CHARACTERIZATION OF AMBIENT LEVELS OF SELECTED METALS AND CPAHS IN NEW JERSEY SOILS:

YEAR III – RURAL AREAS OF NEW JERSEY HIGHLANDS, VALLEY AND RIDGE, AND COASTAL PLAIN PHYSIOGRAPHIC PROVINCES

Prepared for:

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March 2002

Submittal Date: **Version 3 – March 29, 2002**

Project Name: **"Characterization of Ambient Levels of Selected Metals and cPAHs in New Jersey Soils: Year III – Rural Areas of New Jersey Highlands, Valley and Ridge, and Coastal Plain Physiographic Provinces"**

Project Term: October 2000 to January 2002

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EXECUTIVE SUMMARY

BEM Systems, Inc. (BEM) was contracted in March 2000 by the New Jersey Department of Environmental Protection (NJDEP) Division of Science and Research to complete a study to establish ambient background soil concentrations for selected metals and carcinogenic polynuclear aromatic hydrocarbons (cPAH) for rural areas of New Jersey. Specifically, the study area comprised rural areas of the Valley and Ridge, Highlands, and Coastal Plain physiographic provinces. This report is the third in a series of studies commissioned by the NJDEP since 1997.

REGULATORY BASIS OF THE STUDY

The New Jersey Industrial Site Recovery Act (S1070) was adopted in March 1993 and provides the regulatory basis for these commissioned studies. Section 58:10B-12 of this Act requires that the NJDEP adopt minimum remediation standards for soil, groundwater and surface water. In addition, the Act stipulates that remediation goals shall not be required beyond the regional natural levels for any particular contaminant. In 1997, the Technical Requirements for Site Remediation (Chapter 7:26E) was adopted and provides two technical methods for establishing background concentrations in soils. The first method is to collect soil samples for analysis to establish ambient concentrations for particular chemical constituents. A portion of the second method to establishing ambient concentrations, which is the basis of this report, is to compare site specific chemical data to ranges reported in appropriate references. Hence, this report and the other studies commissioned by the NJDEP, are intended to be used as reference studies to establish applicable ambient concentrations. These ambient concentrations will be used in consideration of appropriate remediation goals for specific contaminated sites within New Jersey.

SAMPLE SELECTION PROCESS

A total of ninety soil samples were collected and analyzed from the three physiographic provinces. A breakdown of sample locations by province is as follows:

Physiographic Province	Number of Soil Samples
Valley and Ridge	23
Highlands	23
Coastal Plain	44

A goal of the study was to collect representative soil samples to define concentrations of metals (target analyte list) and cPAHs that occur naturally in soil within rural areas of the study area. The Office of State Planning defines a rural area as having a population density less than 1,000 people per square mile, and this definition was used as a basis for this study. A process was then developed to minimize or eliminate anthropogenic sources of contaminated areas that may impact or otherwise bias the results of the study. First, using Geographic Information System (GIS), the rural areas of the study area were mapped. Next, GIS was used to map soil groups within each of the physiographic provinces and to establish the dominance of a particular soil series within each of the provinces. The number of samples per soil series were then assigned using the percentage of rural acreage of a given soil series within each province. The larger the percentages of rural acreage of a specific soil type the larger the number of soil samples allocated to be collected. The rural area mapping was then overlain with the soil series coverage to provide a geographic area that would be suitable for sample collection. These samples were also correlated to a specific soil series. Several soil series within the Coastal Plain have been documented to contain arsenic-containing glauconite and high levels of iron (Tedrow, 1986). Therefore, the collection of samples from such soils could have indicated a high concentration of arsenic and iron. However, it was determined that the areal extent of these types of soils fell below the required percentage and therefore they were systematically eliminated from the selection of soils to be sampled.

To further refine representative sample locations, potential anthropogenic sources were considered in the sample selection process. Specifically, no sampling was conducted within 250 feet of roads or railroads. In addition, samples were not collected in areas with historic fill, gardens, golf courses, manicured lawns, wetlands or landscaped areas. Through this process, sample locations were selected and sample coordinates were established using GIS. The latitude and longitude of a designated sample was then entered into the GIS unit and was used to locate the sample location in the field. Once the sample was collected, a GIS reference location was obtained to document that the sample was collected in the correct designated area.

RESULTS OF SAMPLING

Summary of Data Evaluation

Data were evaluated against the NJDEP Residential Direct Soil Cleanup Criteria (RDCSCC) and Nonresidential Direct Soil Contact Criteria (NRDCSCC) to determine if any individual compound concentrations were above these criteria. In order to summarize the data further, the arithmetic and geometric means, standard deviation, maximum and minimum concentrations were calculated for each analyte. An analysis of variance and a correlation analyses (Pearsons correlation) was also completed to determine the presence of significance of the analytes between the physiographic provinces and to determine whether soil concentrations of TAL metals and cPAHs correlated to TOC and pH. Finally, the data was compared to previous studies completed for other locales and soil types in New Jersey and completed for soil materials sampled throughout the world.

Summary of Study Results

Since rural soils were the basis of this study, low concentrations of metals and cPAHs were expected and are the results of this study. In the Highlands and Valley and Ridge provinces, the source of metals in soils is derived from glaciation and weathering of the parent bedrock material. Naturally occurring metals are present in soils in this area and vary in constituent type and concentrations due to the variation in bedrock types encountered in these provinces. Metal concentrations in soils within the Coastal Plain are derived from depositional processes during fluctuating sea levels. The largest sources of cPAHs are as a result of atmospheric deposition of particles from sources of fossil fuel combustion.

Metals Results

When using the NJDEP criteria, only one metal was detected in a single soil sample at a concentration that slightly exceeds the NJDEP RDCSCC and NRDCSCC. Specifically, beryllium was detected at a concentration exceeding both the RDCSCC (2 mg/kg) and NRDCSCC (2 mg/kg) in one sample, designated as HI-35. This sample was collected in the Highlands physiographic province and detected a beryllium concentration of 2.8 mg/kg.

Beryllium is a naturally occurring trace element and could occur in the parent bedrock material. However, correlation of the sample location to the parent rock material reveals that the soils in this locale are underlain by a quartz-oligclase gneiss (Owens, et al 1998). These types of rocks do not tend to contain beryllium as a major constituent (Bates, 1983). Therefore, it is likely that the beryllium is from an unidentified anthropogenic source. No exceedances of metals above the RDCSCC or NRDCSCC were detected in the Valley and Ridge and Coastal Plain, the other two provinces that comprise the study area.

cPAH Results

In this study, only one cPAH compound was detected at a concentration that slightly exceeds the RDCSCC and NRDCSCC. Specifically, benzo(a)pyrene was detected at a concentration above the RDCSCC and NRDCSCC of 0.66 mg/kg in one soil sample, designated as HI-34. The detected benzo(a)pyrene concentration in this sample was 0.68 mg/kg and most likely originates from an unidentified anthropogenic source. From the statistical analysis that was conducted for the sample results, this value is insignificant. No exceedances of cPAHs above the RDCSCC or NRDCSCC were detected in the Valley and Ridge and Coastal Plain, the other two provinces that comprise the study area.

CONCLUSIONS OF STUDY

Some of the conclusions of this study are as follows:

- Regulatory cleanup criteria such as the RDCSCC and NRDCSCC are useful benchmarks for the findings of this study. Individual soil ambient concentrations in excess of the RDCSCC were observed only for beryllium and benzo(a)pyrene; however, the overall rural Highlands (as well as Valley and Ridge and Coastal Plain) mean concentration of every constituent was less than the corresponding RDCSCC (and NRDCSCC). In addition, the exceedances were so low they were essentially negligible. The slightly elevated beryllium and benzo(a)pyrene concentrations appear to originate from anthropogenic sources, which were not evident to the sampling team.

- Ambient levels in general (without specific reference to urban, industrial, or rural areas) are also a useful benchmark for the findings of this study. Several prior studies have been conducted at various regional levels and scopes. Although no statistically-based conclusions can be drawn because BEM does not have access to the raw data from these other studies, the following are still useful observations: (1) mean soil concentrations of arsenic are slightly lower as data collected by Rutgers in a study of Red Beds of New Jersey (Ugolini, 1964); (2) mean soil concentrations of other metals are generally below the data compiled by USGS (Shacklette, 1984) for the conterminous United States; and (3) mean soil concentrations of arsenic are approximately the same as the worldwide data (Vinogradov (1959);. However, lead was found to be at higher mean concentrations in this study as compared to the USGS findings. It should be noted that the Rutgers study, the USGS studies and world study used different analytical methods than this study and therefore a direct comparison of the data cannot truly be made. Further, comparisons are not possible for cPAHs because general ambient data are not available.

- Statistically significant differences between mean concentrations in the regions is likely due to the parent material of the soils, rather than to anthropogenic pollution, since samples were specifically targeted to be have a lower potential for these sources. It was determined using Analysis of Variance (ANOVA) that the differences between the mean Coastal Plain and mean Highlands results, as well as between the Coastal Plain and Valley and Ridge results are statistically distinct (at the 95 percent confidence level) for nearly all the TAL metals. Again, this is most likely due to the source of the soil material (i.e. bedrock materials for the two northern provinces, versus depositional marine environments for the Coastal Plain region).

- As expected, since the soil sampled from all three regions did not knowingly have high concentrations of glauconite, arsenic and iron concentrations were relatively low and did not exceed the RDCSCC.

- Overall, the data results were much lower than previous studies completed in New Jersey and around the world. This could be attributed to the differences in analytical methodologies in the several of the studies. Or it could be attributed to the biasing of the studies to rural, not anthropogenically impacted soils and therefore would be an expected finding.

RECOMMENDATIONS

Based upon the findings of this study, the following recommendations are offered:

- The data in this report should be used to establish a range of values (minimum and maximum) and an appropriate measure of central tendency (arithmetic or geometric mean) for the concentrations of TAL metals and cPAHs in soil and soil characteristic parameters. This can be accomplished at various regional levels, however, it should be noted that the data from this study are strictly applicable only to rural areas, based on the population density criterion specified in the project scope. If some larger regional aggregation (e.g., county-level or province-level) is desired, this can easily be accomplished because the data are linked with GIS, but the data set should be augmented to include more urbanized, more industrialized areas within these larger regions (see below). In such a study, soil concentrations of TAL metals at the upper-end of the foregoing ranges (particularly those that exceed the RDCSCC and NRDCSCC) would be likely to be primarily of anthropogenic origin. Soil concentrations of TAL metals at the lower-end of these ranges would probably be of mixed origin, naturally occurring and anthropogenic. As there are no known natural sources for cPAHs, soil concentrations of cPAHs are solely of anthropogenic origin.

- The ambient soil data from this rural soils study (and the Piedmont and Urban Soils) database should be linked to the NJDEP's current groundwater database. It is our understanding that NJDEP's Site Remediation Program (SRP) has developed a database containing regional and site-specific groundwater data, water quality data, and various groundwater indicator parameters, as part of New Jersey's participation in the National Environmental Performance Partnership System (NEPPS). Linking these soil and groundwater databases would permit NJDEP to evaluate corelationships between statistically elevated ambient concentrations of various constituents in soil data and groundwater concentrations within the same aquifer zone, system, or other regional classification. Also, in areas where groundwater data are lacking, the ambient soil data could be used to impute these missing groundwater data via the use of an appropriate groundwater fate and transport model. Similarly, the groundwater data can be utilized to fill in gaps in the soil data.

- Based on the selection process of this study, only soil series with an areal extent above an identified percentage were sampled. This method, although allowing the soils with the most coverage to be sampled, neglected to evaluate soils that may have a significance based on their origin. For example, in the case of the Coastal Plain region, soils known to contain arsenic containing glauconite and iron are present, primarily along Inner Coastal Plain (Tedrow, 1986), but were not sampled as part of this study (since the areal extent of such soils fell below four percent). Sampling of soils, defined as rural, and derived from parent material known or suspected to contain a higher than expected natural concentrations of metals should be completed. Results of such studies should be correlated to the data obtained from this study as well from the studies completed in the urban Piedmont and urban Coastal Plain regions.

