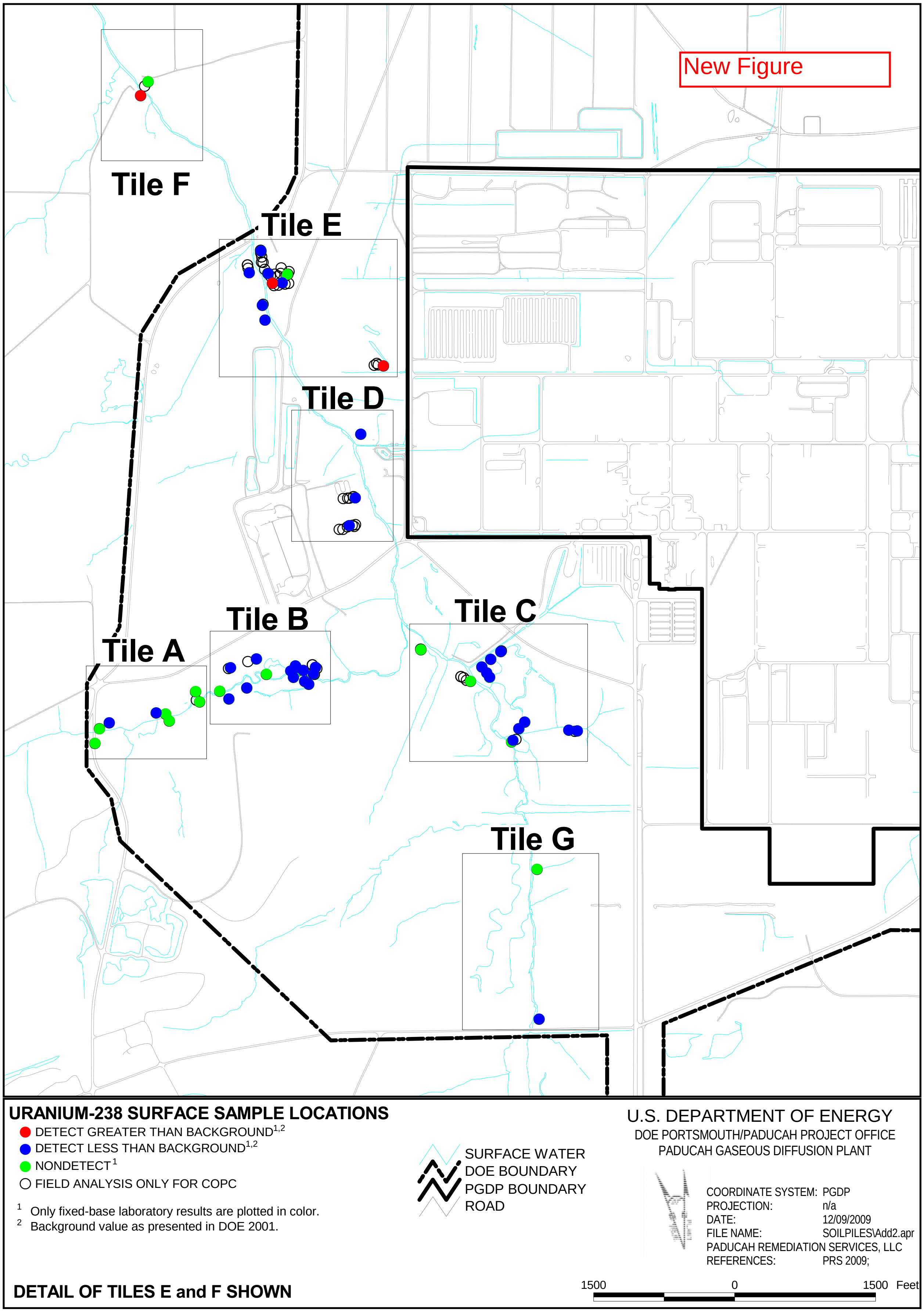

Figure B.31. Location of Sample Stations in Addendum 2 Soil Pile Sampling for Uranium-238 on the Surface