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1.0 INTRODUCTION

The New Jersey Industrial Site Recovery Act (S1070) was adopted on March 15, 1993 and requires the New Jersey Department of Environmental Protection (NJDEP) to adopt minimum remediation standards for soil, groundwater and surface water. To address this mandate, the NJDEP was required, under N.J.S.A. 58:10B-12(g)(4), to *"develop regulations that set forth a process to identify background levels of contaminants for a particular region"*. The basis for establishing natural background concentrations is found in [N.J.S.A. 58:10B-12(g)(4)] which also places restrictions on remediation standards as follows: *"Remediation shall not be required beyond the regional natural background levels for any particular contaminant"*. The citation also states that "…'regional' natural background levels' means the concentration of a contaminant consistently present in the environment of the region of the site and which has not been influenced by localized human activities…" This would include naturally occurring constituents and concentrations resulting from regional deposition, but not levels contributed from the immediate locale. For purposes of this report, the concentrations of contaminants included in the N.J.S.A. definition will be called "ambient concentrations".

The Technical Requirements for Site Remediation (Chapter 7:26E) was established on February 18, 1997 and constitutes the minimum technical requirements to investigate and remediate contamination at any site. Subchapter 7:26E-3.10 provides two methods for establishing ambient concentrations in soil. The first method is to conduct an ambient soil investigation by sampling to establish "representative" ambient constituent concentrations. The second method is to demonstrate that the contaminant concentrations at the site are due to ambient conditions. As part of this second method to establish ambient conditions, subchapter 7:26E-3.10 (a) (2ii) states, *"the chemical concentrations detected in soil at the site are within ranges reported in appropriate references for background levels for New Jersey"*.

Since 1997, the NJDEP Division of Science and Research commissioned several studies to be used as appropriate references for establishing ambient soil concentrations. This report and study is entitled, *"Characterization of Ambient Levels of Selected Metals and cPAHs in New Jersey Soils: Year III – Rural Areas of New Jersey Highlands, Valley and Ridge, and Coastal Plain Physiographic Provinces"*. This report is a third in a series and the data augments information obtained and reported in the following prior studies:

"Characterization of Ambient Levels of Selected Metals and Other Analytes in New Jersey Soils: Year 1, Urban Piedmont Region," BEM, 1997; and

"Characterization of Ambient Levels of Selected Metals and Other Analytes in New Jersey Urban Coastal Plain Region Soils", BEM, 1998.

This report is presented in following sections:

- Section 1.0 states the study's primary objective and the project-specific definitions;
- Section 2.0 contains descriptions of the geology and the selected soils sampled in the three physiographic provinces;
- Section 3.0 presents the specifics of the sample site selection process such as site screening criteria and the underlying rationale for these criteria are discussed at length;
- Section 4.0 contains information on the sampling and analytical methodologies.
- Section 5.0 presents the quality assurance/quality control (QA/QC) measures for the study;
- Section 6.0 contains discussions pertaining to analytical results of soil samples and the statistical analyses of these results;
- Section 7.0 contains an overall discussion summarizing the findings and conclusions of this study
- Section 8.0 provides conclusion based upon the results of the study;
- Section 9.0 discusses recommendations for application of this study and possible future research; and
- Section 10.0 cites the references.

1.1 Project Objectives

The objective of this project was to define and quantify ambient levels of target analyte list (TAL) metals[1] and carcinogenic polynuclear aromatic hydrocarbons (cPAHs[2]) in rural land use areas ("RLUAs") within New Jersey's Valley and Ridge, Highlands, and Coastal Plain physiographic provinces (Figure 1). More specifically, the areas selected for sampling were biased toward locales that were likely comprised of naturally occurring soils and were not altered by man-made activities.

The types of soils present in any given area are related to the geology, landforms, relief, climate and natural vegetation of the area. Naturally occurring or background soils are within the study area and are likely originate from weathering of parent bedrock material in the case of the Valley and Ridge, and Highlands physiographic provinces. These soils are then influenced by the other factors that typically form soils (e.g. landforms, relief, and climate). In the case of the Coastal Plain physiographic province, the soils originate from of layers of sand, silt and clay that were deposited alternately in deltaic and marine environments, (NJDEP, 1999)

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[1] Target Analyte List Metals include aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, nickel, potassium, selenium, silver, sodium, thallium, vanadium, and zinc. The rationale for selecting these materials as analytes is in accordance with an earlier study conducted in the Piedmont physiographic region (BEM, 1997b) and the Coastal Plain physiographic region (BEM, 1998b).

[2] Only carcinogenic polynuclear aromatic hydrocarbons (cPAHs) were analyzed. These included benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoroanthene, benzo(k)fluoroanthene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-c,d), pyrene. The rationale for selecting these materials as analytes is in acccordance with two earlier studies conducted in the Piedmont physiographic region (BEM, 1997), and the Coastal Plain physiographic region (BEM, 1998).

The counties included in this study as they lie within the three physiographic provinces were (Figures 2 and 3):

Valley and Ridge Physiographic Province:

Warren
Sussex
Highlands Physiographic Province:

Warren
Sussex
Morris
Hunterdon
Somerset
Passiac

Coastal Plain Physiographic Province:

Atlantic
Burlington
Camden
Cape May
Cumberland
Gloucester
Mercer
Middlesex
Monmouth
Ocean
Salem

The results of this study will be used in tandem with the results of the research conducted during the first two phases of the study to develop regulatory criteria for the ambient levels of target metals and cPAHs in New Jersey.

1.2 Definitions

The following is a list of key definitions used throughout this report:

- ***Anthropogenic Sources:*** The term "anthropogenic sources" is defined as sources of, relating to, or resulting from the influence of human beings on nature. Anthropogenic sources of metals include fossil fuel combustion, industrial and incinerator emissions, mining and smelting, agricultural chemicals, inorganic fertilizers and liquid and solid wastes (Campbell, 1976, Davies, et al., Law & Gordon, 1979, Menzie et al., 1992 Perwak et al., 1982 Santodonato, 1981). Most cPAHs are a result of atmospheric deposition of particle-bound PAHs after local and long-range transport (Thomas, 1986).

- ***Background:*** The term “background” is defined as “soil concentrations which include constituents that naturally occur in soil” [(N.J.S.A. 58:10B-12(g)(4)] and concentrations attributable to regional atmospheric deposition.”[3] These data will augment the database compiled during an earlier studies conducted within the Piedmont physiographic region and Coastal Plain physiographic region of New Jersey (BEM, 1997a, BEM, 1997b, BEM, 1998a and BEM, 1998b).

- ***Carcinogenic Polycyclic Aromatic Hydrocarbons (cPAHs):*** Only cPAHs were analyzed. These suite of specific compounds are: benzo(a)anthracene; benzo(a)pyrene, benzo(b)fluoranthene; benzo(k)fluoranthene; chrysene; dibenzo(a,h)-anthracene; and indeno (1,2,3-cd) pyrene. The rationale for selecting these materials as analytes is in accordance with an earlier study conducted in the Piedmont physiographic region (BEM, 1997b) and the Coastal Plain physiographic region (BEM, 1998b).

- ***Rural Land Use Areas (RLUAS):*** For purposes of this study, RLUAs are defined as municipalities with population densities less than 1,000 people per square mile (NJDEP, 1997) (Figure 1).

- ***Target Analyte List (TAL) Metals:*** TAL Metals include aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, nickel, potassium, selenium, silver, sodium, thallium, vanadium, and zinc. The rationale for selecting these materials as analytes is in accordance with earlier studies conducted in the Piedmont physiographic region (BEM, 1997b), Coastal Plain physiographic region, (BEM, 1998b).

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[3] As amended by NJDEP in comments to the Characterization of Ambient Levels of Selected Metals and Other Analytes in New Jersey: Year 1, Urban Piedmont Region (BEM, 1997b).

2.0 PROJECT AREA DESCRIPTION

2.1 Valley and Ridge Physiographic Province

2.1.1 Geology

The Valley and Ridge physiographic province is located in the northwestern part of New Jersey (Figure 3). This province comprises 635 square miles, or approximately eight percent of the area of the state and is made up of primarily sandstone, shale and limestone. It consists of Lower Cambrian through Upper Ordovician age rocks of the Kittatinny Valley sequence to the southeast and Lower Silurian through Middle Devonian age rocks to the northwest. These rocks originated as sand, mud, and lime sediment deposited in former seas and floodplains. During the Ordovician time and again during Permian time, the rocks were deformed by compression into folds and thrust along faults. As a result of the deformation, the originally flat sedimentary layers were tilted and now outcrop as northeast to southwest linear belts.

The Appalachian Valley is located along the northwest margin of Warren and Sussex Counties. It consists of a northeast to southwest trending belt approximately 12 miles in width. Other notable landscape features are the Minisink Valley, which borders the Delaware River, the Kittatinny Ridge, averaging 1,600 to 1,800 feet above mean sea level (msl), and the broad Kittatinny Valley. Valley surfaces lie as much as 800 feet below the crest of the ridge. The Kittatinny Mountains in northwestern New Jersey mark the northeasternmost extension of the high ridges of the Valley and Ridge Province

The Kittatinny Mountain is composed of Silurian age formations. The southeast margin of the mountain is composed of the Shawangunk conglomerate, consisting of a light gray quartzite containing rounded white quartz pebbles set in a steel-gray siliceous matrix. The top of the Kittatinny Mountain and its northwestern flank are composed of the Bloomsburg (High Falls) Formation. This formation consists of red sandstones and shales. The Delaware River has eroded through the Kittatinny Mountain to form the Delaware Water Gap.

Between Flat Brook and the Delaware River, located in Sussex County, a series of sedimentary rocks of Silurian and Devonian ages are present. These deposits consist mainly of gray limestone and shales (Tedrow, 1986).

2.1.2 Soils

A review of the most recent United States Department of Agriculture (USDA) Soil Conservation Service (SCS) Soil Surveys (1962-1989) was completed for the counties in the Valley and Ridge region. Soil samples were collected from three different soil series (Figure 4) which are described below; the soil series classification of each sample is summarized in Table 1 (along with other sample information). A brief description of each soil-type (and its associated code) is presented below along with a description of the surface layer (top six inches). For the purposes of this study, like soil-types were consolidated and considered a single series. It is important to note that the descriptions provided below reflect only the soil series that were sampled, not all possible soil series in the rural Valley and Ridge physiographic province, since the many did not meet the selection criteria defined by the study.

Bath/Norwich
(Hereafter referred to as the "Bath" group, or soil series)

Sussex County (BaB, BaC, BfD, BfE, BgB, BgD, BgE, NhA, NoA)
Warren County (BfB, BfC, BfD, BfE, BgB, BgC/NpA, NpB)

Sample locations are shown on Figure 4 and are listed in Table 1. The Bath series consists of well-drained soils that originate from glacial till derived mainly from slate, sandstone and shale (USDA, SCS, Warren County, 1975). The surface layer is dark brown gravelly loam with fine and medium pebbles (approximately eight inches thick). Typical vegetation consists mostly of ash and cedar trees and shrubs such as arrowwood and azalea (USDA SCS, Warren County, 1975).

Swartswood/Nassau/Wurtsboro/Oquaga
(Hereafter referred to as the "Swartswood" group, or soil series)

Sussex County (SwB, SwC, SwD, SxB, SxE, NaB, NaC, NfD, NfE, Ng, WtB, WtC, WuB, WuC, OmB, OmD, OrD)
Warren County (SuB, SvB, SvC, SvD, SwB, SwC, SwD, SxB, SxC, SxD, SxE/NaC, NbB/WvB, WvC/ORD)

Sample locations are shown in Figure 4 and are listed in Table 1. The Swartswood series soils originate from glacial till derived mainly from sandstone, quartzite and shale (USDA, SCS, Warren County, 1975). The Swartswood series consists of dark brown, including dark grayish brown and dark yellowish brown, somewhat excessively drained, well-drained, moderately well-drained, to somewhat poorly drained soils that are common in Sussex and Warren counties. The surface layer (zero to six inches in depth) is typically dark brown leaf litter with a black mat of decayed leaves underlain by dark brown to dark grayish/yellowish gravelly silty loam with stones and many fine to medium roots. Typical vegetation consists mostly of ash, cedar, pine and oak trees and shrubs such as arrowwood and azalea. (USDA SCS, Warren County, 1975)

Washington/Wassaic
(Hereafter referred to as the "Washington" group, or soil series)

Sussex County (WhB, WhC, WhD, WkC, WkD, WlC, WlD, WmC, WmD, WnD)
Warren County (WaA, WaB, WaC2, WaD2, WgB, WgC, WgD, WkB, WkC, WkD, WkE/WmA, WmB, WnC, WnD)

Sample locations are shown in Figure 4 and are listed in Table 1. The Washington series originates from glacial till derived from limestone, shale and granitic material (USDA, SCS, Warren County, 1975). These soils consist of brown to dark grayish or yellowish-brown, well-drained loamy soils. The surface layer (zero to six inches in depth) is comprised of dark grayish-brown, loam/gravelly loam with many fine to medium roots and angular limestone fragments. Typical vegetation consists mostly of ash and cedar trees and shrubs such as arrowwood and azaleas. (USDA SCS, Warren County, 1975).

2.2 Highlands Physiographic Province

2.2.1 Geology

On the eastern edge of the Valley and Ridge region is the Highlands physiographic province (Figures 2). It is located along a line from Franklin through Andover to the Delaware River just north of Phillipsburg. An irregular escarpment averaging 500 feet in height marks the boundary the province. The Highlands physiographic province, known more broadly as the Reading Prong of the New England Upland, is an extension of the ancient rocks of New England across northern New Jersey and extends from the Hudson Highlands in New York State southwesterly through New Jersey.

The Highland Region encompasses the upland areas of northern New Jersey, the Hudson Highlands region of southern New York (including Manhattan, the Bronx, and parts of Brooklyn and Staten Island), and upland parts of Connecticut. The region is a rugged, hilly to mountainous terrain, bearing the characteristic scars of Pleistocene glaciation. The rocky outcrops visible on hillsides and along stream banks consist mostly of ancient gneiss and schist (highly metamorphosed sedimentary and igneous rocks) that were once buried many miles below the earth's surface. The highest elevations within this province range from approximately 1,500 feet above msl in the northeast to just below 1,000 feet above msl along the Delaware River. There are several long, narrow valleys which stand from about 500 to about 800 feet above msl. The largest of these is Musconetcong Valley, with a river of the same name issuing from New Jersey’s largest lake, Lake Hopatcong, (Wolfe, 1977).

These rocks, the oldest in New Jersey, were formed between 1.3 billion and 750 million years ago by melting and recrystallization of sedimentary rocks that were deeply buried, subjected to high pressure and temperature and intensely deformed. The Precambrian rocks are interrupted by several elongate northeast-southwest trending belts of folded Paleozoic sedimentary rocks (NJDEP, 1999).

2.2.2 Soils

Within the Highlands physiographic province soil samples were collected from three different soil series (Figure 5); the soil series classification of each sample is summarized in Table 1 (along with other sample information). A brief description of each soil-type (and its associated code) is presented below along with a description of the surface layer (zero to six inches below grade) from which the soils were collected. It is important to note that the descriptions provided below reflect only the soil series that were sampled, not all possible soil series in the rural Highlands province, since the many did not meet the selection criteria defined by the study.

Parker/Edneyville (Hereafter referred to as the "Parker" group, or soil series)

Warren County (PbD, PbE/EdB, EdC, EeB, EeC, EPD)
Morris County (PeC, PeD for Parker-Edneyville; PaC, PbD for Parker; EdB, EdC, EdD for Edneyville)
Hunterdon County (PaC, PaD/EdB, EdC2, EdD and EeC)

Sample locations are shown in Figure 5 and are listed in Table 1. The Parker series soils originate from granitic gneiss that formed glacial till (USDA, SCS, Warren County, 1966). The Parker series consists of well drained to excessively drained soils that occur on uplands. The surface layer is dark-brown, cobbly or gravelly loam (approximately 10 inches thick). In the Parker series, the soils are often consist of extremely stony sandy loams. Types of vegetation typically found in the Parker series are oak, ash, hornbeam, ironwood, zelkova and pine trees, and arrowwood, azalea and bayberry shrubs. (USDA SCS, Warren County, 1966; Morris County, 1974; Hunterdon, 1974).

Rockaway/Whitman (Hereafter referred to as the "Rockaway" group, or soil series)

Passaic (RmB, RmC, RrC, RrD, RsC/Wo)
Sussex County (RoB, RoC, RoD, RpD, RpE, RrD, Wo)

Sample locations are shown in Figure 5 and are listed in Table 1. The parent material for the Rockaway series is glacial till composed mainly of granitic gneiss (USDA, SCS, Passiac County, 1975). The Rockaway series consists of moderately well drained to well drained soils. The surface layer (approximately zero to six inches) is very dark grayish-brown to yellowish brown gravelly sandy loam and contains an abundance of roots. Typical vegetation consists mostly of pine, oak and some ash trees. (USDA SCS, Passaic County, 1975).

Washington/Wassaic (Hereafter referred to as the "Washington" group, or soil series)

Sussex County (WhB, WhC, WhD, WkC, WkD, WlC, WlD, WmC, WmD, WnD)
Warren County (WaA, WaB, WaC2, WaD2, WgB, WgC, WgD, WkB, WkC, WkD, WkE/ WmA, WmB, WnC, WnD)

Sample locations are shown in Figure 5 and are listed in Table 1. The Washington series originates from glacial till derived mainly from limestone, shale and granitic material (USDA, SCS, Warren County, 1975). These soils consist of brown to dark grayish or yellowish-brown, well-drained loamy soils. The surface layer (zero to six inches) is generally comprised of dark grayish-brown, loams/gravelly loams with many fine to medium roots and angular limestone fragments. Typical vegetation found in this soil type are ash and cedar trees, and shrubs such as arrowwood and azaleas. (USDA SCS, Warren County, 1975).

2.3 Coastal Plain Physiographic Province

2.3.1 Geology

The Atlantic Coastal Plain is located to the southeast of the Piedmont physiographic province, extending to northeast to southwest along the Atlantic seaboard from the southernmost part of the United States to New England. In New Jersey, the Coastal Plain region (Figure 2 and Figure 3) consists of a seaward-dipping wedge of unconsolidated deposits of Cretaceous to Quaternary age overlying Precambrian bedrock (Zapecza, 1990). The deposits generally consist of clay, silt, sand, and gravel, and are of marine, continental, or coastal origin. Glacial deposits associated with the terminal moraine (outwash and till) are found only in the northern tip of Middlesex County, which marks the southern limit of late Wisconsin glaciation in the study area.

The Coastal Plain deposits are thinnest in the western part of Middlesex and Mercer Counties where the deposits pinch out along the fall line, where younger Coastal Plain deposits and the underlying Triassic Age bedrock come into contact, and in the northwest part of Burlington, Camden, Gloucester, and Salem Counties, where the Delaware River separates this portion of New Jersey from Pennsylvania. The Coastal Plain deposits thicken to greater than 6500 feet at the southern tip of Cape May County along the Atlantic coast.

The Cretaceous age deposits crop out in the southeast portion of Middlesex and Mercer Counties and in the northwest portions of Monmouth, Burlington, Camden, Gloucester and Salem Counties (NJDEP 1984). These Coastal Plain deposits are composed predominantly of sand, clay, and greensand marl. From oldest to youngest, the geologic formations associated with these deposits are as follows (Zapecza, 1990):

- The Potomac Group (Lower Cretaceous);
- The Raritan Formation (Upper Cretaceous);
- The Magothy Formation (Upper Cretaceous);
- The Merchantville Formation (Upper Cretaceous);
- Woodbury Clay (Upper Cretaceous);
- The Englishtown Formation (Upper Cretaceous);
- Marshalltown Formation (Upper Cretaceous);
- Wenonah Formation (Upper Cretaceous); and
- Mount Laurel Sand (Upper Cretaceous).

Due to their gently sloping (southeast) dip, Tertiary Age deposits underlie a large portion of the land surface in the Coastal Plain province of New Jersey. These Coastal Plain deposits are composed of sand, greensand marl, and clay, and are found near the surface in large areas of Monmouth, Ocean, Burlington, Camden, Atlantic, Gloucester, Salem, Cumberland, and Cape May Counties. From oldest to youngest, these Tertiary deposits comprise the following formations:

- Kirkwood Formation (Miocene);
- Cohansey Sand (Miocene);
- Beacon Hill Gravel (Miocene); and
- Bridgeton Formation (Miocene).

Quaternary Age (Holocene to recent) deposits are found in limited areas along the Atlantic Coastal Plain shoreline in Monmouth, Ocean, Atlantic, Cape May, Cumberland, and Salem Counties. These deposits are undifferentiated and consist predominantly of beach and estuarine deposits.

2.3.2 Soils

The soils in the Coastal Plain province were derived from the weathering of the unconsolidated deposits that underlie the study area. As described in the foregoing section these surficial, unconsolidated deposits can be broadly classified as:

- The Wisconsin Glaciated Area;
- The Cretaceous outcrop area;
- The Tertiary deposit area (gently dipping); and
- The Recent beach/estuary deposits area.

For the Coastal Plain physiographic province, soil samples were collected from seven different soil series (Figure 6) and the soil series classification of each sample is summarized in Table 1 (along with other sample information). A brief description of each soil-type (and its associated code) is presented below along with a description of the surface layer (zero to six inches below grade) from which the soils were collected. It is important to note that the descriptions provided below reflect only the soil series that were sampled, not all possible soil series in the rural Coastal Plain province, since the many did not meet the selection criteria defined by the study.

Atsion

Burlington County (At, Au, Av, Aw)
Ocean County (At, Aw)

Sample locations are shown in Figure 6 and are listed in Table 1. The Atsion soils originate from the Kirkwood and Cohansey Formations and form in acid sandy Coastal Plain sediments (USDA, SCS, Ocean County, 1989). The Atsion series, consisting of poorly-drained dark-gray soils, formed on the borders of swamps and the bottoms of some circular depressions in the outer Coastal Plain. The surface layer (zero to six inches) is a loose, dark gray, sometimes black, sand with many fine to medium roots. These soils are nearly level and in low positions and have moderate natural fertility and organic-matter content. Typical vegetation includes pine and oak trees, highbush blueberry and sweet pepperbush. (USDA, SCS, Burlington County, 1971; Ocean County, 1989).

Aura

Gloucester County (AmB, ArB)
Camden County (AmA, AmB, ArA, ArB)
Ocean County (AxB)
Atlantic County (AmB, ArA, ArB, AvB)

Sample locations are shown in Figure 6 and are listed in Table 1. The Aura series originates from the Bridgeton Formation (USDA, SCS, Camden County, 1966) and formed in acid, loamy Coastal Plain sediments. They consist of well-drained soils and are common in areas of high slope and elevation. The surface layer (zero to six inches) is generally a grayish brown to yellowish brown sandy loam containing gravel and many fine to medium sized roots. These soils are low in natural fertility and organic-matter content and the typical vegetation is mixed oak and pine trees and scrub oak. (USDA, SCS, Gloucester, 1962; Camden County, 1966; Ocean County, 1989; Atlantic County, 1978).