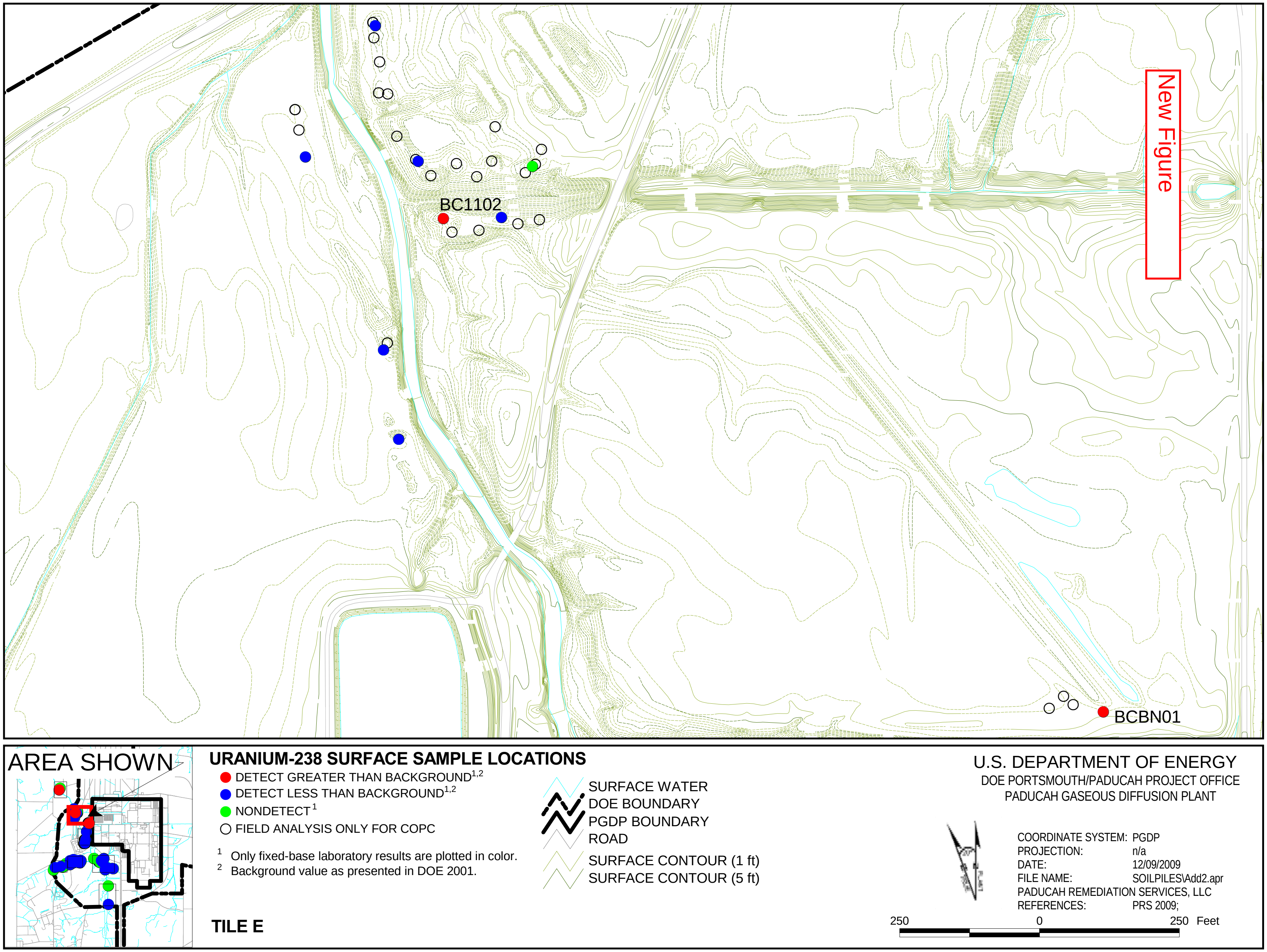

Figure B.31. (Continued)

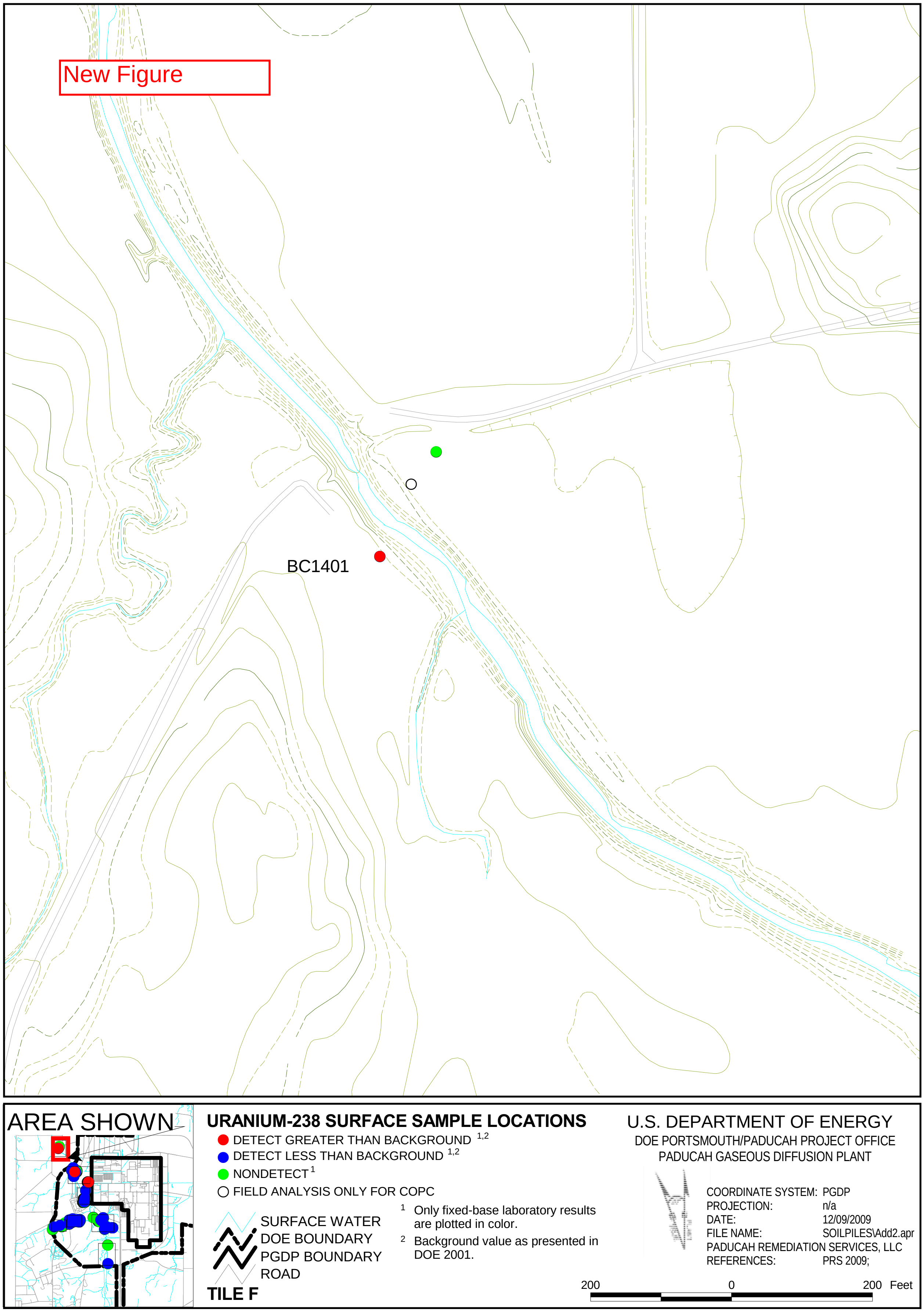

Figure B.31. (Continued)

Uranium-238–Subsurface. Due to the method by which uranium isotopes were analyzed by the laboratory, an incremental adjustment was applied in order to compare these results with screening values.[3] Incrementally adjusted uranium-238 values in subsurface soil samples exceed the background value of 1.2 pCi/g (1.31 and 1.756) in 2 of the 56 samples. The exceeding values are the following: 0.51 and 0.956 pCi/g. Prior to the incremental adjustment, uranium-238 values in subsurface soil samples did not exceed background. The revised background value, which is derived using two times the log-transformed mean, is 1.8 pCi/g (DOE 2009). Comparing the subsurface uranium-238 values to the adjusted, revised background value, there are no subsurface soil samples exceeding background.