Downer

Ocean County (DoA, DpA, DpB, DrB)
Burlington County (DoA, DoB, DoC, DpB, DrA, DsB)
Cape May County (DoA, DpA, DrA, DrB, DsB)
Gloucester County (DoB, DsA, DsB)
Atlantic County (DoA, DsA)
Salem County (DoB, DoC)
Cumberland County (DoB, DoC, DrA, DrB)

The sample locations are shown in Figure 6 and are listed in Table 1. The Downer series originates from Coastal Plain sediments (i.e. Cape May, Pennsauken and Bridgeton Formations), (USDA SCS, Camden County, 1961). These soils consist dark grayish-brown, nearly level to sloping well-drained soils. The surface layer is dark grayish-brown, loose loamy sand (approximately 10 inches thick) with a weak fine granular structure and many fine to medium roots. In most places, Downer soils have light sandy loam subsoil over a sandier substratum. Typical vegetation consists mostly of pine and oak trees, lowbush blueberry and bracken fern. (USDA SCS, Ocean County, 1989; Burlington County, 1971; Cape May, 1977; Gloucester, 1962; Atlantic County, 1978; Salem County, 1969; Cumberland County, 1978).

Evesboro

Middlesex County (EvB)
Mercer County (EvB, EwB)
Ocean County (EvB, EvC, EvD)
Burlington County (EvB, EvC, EwB, EyB)

Sample locations are shown in Figure 6 and are listed in Table 1. The Evesboro series, is formed of loose, siliceous sandy material derived from acid sandy Coastal Plain sediments (Tedrow,

1986) originates from the Cohansey and Kirkwood Formations (USDA, SCS, Monmouth County, 1989). It consists of excessively drained sandy soils, are common in areas of high slope and elevation. The surface layer is typically very dark gray, turning to dark yellowish brown, loose loamy sand and is approximately six inches in thickness. The dominant vegetation consists of mixed oaks and pitch pine (USDA, SCS, Mercer County, 1972; Ocean County, 1989; Burlington County, 1971).

Lakehurst

Ocean County (LhA, LmA, LwB, LwC)
Camden County (LaA)
Burlington (LaA, LlA, LmA, LnA, LoA)
Atlantic (LaA, LeB, LeC)

Sample locations are shown in Figure 6 and are listed in Table 1. The Lakehurst series consists of moderately well drained to somewhat poorly drained sandy soils (i.e. Kirkwood and Cohansey Formations) that formed in sandy acid Coastal Plain sediments (USDA, SCS, Ocean County, 1989, USAD, SCS, Camden County, 1966). The surface layer (zero to six inches) is dark to light colored loose sand, often covered with a layer of black or very dark gray sand. These soils are found in depressed areas and on low terraces and typical vegetation consists of pine, oak, blackgum and hickory trees and lowbush blueberry. (USDA SCS, Ocean County, 1989; Camden County, 1966; Burlington County, 1971; Atlantic County, 1978).

Lakewood

Ocean County (LwB, LwC)
Burlington County (LtB, LtC, LtD, LuB, LvB, LwB, LyA)
Camden County (LfB, LfC, LfD, LgH, LgC, LhB)

Sample locations are shown in Figure 6 and are listed in Table 1. The Lakewood soils are developed from the seaward slope of the Coastal Plain in New Jersey from material that is very sandy (Tedrow, 1986), more particularly, white sands of the Kirkwood and Cohansey Formations (USDA, SCS, Camden County, 1966). The Lakewood series, consisting of excessively-drained soils, formed under a forest in which oak and pine trees were the predominant vegetation. The surface layer is loose gray (to brownish gray) sand (about 10 inches thick) with some medium roots. These soils are common in areas of high slope and elevation, and are low in natural fertility and organic-matter content. (USDA, SCS, Ocean County, 1989; Burlington County, 1971; Camden County, 1966).

Sassafras

Salem County (SdF, SfB, SfC, SfD, SrA, SrB, SrC, SrC2, SrD, SrD2)
Cumberland County (SgA, SgB, SgC2, SrA, SrB, SrC2)
Cape May County (SaA, SaB, SbA)
Monmouth County (SaB, SaC, SaD, SaE, SgB, SgC)

Sample locations are shown in Figure 6 and are listed in Table 1. The Sassafras series consists of well-drained, moderately coarse textured soils formed in water-laid deposits that are derived from sand and clays (Tedrow, 1986) and originate from deposits in the Pennsauken Formation (USDA, SCS Monmouth County, 1989). The surface layer is dark grayish-brown (in some cases a dark yellowish brown), fine sandy loam (approximately 10 inches thick) and the natural vegetation is mixed oak forest with scattered pine trees and lowbush blueberry. Some of the soils also contain increased gravel, or increased sand. (USDA SCS, Salem County, 1969; Cumberland County, 1978; Cape May, 1977; Monmouth County, 1989).

3.0 SAMPLE SITE SELECTION PROCESS

This section describes the key elements of the sample selection process. The information in this section is organized to discuss the study sample size as well as the sample distribution (i.e., the specific number of samples that were collected from each county and each physiographic province); a description of how soil sample locations are screened by population density and subsequently classified as either RLUAs or non-RLUAs; and a description and rationale for how acceptable sample points are located within the designated RLUAs. Figure 7 presents a flowchart that summarizes the selection process.

3.1 Study Sample Size

The sampling and analysis plan for this project was developed to provide the NJDEP with data to evaluate and promulgate ambient soil conditions in major geologic formations for the selected physiographic provinces in New Jersey. Based on the variance of pre-existing and proximate data, a sample size of 90 was computed to be sufficient for this purpose. Details are provided below.

A logic diagram for the selection of sample locations within the focus provinces and related areas is shown in Figure 7. This figure presents a GIS analysis for the selection of the final rural sampling locations by incorporating land use, population density, USGS soil classification, buffer zones from anthropogenic influences and sample location accessibility. GIS analysis was used to establish the correlation between multiple variables for determining the final location of the sample points.

3.2 Study Sample Distribution

A crucial feature of the sample point selection process is the sample distribution, or equivalently, the number of sample points within each of the counties of the selected physiographic provinces.[4] Therefore, an appropriate proration element (e.g., by area and/or population) had to be defined. Population and area proration are both consistent with a rural premise in selecting general sample locations.

A sample distribution that is prorated by area implicitly controls for spatial variability in heterogeneous soil-related parameters such as subsurface soil chemistry, texture, permeability, and surface water run-off. Proration by population means making the number of sample points in a given county directly proportional to its contribution (as a ratio) to the total population of the three physiographic provinces. Similarly, a sample distribution that is prorated by area forces the

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[4] Because the locations of county and municipal boundaries have no direct association with contamination levels or the locations of RLUAs, the use of these boundaries is arbitrary. However, many of the data that are central to this study are available only by county and/or municipality. In particular, population and land area statistics are available (from the U.S. Census Bureau) only at municipal and county levels. As well, most of the street and topographical maps needed for this study are only available by county. Therefore, the use of county boundaries is justified, but for reasons that are not directly connected with the study premise.

number of sample points in a given county to be directly proportional to its areal contribution (as a ratio) to the total area of its respective physiographic province.

Proration by population governs for bias through failure to control the number of samples collected per resident in each county, but it completely neglects area biasing. For example, because certain counties in the New Jersey Coastal Plain have municipalities with large areas of undeveloped land (e.g., Atlantic and Cumberland counties), sampling distributions in these counties would be skewed if sample distributions were based on area alone or by area and population.

Hence, the secondary criteria for proration of samples in each physiographic province of the counties is dependent on the areal extent as well as the percentage prevalence of soil that falls under a specific USCS classification and/or origins. The soil classifications used for this study have been tied to the different underlying geologic formations that comprise the physiographic province being studied. Soils derived from geologic formations have characteristic and consistent ranges of metals. Therefore, geologic formations were chosen as a screening criterion for this study.

As part of the secondary proration criteria, the areal extent of each soil type was cumulated and the number of samples within each soil type was prorated accordingly. Statistically insignificant soil types were not characterized or sampled during this program. Therefore, sample distribution was based on the areal extent of Rural Areas and the prevalence of each USCS soil type identified in each physiographic province (Tables 2, 3 and 4).

3.3 Screening of Soil Sample Location

A brief description of the various criteria used to screen soils in the target physiographic provinces is presented below. Table 5 summarizes the critical distance to point source factors used in the selection of a sampling location.

3.3.1 Screening Based on Population Density

The Office of State Planning defines a rural area as having a population density less than 1,000 people per square mile. Hence, the population density for each municipality of the 16 counties was assessed to identify the areal extent of each county that falls under a rural or non-rural classification. At the conclusion of this screening step, each of the municipalities within the study area were classified as either an RLUA (and thus, further considered) or a non-RLUA (given no further consideration).

3.3.2 Screening Based on Proximity to Anthropogenic Source Areas

In addition to the municipality-level population density screening, sample locations were also screened using critical distances to urban areas, anthropogenic and natural point sources from information queried in NJDEP and commercially available GIS databases (Keystone, 1994; NJDEP, 1995a; NJDEP, 1995d). By specifying a minimum acceptable distance between a sample location and an anthropogenic source (e.g., roads, historic land-use, etc.), unacceptable sample points were identified and eliminated. In this case it was determined, with concurrence from NJDEP, that sampling would not occur within 250 of roadways or railroads.

3.3.3 Location of Point Sources

This study assumed that background levels of TAL metals potentially originate from both natural and anthropogenic sources. In contrast, cPAHs (and other organic constituents) are assumed to be solely of anthropogenic origin[5]. The presence of these compounds in samples collected for this study were used to evaluate the effects of anthropogenic sources of organic contaminants on ambient areas within each physiographic province. In addition, all ambient concentrations in this study were measured directly, not imported from pre-existing data.

3.3.4 Anthropogenic Sources

Anthropogenic sources were queried using a GIS database to determine known contaminated sites (NJDEP, 1995c) within rural areas. Contaminated sites were sorted into two groups: (1) Bureau of Underground Storage Tank (BUST) sites, and (2) non-BUST sites. Only non-BUST sites were considered, as UST sites would have a negligible impact on surface soil. As previously agreed upon by NJDEP and BEM (BEM, 1998b), the critical difference from a potential sampling point and a known anthropogenic source was selected to be at least one-eighth of a mile.

Asphalt surfaces were also considered as anthropogenic sources, therefore, it was determined that no sampling would occur within 250 feet of roadways[6] or railroads. Samples were not collected in historic fill[7], as analyte concentrations in fill depend on the source and type (of fill) rather than on ambient conditions. If a selected location appeared to be fill (i.e. containing materials associated with fill[7]), then a sample would not be collected and the location reassigned. However, none of the sample materials appeared to be indicative of historic fill. Samples were not collected in pesticide/herbicide-impacted areas (e.g., gardens, golf courses, or other manicured lawn or landscaped areas).

3.3.5 Screening Based on Bedrock and Soil Types

The *Sampling and Analysis Plan (SAP)*, (BEM, 2000b) for the project was developed through the interpretation of maps generated through GIS, county soil surveys, bedrock geologic maps, and NJDEP information regarding soil classifications within the state. Using this information, an evaluation of bedrock geology was performed. Soil derived from different rock formations retains the chemical properties of the formation, therefore, screening for sample locations were

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[5] Certain polycyclic aromatic hydrocarbons (PAHs) have been found to occur naturally; however, cPAHs, a specific subset of PAHs, are solely of anthropogenic origin.

[6] The distance of 250 feet is based on the typical decline of lead concentrations from roadways which approaches background at 150 feet (Krishnaya and Bedi, 1986). As a safety factor, an additional 100 feet buffer was added.

[7] Historic fill is a general term to describe a wide variety of materials including dredge spoils, construction and demolition debris, industrial wastes, slag, cinders, and ash and are not indigenous soils.

also conducted based on soil types, (i.e., soil types that are prominent among each physiographic province).

New Jersey Valley and Ridge and Highlands Physiographic Provinces

Presented below are the criteria used to screen the soils within the Valley and Ridge and Highlands physiographic provinces.

- Rural land-use area soils were selected for this study as defined in Section 1.2 – Definitions.
- Soils from derived from weathered bedrock were selected because of their abundance in the provinces,
- Manmade filled land, gravel pits, and quarries were not selected for this study – these soils may have been disturbed or imported from other areas and are not typical of the provinces.
- Soils surrounding water-ways, marshland and wetland areas could be representative of some soil types in the Valley and Ridge and New Jersey Highlands Provinces, however, these soils were not selected because discharges to these areas would be considered surface water discharges and sampling of saturated soils would not yield representative samples of soils in the Valley and Ridge and Highland Provinces.
- Soils within 250 feet of roadways were not selected. This eliminated the possibility of metal and cPAH contaminants due to vehicular traffic.
- Due to a large number of soil types and the variation in soil names between counties, soils were categorized into groups associated with specific bedrock formations and outcrops. These groupings were compared with published soil classification charts [8,9].