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Deleted: The revised background value adjusts to 1.0 pCi/g.

Figure B.32 graphically shows the results with the background value and other comparison values. Figure B.33 illustrates the spatial distribution of the sampling locations in which the background value was exceeded.

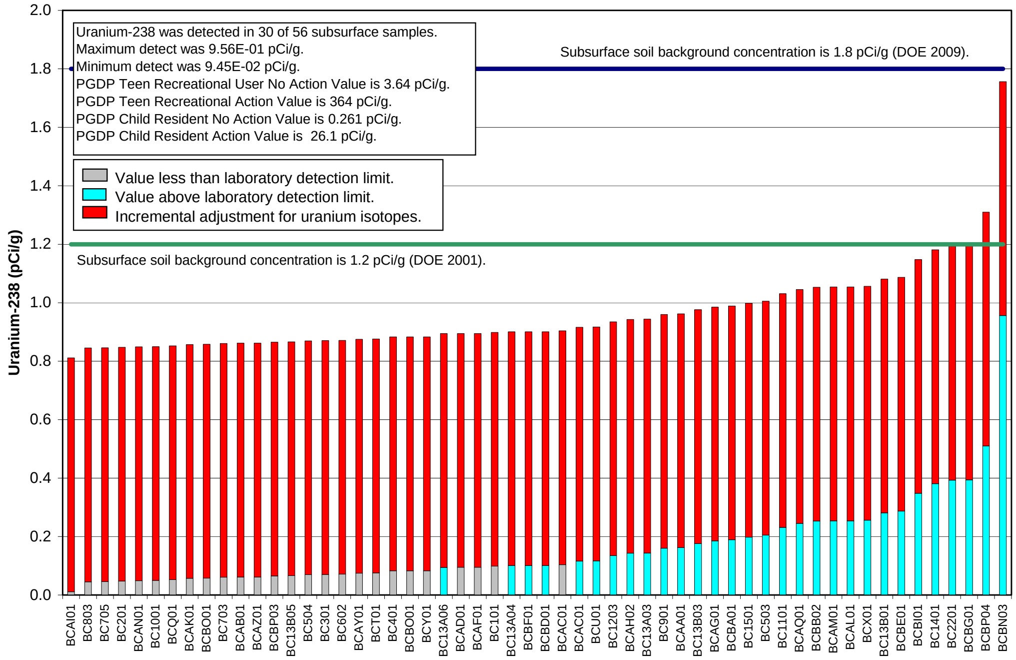

Figure B.32. Comparison between Uranium-238 Concentrations in Samples from Soil Piles Addendum 2 and Subsurface Soil Background Concentrations

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[3] The laboratory reported results for uranium isotopes near background values may be low based on the laboratory's extraction method. Due to this method, an incremental adjustment is necessary prior to comparison of the data to screening values. To simplify the comparison, the adjustment was made to the data results and not the screening values themselves. The incremental adjustments (0.77 pCi/g, 0.04 pCi/g, and 0.8 pCi/g for uranium-234, uranium-235, and uranium-238, respectively) were applied to results less than 10 pCi/g within the dataset. Screening is conducted upon detected values only; thus, the incremental adjustment did not affect results qualified by the laboratory as not detected.