Coastal Plains Physiographic Province

The following were criteria used in the selection of sample locations within the Coastal Plains physiographic province.

- Rural land-use area soils were selected for this study as defined in Section 1.2 – Definitions.
- Soils which are tidally influenced, marshlands and wetland areas were not selected for this study – discharges to these areas would be considered surface water discharges, sampling of saturated soils would not yield representative samples of soils in the Coastal Plains Province.
- Manmade filled land and sand/gravel pits are not representative of Coastal Plains Province soil and were not selected for this study.
- Dredge material and landfills are not representative of the Coastal Plains Province. In addition, these soils typically have elevated levels of metals and therefore were not selected for this study.
- Soils within 250 feet of roadways were not selected to eliminate the possibility of metal and cPAH contaminants due to vehicular traffic.

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[8] Soils of New Jersey, 1985, John C. F. Tedrow, Department of Soils and Crops, New Jersey Agricultural Experiment Station, Cook College.

[9] United States Department of Agriculture, Soil Conservation Service, Soil Survey (Incl. Soil Survey of all Counties within New Jersey.)

- Coastal Plains soils were grouped to evaluate area extent of various soil types consistent with soil classification maps. Comparison of soil survey maps from adjacent counties reveal that a given soil type sometimes changes names across county boundaries, resulting in two or more names for the same soil type. When this occurred, these names were grouped together for purposes of this study, [8,9].

3.3.6 Naturally Occurring Point Sources

A preliminary investigation was conducted to locate specific natural point sources of chemical constituents, based on parent geology (e.g., a localized gypsum/pyrite substratum or a localized limestone outwash). In the New Jersey Coastal Plain, a band of glauconitic soil containing higher levels of arsenic exists in the Monmouth County area and may have biased the results of the arsenic concentrations too high (USDA, SCS, Monmouth County, 1989). If arsenic concentrations or the concentration of any other constituent were biased high due to parent geology, the data was not included in the overall statistical results. Soil units within the Coastal Plain physiographic province that are documented to contain glauconite soils (Tedrow, 1986, USDA, SCS, Burlington County, 1971, USDA SCS, Camden County, 1966) are identified as following:

- Adelphia
- Collington
- Freehold
- Holmdel
- Kresson
- Marlton
- Shrewsbury

However, none of these soil series were considered for sampling, as they did not meet the criteria for selection (i.e. soils that attribute to over four percent of the total rural extent of the Coastal Plain physiographic province, Table 4).

Another natural point source is vegetative matter as plants can uptake and accumulate metals. To avoid potentially biasing a metal result high in a sample, surficial vegetative matter was not to be included in a soil sample. Therefore, samples to the point possible, were not be collected in parks that are greater than 50 percent forested or in areas with leaf litter or pine needles. However, since this study focused on rural soils as specifically defined by the parameters of the *SAP*, areas targeted for sampling often were within forested areas or covered by organic vegetative material and could not be avoided. In such cases, this material was removed from the sample locale, prior to the collection of the sample. If sample results indicated a higher than expected concentration of metals or TOC than expected, the field notes would be consulted to determine if the presence of vegetative matter may have biased the sample results. Based on the a review of the field sampling procedures surficial vegetative matter when present was removed prior to a sample's collection.

Based on above stated criteria the following soil series were selected for sampling:

Physiographic Province	Soil Group	Percentage of Rural Acreage Within Province	Number of Designated Samples
Valley and Ridge	Swartswood, Nassau, Wurtsboro, Oquaga	51.86	13
	Bath- Norwich	9.32	5
	Washington-Wassaic	18.63	5
Highlands	Parker-Edneyville	28.44	8
	Rockaway-Whitman	28.54	9
	Washington-Wassaic	15.88	6
Coastal Plain	Atsion	7.00	6
	Downer	15.98	11
	Evesboro	5.44	5
	Lakehurst	8.76	7
	Lakewood	5.66	5
	Sassafras	6.60	5
	Aura	4.21	5

3.3.7 Selection of the Sample Area

Upon selection of the number of soil samples per soil type within each province, GIS analysis was performed to determine the rural areas that are accessible for sampling (state-owned lands such as parks, forests, etc.) An evaluation of the total areal extent of soils that falls under each soil classification present in the different physiographic provinces also contained the soil classifications representative of the study province. Finally, GIS analysis was utilized to apply final screening criteria for locating sampling points. These criteria included buffer distances from urban areas bordering on the rural areas, roads, parking lots, waste handling, disposal and storage areas, railroad tracks, historic fill material, storm drains, catchment areas, residential dwelling units, commercial buildings, park administrative buildings and NJDEP known contaminated sites (from the KCSL), with special attention given to non-BUST sites.

3.3.8 The Use of State Lands as Sample Points

In the previous sections, it was determined that only municipalities with population densities below 1,000 people per square mile would be defined as RLUAs and further considered in this study.

NJDEP indicated that ambient soil samples would be collected from State lands (e.g., parks forests, reservations, game-lands, etc.) if possible, to maximize the probability of targeting ambient soils that are devoid of any anthropogenic effects. To control for bias, the selected parks had to extend across each of the physiographic provinces of New Jersey in a uniform and unbiased manner consistent with the foregoing prorated sample distribution. To ensure a broad soil sample distribution, sample locations were adjusted through the use of GIS analysis to include the State Lands where possible.

4.0 SOIL SAMPLING METHODS AND PROCEDURES

This section summarizes information on the sample locations within the parks (Section 4.1) the sample collection methodology (Section 4.2), and sampling decontamination protocols (Section 4.3). In general, samples were collected in accordance with guidelines specified in the NJDEP *Field Sampling Procedures Manual*, (May 1992) and the NJDEP approved *SAP* (BEM, 2000b).

4.1 Sample Locations

Samples were collected from 90 (locations) selected in 13 major soil types located within the physiographic provinces as shown in Table 1 and Figures 4, 5 and 6.

After locating a suitable sample point, the Global Positioning System (GPS) coordinates of the sampling point were recorded in the portable GPS unit for download onto the GPS database.[10]

The names of the 90 locations sampled along with the sample identification number, sample date and time, county, municipality, GPS coordinates (northing and easting), and generic soil-type classification are presented in Table 1.

4.2 Sample Collection

4.2.1 Sample Labeling Protocol

Samples were assigned a logical, unique sequential alphanumeric code identifying the specific sampling point:

CP-XX (Coastal Plain, where XX is the sample number).

In this manner, a sample identification number from the Coastal Plain region is CP-90, a sample identification number from the Valley and Ridge region is VR-05, and a sample identification number from the Highlands region is HI-32.

4.2.2 Sampling Procedures

Ninety soil samples were collected in accordance with NJDEP's *Field Sampling Procedures Manual* (NJDEP, 1992) using a hand trowel. Surficial organic material (e.g. leaf litter) that was present was removed from the sampling area prior to sample collection. Surface soils from the zero to six inch depth interval were composited to produce a representative sample of the surface soils.

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[10] The GPS determines the position of earth-bound reference points relative to multiple (between 4 and 7) roving satellites and fixed base station. The device is self-calibrating; it automatically locates its relative position with respect to possible satellites (those above the horizon at the time of measurement) and adjusts itself accordingly. Therefore, there is no formal calibration procedure. The GPS actually averages several position readings over the time interval of measurement. The device incorporates a real-time error tracking system; it corrects itself in real time. GPS coordinates recorded in this study are accurate to between one meter and six meters.

Samples were placed in pre-cleaned amber glass jars provided by the analytical laboratory. The Samples were immediately placed in a cooler where the temperature was maintained at 4 °C. Samples were shipped to the laboratory for analysis of TAL metals, cPAHs, Total Organic Carbon (TOC), and pH. The following information was included in the field logbook:

- Sample Location;
- Sample Depth;
- GPS Coordinates (either recorded in field book or logged on GPS unit);
- Soil Description/Classification;
- Date/time/weather, and
- Sample description.

The decontamination of field sampling equipment was conducted in accordance with NJDEP's *Field Sampling Procedures Manual*.

4.2.3 Quality Assurance/Quality Control Samples

4.2.3.1 Duplicate Samples

To evaluate the analytical laboratory's performance duplicate samples were also collected. Duplicate samples were included at a rate of one per 20 environmental samples per matrix. Accordingly, four duplicate samples were collected and analyzed for the same parameters as soil samples and were designated as 78A-CP, 85ACP, 89CPA, and 92A-CP.

4.2.3.2 Matrix Spike/Matrix Spike Duplicate Samples

Because the soil samples collected for the rural soils study were presumably not contaminated and because none of the soil showed any evidence of contamination, matrix spike/matrix spike duplicate (MS/MSD) samples were not analyzed for this study.

4.2.3.3 Field Blanks

Field blanks consisting of demonstrated analyte-free water were collected at a rate of one per 23 samples and in accordance with the procedures presented in the NJDEP *Field Sampling Procedures Manual*. Accordingly, three field blanks samples were collected and analyzed for cPAHs and TAL metals. These samples were designated as FB00.12.01, FB-VR 12.12.00, FBHI050401, and FB 00.12.01.

4.2.4 Analytical Parameters

Consistent with sampling protocols for the Year I Piedmont study and the Urban Coastal Plain Region Soil study (BEM, 1997b and 1998b, respectively), soil samples were analyzed for the 23

TAL metals (EPA Target Compound List), eight cPAHs, TOC[11] , and pH by Accutest Laboratories, Dayton, New Jersey (New Jersey Certification No. 12129). The digestion method used for the TAL metals was SW846 3050B, which is an acid digestion for sediments, sludges and soils.. The extraction method that was used for the cPAHs was ASE#1 SW3545, which is a pressurized fluid extraction for accelerated solvent extractor. A summary of the specific analytical parameters, methodologies, and QA/QC requirements is presented in Table 6. A summary of the analyte-specific method detection limits (MDLs) is presented in Table 7.

4.2.5 Sample Shipment

One temperature blank (provided by the laboratory) was placed in each cooler prior to shipment. Chain-of-custody documentation procedures were implemented during sampling efforts in both field and laboratory operations to ensure that each sample was accounted for at all times. Sample labels, field logbooks, and chain-of-custody records were accurately completed. All samples were hand-delivered to the laboratory by Accutest couriers.

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[11] TOC was analyzed according to the USEPA, Region II, Lloyd Kahn Method, developed by USEPA, Region II, July 1988 and approved by the NJDEP.

5.0 QUALITY ASSURANCE

This section summarizes the information provided in the quality assurance/quality control (QA/QC) report included in Appendix E. Data for this study were validated in accordance with NJDEP Bureau of Environmental Measurements and Quality Assurance (BEMQA) and USEPA Region II protocols. Specifically, the data study were reviewed and validated by BEM's using the QC Central data validation package. QC Central is an "Integrated Analytical Data Management System that has been developed by BEM. This application facilitates partially automated analytical data validation, laboratory data management, sampling tracking and reporting. This validation included a QC summary data review and qualifier application. Validation parameters reviewed were:

<u>TAL Metals</u>

- Deliverable completeness
- Case narrative/Nonconformance summaries
- Technical holding times
- Initial and continuing calibration verification
- Initial and continuing calibration blanks
- Contract required detection limit standard for graphite furnace atomic absorption (GFAA) and inductively coupled plasma (ICP) atomic emission spectroscopy
- Preparation blank frequency and contamination
- ICP interference check sample
- Spiked sample analysis
- Post-digestion spike sample recovery analysis
- Duplicate sample analysis
- Laboratory control sample
- Method of standard additions analysis
- ICP serial dilution
- GFAA QC
- Quarterly verification of instruments parameters
- Sample result verification
- Preparation Logs
- Analyses Logs

<u>cPAHs</u>

- Deliverable completeness
- Case narrative/Nonconformance summaries
- Technical holding times
- Surrogate or system monitoring compounds
- Matrix spike/matrix spike duplicate (MS/MSD) analysis
- Method blank frequency and contamination

- Gas chromatograph/mass spectrometer (GC/MS) tuning
- Initial and continuing calibration
- Internal standard areas and retention times
- Field duplicate comparability
- Compound identification (spectral match quality) and quantitation
- System performance and chromatography

Reviewing the QA/QC data for the TAL metals analysis, all detection limits were appropriately achieved by the laboratory. Further all holding times, the laboratory control sample analysis and matrix spike analyses were within acceptable ranges for the analyses. All data for the post-digestion spike analysis were within the required quality control limits and no quality control deficiencies were observed. All sample data for the TAL Metals analysis was deemed to be usable.

Based on the results of the data validation for the cPAHs, all data were within the required quality control limits for the following: blank contamination; holding times; internal standards; and matrix spike/matrix spike duplicates or surrogates. All sample data for the cPAH analysis was deemed to be usable.

6.0 ANALYTICAL RESULTS

6.1 Summary of Analytical Results

This section summarizes the analytical results of TAL metals (Section 6.1.1), cPAHs (Section 6.1.2), and soil characteristic parameters (Section 6.1.3). For comparison, study constituents that were detected at concentrations exceeding the NJDEP Residential Direct Contact Soil Cleanup Criteria (RDCSCC) and Nonresidential Direct Contact Soil Cleanup Criteria (NRDCSCC) are summarized in Table 8. Isolated measurements of beryllium and benzo(a)pyrene exceeded the RDCSCC in two separate samples collected from within the Highlands physiographic province. However, the overall, Highlands (and Valley and Ridge and Coastal Plain) mean concentrations of every compound analyzed was less than the RDCSCC. Tables 9, 10 and 11 present the results for all the samples.

6.1.1 TAL Metals

6.1.1.1 Valley and Ridge Physiographic Province

Twenty-three samples were collected and analyzed from the Valley and Ridge region. Samples VR-16 through VR-20 were collected from the Bath soil series. Samples VR-1 through VR-15 were collected from the Swartswood soil series. Finally, samples VR-21 through VR-25 were collected from the Washington series.

Within the 23 soil samples, beryllium and calcium were detected in less than 50 percent of the samples. Metals detected in greater than 50 percent of the samples include aluminum, arsenic, barium, cobalt, chromium, copper, iron, lead, magnesium, manganese, mercury, nickel, potassium, vanadium, and zinc. Antimony, cadmium, selenium, silver, sodium and thallium were not detected in any of the 23 samples. Table 9 summarizes the TAL metal results.

None of the detected metals in the 23 samples from this region exceeded either the RDCSCC or NRDCSCC.

6.1.1.2 Highlands Physiographic Province

Twenty-three samples were also collected as representative samples from the Highlands physiographic province. Samples HI-26 through HI-34 were collected from the Parker soil series. Samples HI-35 through HI-44 were collected from the Rockaway series. Finally, samples HI-45 through HI-50 were collected from the Washington soil series. Three samples, HI-36, HI-37 and HI-39 were inadvertently not analyzed by the analytical laboratory for mercury. However, there are mercury results for twenty samples, therefore, the mercury results were included in the statistical evaluation for this province.

Cadmium, selenium, silver, and sodium were detected in less than 50 percent of the samples. Metals detected in greater than 50 percent of the samples include aluminum, arsenic, barium, beryllium, calcium, cobalt, chromium, copper, iron, lead, magnesium, manganese, mercury, nickel, potassium, vanadium, and zinc. Antimony and thallium were not detected in any of the samples. Further:

- Beryllium was detected in sample HI-35 at a concentration of 2.8 milligrams per kilogram (mg/kg) exceeding both the RDCSCC (2 mg/kg) and NRDCSCC (2 mg/kg);

Concentrations of beryllium in the 23 Highland region samples ranged from 0.12 mg/kg to 2.8 mg/kg. Table 10 summarizes the TAL metal results for the samples collected in the Highlands region.

6.1.1.3 Coastal Plain Physiographic Province

Forty-four samples (plus four duplicate samples) were collected from the Coastal Plain physiographic province and analyzed for the targeted parameters. Samples were collected from seven soil series. The number of samples collected from each series and the sample identifications were:

- Astion: 6 samples designated CP-51 through CP-56
- Aura: 5 samples designated CP-91 through CP-95
- Downer: 11 samples designated CP-57 through CP-68
- Evesboro: 5 samples designated CP-69 through CP-73
- Lakehurst: 7 samples designated CP-74 through CP-79
- Lakewood: 5 samples designated CP-81 through CP-85
- Sassafras: 5 samples designated CP-86 through CP-90

Antimony, selenium and thallium were detected in less than 50 percent of the samples. Metals detected in greater than 50 percent of the samples include aluminum, arsenic, barium, beryllium, calcium, cadmium, cobalt, chromium, copper, iron, lead, magnesium, manganese, mercury, nickel potassium, sodium, vanadium, and zinc. Silver was not detected in any of the 44 soil samples.

TAL metals that were detected in less than 50 percent of the Coastal Plain soil samples included antimony, selenium and thallium. Silver was the only metal not detected in any of the 44 samples. The remaining metals were present in over 50 percent.

In the Coastal Plain samples (including the duplicate samples) none of the detected metal concentrations exceeded the RDCSCC or the NRDCSCC. Table 11 summarizes the TAL sample results.

6.1.2 Carcinogenic PAHs

6.1.2.1 Valley and Ridge Physiographic Province

With regard to cPAHs, compounds detected in less than 50 percent of the Valley and Ridge samples include benzo(a)anthracene, benzo(b)fluroanthene, indeno(1,2,3-c,d)pyrene and chrysene. Benzo(a)pyrene, benzo(k)fluoranene and dibenzo(a,h)anthracene were not detected above the minimum detection level in any of the 23 samples.

All detected cPAH concentrations present in the 23 samples were below the RDCSCC and the NRDCSCC. Table 9 presents a summary of the cPAH results for the Valley and Ridge region.

6.1.2.2 Highlands Physiographic Province

With regard to cPAHs, the compounds detected in less than 50 percent of the Highlands region samples included: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, and indeno(1,2,3-c,d)pyrene. Dibenzo(a,h)pyrene was not detected in any of the 23 samples.

- Benzo(a)pyrene was detected at a concentration just slightly exceeding the RDCSCC (0.66 mg/kg) and NRDCSCC (0.66 mg/kg) in one soil sample [HI-34 at 0.68 mg/kg). Values of benzo(a)pyrene ranged in the 23 soil samples from 0.11 mg/kg to 0.68 mg/kg.

Table 10 summarizes the cPAH results for the samples collected in the Highlands region.

6.1.2.3 Coastal Plain Physiographic Province

In the 44 samples collected from the Coastal Plain region the following cPAHs, compounds were detected in less than 50 percent of the samples: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, and indeno(1,2,3-c,d)pyrene. Dibenzo(a,h)anthracene was not detected in any of the 44 soil samples collected from the Coastal Plain physiographic province.

Regarding the four duplicate samples collected and analyzed, no cPAH compounds were detected. Although these results are not the same as the results for the 44 samples collected and sampled for cPAHs in the Coastal Plain Province, they are consistent with the their respective duplicates (i.e. sample no cPAHs were detected in CP-78 and duplicate sample 78A-CP).

All of the 44 samples contained cPAH concentrations below the RDCSCC or the NRDCSCC. Table 11 summarizes the cPAH results for the samples collected in the Coastal Plain region.

6.1.3 Soil Characteristic

6.1.3.1 Valley and Ridge Physiographic Province

Samples collected from the selected soils of the Valley and Ridge physiographic province vary in pH, but are on average slightly acidic. Values of pH approach a mean value of approximately 5.0, ranging from 3.5 (sample VR-06) to 7.1 (sample VR-24). Values of TOC ranged from 19,500 mg/kg (sample VR-08A) to 169,000 mg/kg (sample VR-10). Values of percent total solids ranged from 63.3% (sample VR-16A) to 88.9% (sample VR-22A). Table 9 summarizes the soil characteristic parameter results for the samples collected from the Valley and Ridge region.

6.1.3.2 Highlands Physiographic Province

The representative rural soils of the Highlands physiographic province vary in pH, but are on average slightly acidic. Values of pH approach a mean value of approximately 5.4, ranging from 3.3 (sample HI-31) to 7.0 (sample HI-32). Values of TOC ranged from 6,610 mg/kg (sample HI-32) to 159,000 mg/kg (sample HI-31). Values of percent total solids ranged from 48.7% (sample HI-36) to 92% (sample HI-50). Table 10 summarizes the TOC and pH results for the Highland region soil samples.

6.1.3.3 Coastal Plain Physiographic Province

Soils of the New Jersey Coastal Plain vary considerably in pH, but are on average acidic. Values of pH approach a mean value of approximately 4.0, ranging from 3.3 (sample CP-58) to 5.6 (sample CP-76). Values of TOC ranged from 4,530 mg/kg (sample CP-82) to 450,000 mg/kg (sample CP-55). Review of the field notes for sample CP-55 indicates that a high content of organic matter was present in this soil sample. Values of percent total solids ranged from 28.4% (sample CP-55) to 96% (sample CP-83). Table 11 presents a summary of the soil characteristic parameter results for the Coastal Plain region samples.

6.2 Statistical Analysis of Results

6.2.1 Descriptive Statistical Summary

For the purpose of summarizing the data and draw meaningful comparisons with other study data, the overall arithmetic mean, median, minimum, maximum, 90th percentile, 95th percentile, geometric mean, and standard deviation were calculated for each TAL metal (Tables 12, 13 and 14), cPAH (Tables 15, 16 and 17), and soil characteristic parameters (Tables 18, 19 and 20).

To explore the data further for soil-specific trends in contaminant concentrations, mean (arithmetic) TAL metal concentrations, cPAH concentrations, and soil characteristics (by soil-type) were compared to the corresponding overall (Valley and Ridge, Highlands, and Coastal Plain regions) mean concentrations (Tables 21, 22 and 23).

One-half of the method detection limit (MDL) was used as the concentration for non-detected parameters in calculating the summary statistics, in accordance with NJDEP's Technical Requirements for site remediation (N.J.A.C. 7:26E-4.8(c)i(3)). For cases in which there were no detection for a given analyte, summary statistics are tabulated as "not applicable" (NA).

6.2.2 Correlation Analysis

A Pearsons Correlation Analysis was completed to determine whether TAL metals and cPAHs are statistically correlated to soil characteristic parameters (pH, TOC, and percent solids). The rationale for using Pearsons Correlation Analysis is that it provides a quantitative measure of the dependence between two variables (i.e. measurements) in the same units and with the same approximate ranges.

The results of the Pearsons Correlation Analysis are provided in Appendix F and discussed in Section 7.0.

6.2.3 Analysis of Variance (ANOVA)

Single factor ANOVA was used to compare the mean values of TAL metal concentrations, cPAH concentrations, and soil characteristics from the Valley and Ridge, Highlands and Coastal Plain physiographic provinces.

The results of this ANOVA are provided in Appendix F and discussed in Section 7.0.

7.0 DISCUSSION OF RESULTS

7.1 NJDEP Direct Contact Soil Cleanup Criteria Exceedances

7.1.1 Exceedances For TAL Metals

In this study, only one metal was detected in single soil sample at a concentration slightly exceeding the NJDEP RDCSCC and NRDCSCC. Specifically:

- Beryllium was detected at a concentration exceeding both the RDCSCC (2 mg/kg) and NRDCSCC (2 mg/kg) in one sample [HI-35 (2.8 mg/kg)]. This sample was collected from the Highlands physiographic province.