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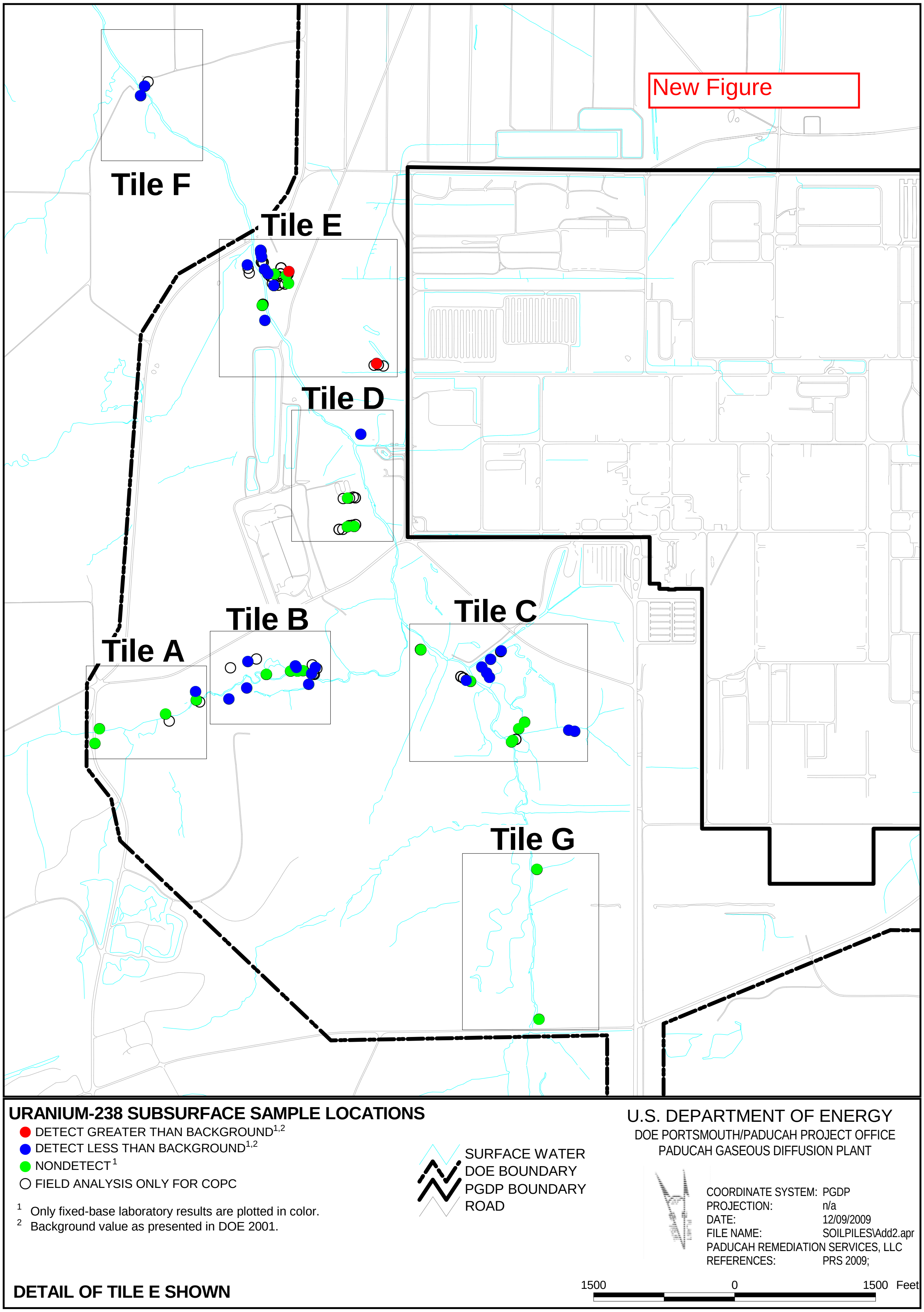
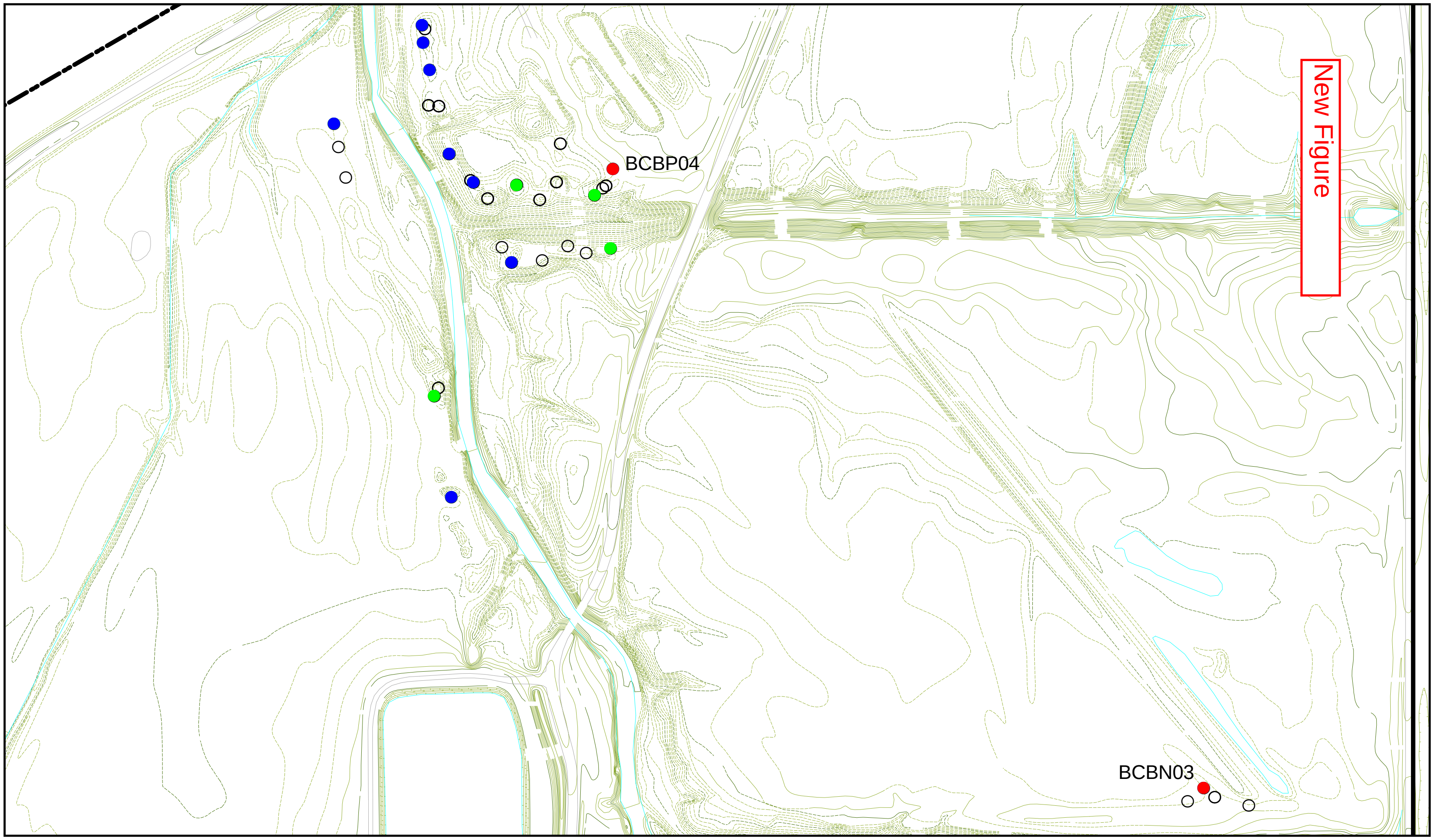
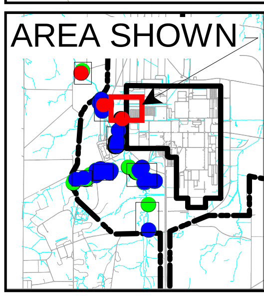


Figure B.33. Location of Sample Stations in Addendum 2 Soil Pile Sampling for Uranium-238 in the Subsurface





URANIUM-238 SUBSURFACE SAMPLE LOCATIONS

- DETECT GREATER THAN BACKGROUND[1,2]
- DETECT LESS THAN BACKGROUND[1,2]
- NONDETECT[1]
- FIELD ANALYSIS ONLY FOR COPC

[1] Only fixed-base laboratory results are plotted in color.
[2] Background value as presented in DOE 2001.