Beryllium is a naturally occurring trace element and could occur in the parent bedrock material. However, correlation of the sample location to the parent rock material reveals that the soils in this locale are underlain by a quartz-oligclase gneiss (Owens, et al 1998). These types of rocks do not tend to contain beryllium as a major constituent (Bates, 1983). Therefore, it is likely that the beryllium is from an unidentified anthropogenic source. The following are key observations: (1) the exceedance was so low that it is negligible and (2) while one individual measurement of beryllium exceeded the RDCSCC/NRDCSCC, the overall Highlands province mean concentration(s) (in addition to the mean concentration of all 90 samples in the overall project) of all TAL metals were far less than corresponding RDCSCC and NRDCSCC.

7.1.2 Exceedances For cPAHs

In this study, one cPAH compound was detected at a concentration very slightly exceeding the NJDEP RDCSCC/NRDCSCC. Specifically:

- Benzo(a)pyrene was detected at a concentration above the RDCSCC and NRDCSCC of 0.66 mg/kg in one soil sample [HI-34 (0.68 mg/kg). This sample was collected within the Highlands physiographic province.

As with the detected exceedance for the TAL metal, the concentration of benzo(a)pyrene in sample HI-34 is so very low that it should be considered of no value. Further, while one individual measurement of benzo(a)pyrene exceeded the RDCSCC/NRDCSCC, the overall Highlands province mean concentration(s) (in addition to the mean concentration of all 90 samples in the overall project) of all cPAHs were far less than corresponding RDCSCCs and NRDCSCCs.

7.2 Pearsons Correlation Analysis

The strength of correlation between two variables is measured by the Pearsons Correlation Coefficient (r), which varies between -1.00 and +1.00. The algebraic sign of r gives the direction of correlation. Positive values of r signify a positive correlation (if x increases then y increases, and vice versa); negative values of r signify a negative correlation (if x decreases then y increases, and vice versa). The magnitude of r gives the strength of correlation. In terms of absolute value, r-values between 0.5 and 0.8 indicate a weak correlation; r-values greater than approximately 0.8 indicate a strong correlation.

The results of Pearsons Correlation Analyses are provided in Appendix F; key findings are summarized below.

7.2.1 Correlation Between TAL Metals and Soil Characteristics

7.2.1.1 Valley and Ridge Physiographic Province

- In the Valley and Ridge samples, several metals displayed a possible correlation to certain soil indicator parameters. Lead showed a tentative positive correlation to TOC with a value of the Pearsons Coefficient (r) equaling 0.64; this finding is expected because the concentrations of many metals are well-documented to be positively correlated with soil organic carbon content (Dragun, 1988, Lyman, 1982, Allen et al., 1993).

- Iron and vanadium showed a slight negative correlation to TOC with r-values of –0.58 and -0.57, respectively.

- Calcium is weakly correlated to pH at 0.51. This finding is also expected since an increase in soil pH causes calcium to form immobile precipitates in soil.

- Arsenic, calcium, magnesium, and potassium each show a slight positive correlation to pH with values of r between 0.51 and 0.63 while lead shows a slight negative correlation to pH with an r value of –0.56;
-
- Silver and cadmium showed a strong negative correlation to the percentage of total solids in the soil matrix with r-values of –0.87 and –0.82, respectively. Selenium and zinc showed a weak negative correlation to the percentage of total solids in the soil matrix with r-values of -0.76 and -0.52, respectively.

7.2.1.2 Highlands Physiographic Province

- In the Highlands samples, several metals display a tentative positive correlation with certain soil indicator parameters. Lead, mercury, selenium, silver, and vanadium show a weak positive correlation to TOC with values r between 0.52 and 0.67; these findings are expected because the concentrations of many metals are well-documented to be positively correlated with soil organic carbon content (Dragun, 1988, Lyman, 1982, Allen et al., 1993).

- Calcium is weakly correlated to pH at 0.67. This finding is also expected since an increase in soil pH causes calcium to form immobile precipitates in soil.

- Barium, magnesium, and potassium each show a weak positive correlation to pH with values of the r between 0.52 and 0.67;

- No metals show a positive or negative correlation to the percentage of total solids in the soil matrix for the Highlands samples.

7.2.1.3 Coastal Plain Physiographic Province

- In the Coastal Plain samples, several metals displayed correlation with certain soil indicator parameters. Calcium, potassium and sodium each showed a weak positive correlation to TOC with r-values between 0.52 and 0.64. As stated previously, these findings are expected because the concentrations of many metals are well-documented to be positively correlated with soil organic carbon content (Dragun, 1988, Lyman, 1982, Allen et al., 1993).

- Manganese and zinc each showed a weak positive correlation to pH with r-values of 0.52 and 0.53, respectively;

- Antimony, copper, mercury, potassium, selenium, silver, and thallium showed a negative correlation to the percentage of total solids in the soil matrix with values of r ranging from -0.50 to -0.87 (Silver and thallium showed a strong negative correlation and the remaining metals were weakly correlated).

7.2.1.4 Overall Study – TAL Metals and Soil Characteristics

In summary, for the overall study,

- Metals that displayed a weak positive correlation with to TOC with values of the Pearsons Coefficient (r) between 0.52 and 0.67 were: Calcium, iron, lead, mercury, potassium, selenium, silver, sodium, and vanadium. These findings are expected because the concentrations of many metals are well-documented to be positively correlated with soil organic carbon content (Dragun, 1988, Lyman, 1982, Allen et al., 1993).

- Calcium is correlated to pH, with r between 0.51 and 0.67. This finding is also expected since an increase in soil pH causes calcium to form immobile precipitates in soil.

- Arsenic, barium, calcium, lead, magnesium, manganese, potassium, and zinc each show a mild positive correlation to pH with values of the r between 0.51 and 0.68;

- Antimony, cadmium, copper, mercury, potassium, selenium, silver, thallium, and zinc show a negative correlation to the percentage of total solids in the soil matrix with values of r ranging from -0.50 to -0.87.

7.2.2 Correlation Between cPAHs and Soil Characteristic

No noteworthy correlation was observed between the cPAHs and the soil characteristics.

7.2.3 Inter-study Mean Comparisons

It is useful to compare the mean soil concentrations of TAL metals, cPAHs and soil characteristics from between the physiographic provinces, as well as to mean concentrations from other data sets. It is possible to make statistical comparisons as follows:

- Between the Valley and Ridge region and Highlands region;
- Between the Valley and Ridge region and Coastal Plain; and
- Between the Highlands region and Coastal Plain region.

ANOVA quantifies the distinctness of multiple means (in this case, three) data groups: based on the concept of variance. Variance, a measure of the spread or dispersion in data, is partitioned into two components: within-group variance (WGV) and between-group variance (BGV). The ratio of these two variance components, the F-statistic, provides a means of combining both types of variance into a single parameter that summarizes the result of the ANOVA test.

The WGV measures the amount of dispersion within each individual data group separately (e.g., the variance within the Valley and Ridge, Highlands and Coastal Plain data separately). The BGV measures the amount of dispersion between data groups (i.e., the difference between the mean Valley and Ridge concentrations, mean Highlands concentrations and mean Coastal Plain concentrations).

After partitioning a data population of size “n” into a series of “k” categories, a F-value is calculated based upon the resulting within-group and between-group variance. This F-value is then compared to a critical value obtained by evaluating the F-distribution at the appropriate significance level (e.g., $p = 0.05$) and degrees of freedom (i.e., k-1 and n-k). If the computed F-value is greater than $F(k-1,n-k)$, or equivalently, the significance level for the comparison is less than p, then the data groups are said to be statistically different at the 100(1-p)th percent confidence level (or p significance level).

Because the ANOVA method assumes that the data are normally distributed, log-transformed and untransformed data were separately analyzed for lognormal and normal analyte distributions, respectively. A significance level less than 0.05 denotes a statistical significance at the 95th percent confidence level.

The ANOVA results are discussed below and are presented on Table 24. For each analyte, a F-value, significance level (p-value), and yes/no significance flag are provided. A significance level of 0.05 (or less) denotes statistical significance at the 95 percent confidence level (or better). In cases in which a statistically significant difference is found to exist between two group means, this difference should be interpreted as meaning that we are at least 95 percent certain that the two data populations are distinct or equivalently, the probability that the data from groups 1 and 2 were taken from the same (larger) population is less than 5 percent by chance alone.

For additional (but not statistically-based) comparisons, mean soil concentration data for TAL metals are available from several other sources: (1) a study conducted by BEM in 1998 in which soils from urban soils within the Coastal Plain region were analyzed (91 samples); (2) a study completed by BEM in 1997 in which soils from urban soils within the Piedmont region were analzyed (67 samples); (3) a study conducted by NJDEP in 1993 to determine ambient levels of metals in various land-use areas of New Jersey (Fields et al., 1993); (4) soil data compiled at Rutgers University (Ugolini, 1964); these data consist of New Jersey surface soil data from various studies that are based on agricultural soils with low sand content; (5) data compiled by the United States Geological Survey (USGS) from the eastern United States (Shacklette, 1984); and (6) data compiled from various locations around the world (Vinogradov, 1959). However, it should be noted that the Rutgers study, the USGS studies and the world study used different analytical methods for metals analysis than this study. Therefore, this study's results cannot be directly compared to the results of these four other studies. Based on the analytical methodologies used in these four studies, the results would expected to be higher than those obtained for this study.

Mean soil concentrations of TAL metals, cPAHs soil characteristics from these sources are provided in Table 24 along with mean values from this study. Statistically-based comparisons between the three physiographic provinces studied by BEM, as well as other less quantitative comparisons between mean values from this study and the other studies listed in Table 24, are noted below.[12]

7.2.3.1 Inter-study Mean Comparisons For TAL metals

Valley & Ridge Versus Highlands Region

It was determined using ANOVA that the differences between the mean Valley and Ridge region and mean Highlands region are statistically significant (at the 95 percent confidence level) for all study constituents except for:

- Barium, calcium, cobalt, copper, iron, lead, magnesium, manganese, mercury, nickel, potassium, and zinc.

Significance was not calculated for the following compounds, since in one or both the regions the concentrations were not detected:

- Antimony, cadmium, selenium, silver, sodium, and thallium.

More specifically, the mean soil concentration of aluminum was the only compounds of statistical significance that was higher in the Valley and Ridge region than in the Highland

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[12] All means presented in Table 24 are arithmetic means.

region. Within the Highlands physiographic province, compounds with a mean concentration considered of significance and higher than those in the Valley and Ridge region were: arsenic, beryllium, chromium and vanadium.

Valley & Ridge Versus Coastal Plain Region

It was determined using ANOVA that the differences between the mean Valley and Ridge region and mean Coastal Plain region are statistically significant (at the 95 percent confidence level) for all study constituents except for:

- Calcium, lead, and mercury.

Significance was not calculated for the following compounds, since in one or both the regions the concentrations were not detected:

- Antimony, cadmium, selenium, silver, sodium, and thallium.

The mean soil concentration (and of statistical significance) of aluminum arsenic, barium, chromium, cobalt, copper, iron, magnesium, manganese, nickel, potassium, vanadium and zinc were higher in the soil samples collected from the Valley and Ridge than in the Coastal Plain region. Only, the mean concentration of beryllium was higher in the Coastal Plain than Valley and Ridge.

Highlands Versus Coastal Plain Region

Using ANOVA analysis the differences between the mean data for the Highlands region and mean data for the Coastal Plain are statistically significant (at the 95 percent confidence level) for all study constituents except for:

- lead, selenium, and sodium

Significance was not calculated for the following compounds, since in one or both the regions the concentrations were not detected:

- Antimony, silver, and thallium.

The mean soil concentrations for each compound determined to be of statistical significance were higher in the Highlands region than in the Coastal Plain region.

Mean TAL Metal Comparison between Studies

Mean concentrations of all TAL metals (where detected in both studies) were higher in the previous Coastal Plain (urban soils) region study (BEM, 1998) than the from the rural Coastal Plain soils (Table 24).