SURFACE WATER
DOE BOUNDARY
PGDP BOUNDARY
ROAD
SURFACE CONTOUR (1 ft)
SURFACE CONTOUR (5 ft)

TILE E

U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

COORDINATE SYSTEM: PGDP
PROJECTION: n/a
DATE: 12/09/2009
FILE NAME: SOILPILES\Add2.apr
PADUCAH REMEDIATION SERVICES, LLC
REFERENCES: PRS 2009;

250 0 250 Feet

Figure B.33. (Continued)

References

ANL (Argonne National Laboratory) 2007. *Radiological and Chemical Fact Sheets to Support Health Risk Analyses for Contaminated Areas*, Argonne National Laboratory, Environmental Science Division, March.

DOE (U.S. Department of Energy) 1997. *Background Levels of Selected Radionuclides and Metals in Soils and Geologic Media at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/OR/07-1586&D2, June.

DOE 2001. *Methods for Conducting Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky Volume 1. Human Health,* DOE/OR/07-1506&D2, December.

DOE 2009. *Methods for Conducting Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky Volume 1. Human Health*, DOE/LX/07-0107&D1/V1, July.

KEEC (Kentucky Energy and Environment Cabinet) 2004. *Kentucky Guidance for Ambient Background Assessment*, Kentucky Energy and Environment Cabinet, January.

MMES (Martin Marietta Energy Systems) 1991. *Paducah Gaseous Diffusion Plant Environmental Report for 1990*, ES/ESH-18/V3, September.

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Comment Response Summary

EPA and KY Comments for the

Site Evaluation Report
for Addendum 2 Soil Piles at the
Paducah Gaseous Diffusion Plant,
Paducah, Kentucky
(DOE/LX/07-0188&D2)

Prepared for
U.S. Department of Energy
Office of Environmental Management

COMMENT RESPONSE SUMMARY
for the
Site Evaluation Report for Addendum 2 Soil Piles at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky
DOE/LX/07-0188&D2

Comment Number	§/Page/¶	Comment	Response
Kentucky Division of Waste Management and Radiation Health Branch – Nov 25, 2009			
		General Comments	
1.		KY conditionally approved the *Sampling and Analysis Plan for the Soil Piles at the PGDP, Addendum 2* (DOE/LX/07-0015) on July 31, 2008. The conditions were that DOE would correlate gamma walkover survey results to uranium-238 activity in soil and that DOE would audit their laboratory methods and the analyses conducted by these methods to determine why the reported results for radionuclides in Addendum 2, Table 5 are lower than established background levels for PGDP soils. The CRS states that the laboratory audit resulted in no findings. The fact that the laboratory does not use HF is a finding and should be noted. Furthermore, it was determined that the DOE contract laboratory was not using the extraction methodology cited in the Addenda and was, therefore, reporting lower uranium results than would have been reported had they used the methodology cited. In the CRS, DOE stated that the correlation between the walkover survey and uranium-238 was not performed on Addendum 2 because the analytical results were within the range of background. A correlation study was proposed for the Addendum 1-B data. During teleconferences on October 4 and 6, 2009, DOE successfully sustained the argument that they tried to correlate the Addendum 1-B data but a useful correlation did not exist. Therefore, the FFA parties concluded that the gamma walkover survey results do not correlate in a useful, predictive manner with Uranium-238 (238U) activity in soil using the procedures employed by DOE and its contractor, PRS. Due to the lack of data for correlation and the continuing discussions concerning the uranium laboratory data, neither condition was met at the time the D1 CRS was submitted nor, accordingly, at the time *Site Evaluation Report for Addendum 2 Soil Piles* (DOE/LX/07-0188&D2)(A2SER) was issued. The conditions have since been met. No response to this short historical statement is necessary.	No response required.

COMMENT RESPONSE SUMMARY for the *Site Evaluation Report for Addendum 2 Soil Piles at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* DOE/LX/07-0188&D2			
Comment Number	**§/Page/¶**	**Comment**	**Response**
2.		The field results are not discussed in this text of the A2 SER. A discussion of radiological surveys results and XRF data (even qualitatively, such as the area was surveyed but not posted for radiological risk) would help support an argument for collecting fewer hard lab samples from each soil pile and enhance the understanding of the level of contamination exhibited by the soil piles. Include a discussion of field and fixed lab results like the one in Section 5.4 "Surface Distribution of Contamination" of the Soil Pile I SER in the A2 SER.	This text has been added to Section 3.1.5 "The area was surveyed but not posted for radiological occupational exposure." Due to the lack of field and fixed lab detections, a discussion or comparison is not warranted.

COMMENT RESPONSE SUMMARY
for the
Site Evaluation Report for Addendum 2 Soil Piles at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky
DOE/LX/07-0188&D2

Comment Number	§/Page/¶	Comment	Response
3.		Isotopic Uranium data must be compared to adjusted background as agree between the FFA parties. Revised using the correction factors given in the Uranium Data White Paper and compared results to background and NALs. This re-evaluation and the reason for it shall be discussed in the appropriate section of the document. If this evaluation changes the conclusions of the Addendum 2 Site Evaluation Report then the recommendations presented in the document must be modified.	Appendix B has been revised to consider adjusted background for isotopic uranium. The document was revised to indicate isotopic uranium data was adjusted. Footnotes 2 and 3 have been added to indicate the following on pages B-63 and B-67: "The laboratory reported results for uranium isotopes near background values may be low based on the laboratory's extraction method. Due to this method, an incremental adjustment is necessary prior to comparison of the data to screening values. To simplify the comparison, the adjustment was made to the data results and not the screening values themselves. The incremental adjustments (0.77 pCi/g, 0.04 pCi/g, and 0.8 pCi/g for uranium-234, uranium-235, and uranium-238, respectively) were applied to results less than 10 pCi/g within the dataset. Screening is conducted upon detected values only; thus, the incremental adjustment did not affect results qualified by the laboratory as not detected." Uranium-238 in surface and subsurface soil was found to be similar to or less than the 2001 Risk Methods Document after the incremental adjustment. No chemicals of potential concern were added to Addendum 2 as a result of the reevaluation.

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4.		A determination of "no further action" should be made by screening against baseline no action levels (NALs) not site specific NALs. Baseline NALs are developed using default exposure assumptions. Screening against site specific NALs occurs after screening against baseline NALs, for the first determination to be made is whether action is warranted. Insuring that an area is maintained so that exposures are limited to site-specific parameters is an action. Change the NALs to default residential levels for a determination of "no further action", or note that the property will be controlled to insure exposures consistent with present site usage, i.e., maintain exposure controls as a possible interim action.	As discussed on November 4 and 6, 2009, the screening criteria for the residential scenario evaluation were added to Appendix B. Additionally, these NALs were added to the charts. Applicable NALs were not exceeded for Addendum 2 Soil Piles.
		Specific Comments	
1.	Executive Summary, Page xi, Project Objectives, First Bullet	The sampling procedure followed does not address "hot-spot" and "Exposure Units" as defined by DOE Order 5400.5 and Control and Release of Property with Residual Radioactive Material for use with DOE 5400.5 and *Radiation Protection of the Public and Environment.* The following is taken directly from DOE. "DOE Order 5400.5, Chapter IV: 4. GUIDELINES FOR RESIDUAL RADIOACTIVE MATERIAL. *Residual Radionuclides in Soil. Generic guidelines for thorium and radium are specified below. Guidelines for residual concentrations of other radionuclides shall be derived from the basic dose limits by means of an environmental pathway analysis using specific property data where available. Procedures for these derivations are given in DOE/CH8901. Residual concentrations of radioactive material in soil are defined as those in excess of background concentrations averaged over an area of 100 (1) Hot Spots. If the average concentration in any surface or below-surface area less than or equal to 25, exceeds the limit or guideline by a factor of (100/A), [where A is the area (in square meters) of the region in which concentrations are elevated], limits for "hot-spots" shall also be developed and applied. Procedures for calculating these hot-spot limits, which depend on the extent of the elevated local concentrations, are given in DOE/CH-8901. In addition, reasonable efforts shall be*	As stated in the previous CRS, the objective of the Site Evaluation was not to release property. The primary objectives of the sampling effort are listed in the Addendum 2 to the SAP for Soil Piles at the PGDP (DOE/LX/07-0015/A2&D2) June 2008 and do not include property transfer. DOE property transfer will follow applicable requirements and DOE Orders such as DOE 5400.5, if and when the property is to be released.

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		made to remove any source of radionuclide that exceeds 30 times the appropriate limit for soil, irrespective of the average concentration in the soil. It appears that the requirements and guidelines in the cited DOE Order are applicable at the time the property is released. See DOE Order 5400.5, Chapter IV, 1st paragraph. It is the Commonwealths' understanding that DOE will have to follow DOE 5400.5 in the future or the property can't be released. Additionally, it may also be pointed out that the approved SAP was not designed to look for "hotspots" as required by the Order. The SAP design was such as to look for evidence of contamination, i.e., is contamination present. See pg 6, Section 1.2 *Addendum 2 to the Sampling and Analysis Plan for Soil Piles at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, 2007*. If the project objective is not to release the property then DOE 5400.5 is not applicable. Additionally, the analytical parameters are inconsistent with that required for release of property. Please state specifically the goal of the sampling and state specifically the limitations on the use of the collected data; please do not neglect to address property release. Finally, it is requested that it be specifically stated what procedures, sampling, etc., will be followed before the property is released.	
2.	CRS to Executive Summary, Page xi, Project Objectives, 1st Bullet is insufficient:	The CRS states that "the data may be utilized in the future for such a purpose" in reference to the release of property. The CRS failed to address property release as a specific goal for the data collection. If data is to be used for property release then "property release" should be one of the stated project objectives. The CRS failed to specifically address the limitations on the use of the collected data. The CRS should describe how DOE will follow their orders and which of their orders they will follow as related to property release.	See response to specific Comment No. 1.

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3.	Executive Summary, Page xii, Investigation Findings, Fifth Line	This comment was not adequately addressed in the CRS. The sampling and analysis plan was not followed nor was Cs-137 retained as a COC. Given the small number of samples collected and the stated goal of determining if contamination is present, the Cs-137 samples should have resulted in further sampling to determine the boundaries of contamination. See Section 1.2, pg 2 and Addendum 2 SAP, pg 6 for the goal of the sampling effort. Note also, that five collected surface soil samples, as presented in Figure 23, contain values twice the 95% Upper Tolerance Boundary as presented in *Background Levels of Selected Radionuclides and Metals in Soils and Geologic Media at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, 1997*. Figure 26 shows that subsurface soil samples in the same areas as the surface soil samples are also twice the 95% Upper Tolerance Boundary. In Figure 3 from Addendum 2 SAP, the definition of contamination is presented as COPC concentrations resulting unacceptable risks to recreational site users. The agreed upon document *Methods for Conducting Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, 2001* lists the Cs-137 No Action Level for a Teen Recreational User as 0.178 pCi/g. The surface soil Cs- 137 values are greater than 0.8 pCi/g. It strikes this reviewer that a reasonable professional would be negligent in failing to examine collocated samples that have the joint characteristics of being higher than the 95% UTL and higher than the No Action Level under present site usage. It should also be pointed out that had the procedure outlined in Section 5.3, pg 21 been followed, Cs-137 would have been retained as for further consideration as a COC. Please delineate the extent of contamination for Cs-137 as consistent with *Addendum 2 to the Sampling and Analysis Plan for Soil Piles at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, 2007* by additional sampling. If DOE is convinced that the Cs-137 data is consistent with worldwide fallout then DOE may propose sampling a subset of the Cs-137 areas to show that the seemingly high data is anomalous.	Based on conversations between DOE, KY, and EPA on December 10, 2009, Cs-137 was not retained as a COPC because its detections are below the range of background after consideration of default and other reference background values; therefore, additional sampling is not warranted. The results are similar to background and the results referenced were taken from piles that are located upstream of PGDP.

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4.	Executive Summary, Page xii, Summary of Investigation Conclusions, 2nd Sentence	Define the methodology used or the standard by which it was determined that that the data collected for Addendum 2 was not, "was less than or similar to background".	Appendix B documents the methodology used to determine the data collected for Addendum 2 was consistent with background. Executive Summary now states "was less than or similar to background."
5.	Section 2.4.1, Page 6	Much of this paragraph was deleted. It provides the same information as that on Page 4 of this document. This appears to constitute an unsolicited change on a D2 document. Please, state specifically whether the change was in response to regulator input on the D1 document or if the change was unilateral.	The change was made unsolicited; however, it was made because it is redundant with information provided in the previous SAP (DOE/LX/07-0015&D2/R1), Section 1.1, last paragraph.
6.	Section 3.1.2, Page 9, Last Sentence	"In addition, no unexpected field conditions were encountered." This is an unsolicited change in a D2 document. Please, state specifically whether the change was in response to regulator input on the D1 document or if the change was unilateral.	This was added in response to EPA specific Comment No. 3 in regard to their comments on the D1 version.
7.	Section 3.1.4, Page 19, Table 1	The CRS response is clearly contradictory to both the intent of fully disclosing the analytical procedures and the wording associated with Table 1. The Table is labeled "…Analytical Requirements for Soils" and the paragraph above the table states that each soil sample "…was analyzed in accordance with the method requirements outlined in Table 1." It should also be noted that while the CRS proposed changes to Table 1, those changes were not made in the document. Although entering the suggested changes into the document would not address the expressed concern, failing to make any changes leaves the comment unaddressed. By fully addressing the comment which immediately follows this comment (Section 3.1.4, Page 19, Table1), both comments should be satisfactorily addressed.	Please see response to KY specific Comment No. 8.

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8.	Section 3.1.4, Page 19, Table 1	Not only is the DOE contract laboratory (USEC) is not following the cited EML HASL- 300 analytical method but also they failed to cite a methodology which can be checked or easily reproduced by others. The DOE EML HASL-300 method calls for complete dissolution using HF. This was the method cited in the D1 document. In the D2, a vague descriptor is substituted for a description of the method. The methods listed in the CRS are not complete or appropriately cited. If someone desired to reproduce this study what method would they follow? Please cite a peer reviewed or standard methodology for each characterization parameter in Table 1 to address this comment.	Table 1 has been updated to reflect the methods performed by the USEC laboratory (EML HASL-300 methods have been removed). The USEC laboratory's bench methods for the radiochemistry analyses also are included in Table 1, page 20. The lab's methods are peer reviewed by subject matter experts.
9.	Section 4.1.1, Page 21, Second Paragraph	Field splits should be collected instead of field duplicates. The paragraph still states precision is measured using field duplicates. For the lab samples, the MS and MSD pairs are correct. Comment noted is a sufficient response to this comment.	Samples were collected in accordance with the approved SAP and PRS Procedures.
10.	Section 6.1.1, Page 29 and Page 32, Figure 5	The new wording for the D2 in this section and the new graphic illustration on page 32, Figure 5, are not supported by the agreed upon SAP, specifically; the addition of the "other background criteria" and the "DOE 2008" is outside of the SAP. These changes to the screening procedures in this D2 document seem to be designed to support the lack of contingency samples for Cs-137 and do not constitute a response to the clarifications requested but rather represent an unsolicited change to a D2 document. Present a fully developed graphic consistent with the agreed upon SAP.	Other referenced background values were evaluated and utilized in addition to the values noted in the SAP. Background screening completed in this Site Evaluation is consistent with other PGDP projects.
11.	Section 6.1.4, Page 34, Paragraph 1	Please cite the document *National Council on Radiation Protection and Measures* (NCRP) 116, in addition to the PGDP Risk Methods Document (DOE 2001), as the reference for the 1 mrem/yr level. See NCRP Report No. 116 (1993). The CRS states that a reference was added, but we are unable to locate the citation. Please state the location where the citation was added to the text.	The citation was added to Section 6.1.4, page 36.
12.	Section 8.1, Page 41, Bullet point 1	In the definitions of SWMU and AOC the criteria that soil "not pose imminent risk to human health" is a criterion not normally associated with SWMU and AOC. For an AOC soils must be shown not to constitute a "current or potential threat to human health or the environment." See Federal Facilities Agreement 2008 (DOE/OR/07-	"Do not pose imminent risk to human health" was removed from the text. In the February 16, 2007, notification letter, it was noted these soil areas were being designated as SWMUs and/or AOCs based on limited information and the proposed sampling data that

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		1707). Please, harmonize the definition with that of the FFA.	would be collected during the site evaluation would be used to determine which areas may have been “inappropriately designated as a SWMU or AOC in this notification.” When the SWMU/AOC notification was being prepared, the soils piles were conservatively declared SWMUs and/or AOCs pending collection of additional data. The relevant parts of the RCRA Permit definition of a SWMU includes “…any discernable unit which has been used for the treatment, storage, or disposal of solid waste or hazardous waste at any time…” SWMUs include areas that have been contaminated by routine and systematic releases of hazardous waste or hazardous constituents….” Environmental media is not considered a solid waste, nor did the SE identify evidence of solid waste or hazardous waste at these areas. Furthermore, the results of the sampling data from the SE did not confirm these areas to be “contaminated by routine and systematic releases of hazardous waste or hazardous constituents” as originally thought as being possible at the time the February 2007 notification was developed. We do not believe they meet the definition of a SWMU. If an area does not meet the definition of a SWMU, it then is evaluated to determine if it meets the definition of an AOC. The AOC definition from the RCRA Permit includes “Any area having evidence of a release of a hazardous waste or hazardous constituent, which is not from a Solid Waste Management Unit and poses a current or potential threat to human health or the environment.” Again, as noted, the SE sampling confirmed these soil areas do not contain “releases that pose a current or potential threat….” They would not meet the definition of an AOC either. The definition in the SER now reflects the FFA.

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			The text now reads "The Addendum 2 piles do not meet the definition of a SWMU or AOC because the constituent concentrations in soil are at or near background levels or do not exceed NALs, and no documentation exists to indicate the presence of wastes. The soil piles do not pose a current or potential threat to human health or the environment. As a result, no further investigation is recommended for the 54 soil piles along Bayou Creek (Addendum 2 Soil Piles)."
13.	Section 9, Page 43	The "DOE 2008" risk methods document reference was deleted. Please decide if it will be used and then cite it appropriately or if it won't be used then don't cite it. If it is cited, the correct date will likely be 2009, but as the document is still undergoing revisions, so the correct date could be 2010.	The revised, updated risk methods document is not referenced in the main text. References to DOE 2008 in the main text are to the Site Evaluation Report for Soil Pile I. The revised, updated risk methods document is referenced in Appendix B as DOE 2008 under the Appendix B reference section. It is listed as a draft document because at the time the appendix was developed, the 2009 Risk Methods Document had not been submitted as a D1 document. References within Appendix B to DOE 2008 have been revised to DOE 2009.

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14.	Appendix B, Figure B.23 – page B-48, B.26 – page B-52 and B.28 – page B-58	The reference to soil background concentrations from the "(DOE 2008)" is incorrect. The reference in the chart to "DOE 2008" has not changed. The only approved reference is the "(DOE 2001)". The value charted is twice the median or mean from the draft Risk Methods Document (DOE 2010?) It would be best to provide a short paragraph stating that the value on the chart represented as DOE 2008 represents is twice the median or twice the mean from DOE Paducah background project documents. One of the background project documents is 1995 and another is 1997. A third document exists which you may also need to be cited. It will not be necessary to change the charts.	References to DOE 2008 has been revised to DOE 2009. This document has been formally submitted as *Methods for Conducting Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant Paducah, Kentucky, Volume 1. Human Health,* DOE/LX/07-0107&D1/V1. The text "the revised site background values for PGDP published for review in 2009"[1] has been added to the paragraph on page B-4 describing sources for screening values. The background project documents are not referenced because their information is incorporated into the DOE 2009 reference. [1] The draft site background values published for review in 2009 represent two times the log-transformed median (mean for radionuclides) value for use in screening to determine if inorganic chemicals or radionuclides are detected at naturally occurring concentrations in surface or subsurface soil.

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EPA – Dec 3rd, 2009			
1.		EPA general comment #3 questioned why DOE compared chromium to the KEEC 2004 ambient background value and the ANL 2007 instead of the site specific background concentration value which is the most conservative value. Part of DOE's response was "The background screen is not meant necessarily to screen against the most conservative of the background values available, but to screen results that are below values that reasonably could be expected to occur outside the influence of PGDP". The purpose of the background screen should be to screen against site specific background concentrations. The KEEC 2004 value is a state-wide generic value and should not be utilized for comparison to background values especially when site specific background concentrations are available. Remove reference to the KEEC 2004 and ANL 2007 values in the text and tables and summarize results when compared to site specific background concentrations.	Table 7 of the main text and Table 1 of Appendix B provides a summary of results compared to site-specific background concentrations. However, a range of background values is useful for determining whether a value could be reasonably expected to occur outside the influence of PGDP. The values presented in KEEC 2004 are applicable to all sites in Kentucky, but must follow a procedure for application, as defined in the guidance. Additional information has been added to Appendix B regarding the appropriate use of state-wide background values. See specifically pages B-4, B-9, B-14, B-19, B-24, B-32, B-40, B-43, and B-46. Information regarding chromium in surface soil below the range of background presented is found on page B-32. For chromium in subsurface soil, one result is greater than the range of background presented. It is compared to no action levels.

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2.		EPA's specific comment #6, requested Standard Reference Material (SRM) recoveries for the metals to support the assertions made in the D1 document concerning performance. DOE's response discussed the XRF sampling limitations and stated that language was added to the SER to clarify. The SRM recoveries were not addressed in the response or the revised text. None of DOE's response was included in the D2 text. DOE added this sentence in response to the comment: "It should be noted that field screening methods used may not have always achieved detection limits below background due to limitations of the screening method". The added sentence does not address the comment. Please include DOE's response to EPA's comment #6 in the SER and include SRM recovery information.	The SRM recovery information has been added as a Table 2, page 21. In addition, the following previous response has also been added to the SER text. "The XRF provides a value and/or delimiter for each metal analyzed for as well as a range of error. This range of error is vital in interpreting XRF results. For example, if the XRF provided a detection of a certain metal at a value of 10 mg/kg with an error of +/-10, the actual result would be between 0-20 mg/kg. For lead, taking into consideration the range of error values, the XRF results were very close to the results provided by the lab. XRF detections for uranium and chromium were mostly <MDL, so interpretation is limited. However, even though readings of <MDL do not produce an actual value, these still provide valuable information. Knowing that field levels for metals of concern are less than a specific value can help make important decisions in the field. Chromium levels in all of our samples were less than 65 mg/kg, which was the MDL. Analytical data proved that the Cr levels all were less than 65mg/kg. It should be noted that there were a few Cr detections in which the XRF provided an actual value that was less than 65 mg/kg rather than the <MDL. When applying the error associated with this value, the estimated value was very close to the MDL."
3.		EPA's specific comment #8, requested the range of concentrations detected during field measurements for gamma radionuclides using a Canberra IN Situ Object Counting System (ISOCS). A table with the range was included in the comment response summary, but does not match what was presented in the D2 document. Please present the correct range in the SER. In addition, DOE stated that the mean, median, and number of samples would be added to the SER. However, these values are not included, please include these as well.	The SER has been revised to include the correct range of concentrations detected as well as the mean, median, and number of samples. Table 3, page 21.