Overall, the mean concentrations of most metals tested in the urban Piedmont region study (BEM, 1997) were higher than any of the provinces, whether tested as urban or rural soils. However, the mean concentrations of aluminum, calcium, magnesium and manganese were the highest in the rural soils tested in the Valley and Ridge region. Beryllium, iron, potassium, selenium, silver and vanadium were found at the highest mean concentrations in the rural soils of the Highlands region.

In general, when the rural soil data is compared to the NJDEP Urban soils study (NJDEP, 1993), the soils tested by NJDEP have higher mean concentrations of TAL metals (Table 24). Exceptions are antimony (Coastal Plain rural soils), manganese (Valley and Ridge rural soils) and chromium, selenium, silver and vanadium (Highlands rural soils). Comparisons to the studies completed by Rutgers, USGS and for the world are not possible, since many of the parameters were not tested. However, in general arsenic, beryllium, chromium, copper, manganese, nickel, and vanadium concentrations were higher in these other studies when compared to the mean concentrations in the rural soils of the Valley and Ridge, Highlands and Coastal Plain physiographic provinces. Mercury was similar throughout all the studies. Table 24 summarizes these results. Again, a true comparison cannot be made between this study and the Rutgers, USGS and world studies, as the analytical methodologies for obtaining the metals results were conducted differently.

7.2.3.2 Inter-study Mean Comparisons For cPAHS

Valley & Ridge Region Versus Highlands Region

It was determined using ANOVA that between the mean Valley and Ridge region and mean Highlands region that there were no statistical significance for the tested cPAH compounds between the regions.

Significance was not calculated for benzo(a)pyrene, benzo(k)fluoranthene or dibenzo(a,h)anthracene since they were not detected in the soil samples collected from either the Valley and Ridge or Highlands regions.

Valley & Ridge Region Versus Coastal Plain Region

With regard to the cPAH mean concentrations within the Valley and Ridge region versus the Coastal Plain Region, again no significance was determined between the two regions.

Significance was not calculated for benzo(a)pyrene, benzo(k)fluoranthene or dibenzo(a,h)anthracene since they were not detected in the soil samples collected from either the Valley and Ridge or Coastal Plain regions.

Highlands Region Versus Coastal Plain Region

It was determined using ANOVA that the differences between the mean values of cPAHs in the Highlands region and mean values of cPAHs in the Coastal Plain region were not statistically significant.

Significance was not calculated for dibenzo(a,h)anthracene since it was not detected in the soil samples collected either the Highlands or Coastal Plain regions.

Mean cPAH Comparison between Studies

All mean concentrations of cPAHs were higher in the previous Coastal Plain (urban soils) region study (BEM, 1998) than the from the rural Coastal Plain soils.

As expected, cPAH mean concentrations were very low (in the hundredths) in the rural soils collected from the three physiographic provinces. CPAHs in the Urban Piedmont study were approximately a magnitude higher than the rural soil concentrations.

The cPAH data could not be compared to the other six studies conducted by others, as these compounds were not tested. Table 24 summarizes the results.

7.2.3.3 Inter-study Mean Comparisons For Soil Characteristics

Valley & Ridge Versus Highlands Region

It was determined using ANOVA that there is no significance between the Valley & Ridge region soils and the Highland region soils when comparing either pH or TOC.

Valley & Ridge Versus Coastal Plain Region

Based on the ANOVA results, statistically significant differences (at the 95th percent confidence level) were observed between the Valley & Ridge and Coastal Plain regions with regard to pH. However, there was no significance difference with regard to TOC.

Highlands Versus Coastal Plain Region

Based on the ANOVA results, statistically significant differences (at the 95th percent confidence level) were observed between the Highlands and Coastal Plain regions with regard to pH. However, there was no significance difference with regard to TOC.

Mean Comparison between Studies For Soil Characteristics

All mean concentrations of pH were higher (i.e. more neutral) in the Coastal Plain urban soils than in the Coastal Plain rural soils. However, TOC was higher in the rural soils of the Coastal Plain region.

Further, the urban soils of the Piedmont region were also more neutral than any of the rural soils from any of the three physiographic provinces. TOC counts were also a magnitude higher in the samples collected from the three rural areas of the state than the urban Piedmont soils.

Finally, no comparison can be drawn between this study and others, with regard to TOC and pH, as these parameters were not reported in the previous works. Table 24 summarizes these results.

7.3 Soil-Specific Trends

Some additional data exploration was conducted to search for soil-specific trends in the constituents under study. The rationale for conducting these analyses in that based on the fact that certain types (i.e., series) of soil is known to contain high levels of arsenic-containing glauconite and iron. Therefore, it is useful to compare mean levels of arsenic and iron (by soil-type) to the overall physiographic region's mean concentrations. However, based on a review of the soil surveys prepared by each county's Soil Conservation District (see references) and Tedrow (1986) the soils selected for sampling in both the Valley and Ridge region and Highlands region are not identified as containing high levels or glauconite or other TAL metals naturally. To substantiate the literature, a review of the results of this study was completed.
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As presented in Section 3.3.6, some soils within the Coastal Plain physiographic province are documented to contain high levels of arsenic containing glauconite or iron. However, during the sample location selection process, these soils were determined to comprise less than four percent of the total rural extent for the Coastal Plain region and were not sampled. BEM did compare the mean arsenic and iron concentrations of the Coastal Plain for each of the soil series sampled and against studies that have been completed by others to review if there were any findings of interest.

The mean concentrations (by soil-type) of each TAL metal, cPAH, and soil characteristic are presented in Tables 21, 22 and 23. For comparison, the overall Valley and Ridge, Highlands and Coastal Plain means are also provided for each analyte.

7.3.1 Soil-Type Trends For TAL Metals

- Both the Bath soil series and Washington soil series within the Valley and Ridge region, had arsenic concentrations exceeding the mean of 4.98 mg/kg. The arsenic mean for the Bath series was 5.36 mg/kg and for the Washington series was 6.54 mg/kg. The mean for the third soil series sampled, Swatswood was 0.7 mg/kg below the mean arsenic concentration. However, these concentrations on average are approximately five times lower than the RDCSCC of 20 mg/kg, but are relatively consistent with the findings of other studies.

- Arsenic concentrations in the Highlands region were slightly higher than the mean for the Valley & Ridge region. The Washington series contained the highest mean arsenic concentration at 7.80 mg/kg and was above the mean (6.04 mg/kg) reported for the 23 samples collected from this entire province. In general individual arsenic concentrations of the three soil groups (Parker, Rockaway and Washington), as well as the total mean are below concentrations reported in previous studies for New Jersey.

- The mean arsenic concentration, both for the individual soil groups and overall in the Coastal Plain was very low in comparison with the other provinces. The overall mean was 2.33 mg/kg. Arsenic means of the individual soil groups ranged from 0.51 mg/kg (Lakewood) to 4.78 mg/kg (Sassafras). The arsenic concentrations reported are the lowest as compared to any of the other New Jersey studies.

- Mean iron concentrations were the highest in the Highlands Region, followed by the Valley and Ridge region and the Coastal Plain region. Mean concentrations of iron in the individual soil groups within a physiographic province were very similar to the overall mean for the entire region. The mean iron concentrations in the two northern provinces exceeded the reported means previously reported by the urban Coastal Plain region and urban Piedmont Region studies by approximately 6,000 mg/kg. Data for iron is not available from the five other previous studies.

7.3.2 Soil-Type Trends For cPAHs

- Within the Valley & Ridge region, soils collected from the Swatswood and Washington series contained cPAHs equal to or slightly above the overall mean. However, as would be expected, the means for these compounds, either within the individual soil group or as a whole region are below the results previously reported for the urban Coastal Plain soils or the urban Piedmont soils. Data is not available from the other studies and therefore further comparisons are not possible.

- The Parker series, located in the Highlands physiographic province contained the highest mean concentrations of cPAHs. This soil series also consistently contained cPAH concentrations above the overall mean for the Highlands region. Sample HI-34, collected from the Parker series contained a benzo(a)pyrene concentration that exceeded the RDCSCC. However, the mean concentrations for the rural Highlands soils were still below those reported in the urban Coastal Plain and urban Piedmont studies

- Mean concentrations for both the individual soil groups and the entire Coastal Plain region were very low (in the hundredths) for cPAHs, but the samples collected from the Evesboro and Lakehurst series slightly exceeded the overall means. As with the other regions, the cPAHs mean concentrations a well below those previously reported in the urban Coastal Plain and urban Piedmont studies.

7.3.3 Soil-Type Trends For Soil Characteristics

- The Swartswood series (13 samples) was found to be more acidic (4.36 pH units) than the overall mean of 4.86 pH units for the entire Valley and Ridge physiographic province. In general the rural soils in this region are slightly acidic.

- The Washington series, located within the Highlands province had a mean pH concentration of nearly neutral (6.2 pH units). The other two soil series (Parker and Rockaway) were slightly acid and closer to the overall mean for the region at 5.44 pH units.

- Soils in the Coastal Plain were all acidic and the means of all the individual series as well as the overall region were approximately 4 pH units. The lower pH values for these soils is not unexpected, as the soils sampled are known to be acidic to strongly acidic (Soil Conservation Surveys for individual Counties – see References Section 10.0).

- Overall, the samples collected from the rural soils in the three physiographic provinces were more acidic than those collected during either the urban Coastal Plain study or urban Piedmont Study. Measurements for pH were not reported from the other older studies.

- The overall TOC content of the three provinces was higher than previously found in the urban Coastal Plain and urban Piedmont studies. Individual TOC counts within the soil groups of the Valley and Ridge and Highland regions were similar to the overall means. One exception was within the Highland region in which the Washington group had a TOC a nearly ½ of the overall mean. The mean TOC in Astion series (Coastal Plain) was nearly three times higher than the region's mean. The lowest TOC percentage was present in the Lakewood series at 8,436 mg/kg which is approximately six times lower than the TOC mean for the rural Coastal Plain region

8.0 CONCLUSIONS

In the previous section, several findings were presented, some more important than others. The purpose of this section is to distill these findings into a few key conclusions.

- Regulatory cleanup criteria such as the RDCSCC and NRDCSCC are useful benchmarks for the findings of this study. Individual soil ambient concentrations in excess of the RDCSCC were observed only for beryllium and benzo(a)pyrene; however, the overall rural Highlands (as well as Valley and Ridge and Coastal Plain) mean concentration of every study constituent was less than the corresponding RDCSCC (and NRDCSCC). In addition, the exceedances were so low they were essentially negligible. The slightly elevated beryllium and benzo(a)pyrene concentrations appear to originate from anthropogenic sources, which were not evident to the sampling team.

- Ambient levels in general (without specific reference to urban, industrial, or rural areas) are also a useful benchmark for the findings of this study. As discussed in Section 7.2, several studies have been conducted at various regional levels and scopes. Although no statistically-based conclusions can be drawn because BEM does not have access to the raw data from these other studies, the following are still useful observations: (1) mean soil concentrations of arsenic are slightly lower as data collected by Rutgers in a study of Red Beds of New Jersey (Ugolini, 1964); (2) mean soil concentrations of other metals are generally below the data compiled by USGS (Shacklette, 1984) for the conterminous United States; and (3) mean soil concentrations of arsenic are approximately the same as the worldwide data (Vinogradov (1959). However, lead was found to be at higher mean concentrations in this study as compared to the USGS findings. As stated earlier, a true comparison cannot be made between the Rutgers, USGS and world studies to this research, as the former studies used different analytical methodologies to determine metal concentrations. Based on the analytical methodologies used in these four older studies, it would be expected that the metals results would be higher than reported for this study. Further, similar comparisons are not possible for cPAHs because general ambient data are not available.

- Statistically significant differences between mean concentrations in the regions is likely due to the parent material of the soils, rather than to anthropogenic pollution, since samples were specifically targeted to be have a lower potential for these sources. It was determined using ANOVA that the differences between the mean Coastal Plain and mean Highlands results, as well as between the Coastal Plain and Valley and Ridge results are statistically distinct (at the 95 percent confidence level) for nearly all the TAL metals. Again, this is most likely due to the source of the soil material (i.e. bedrock materials for the two northern provinces, versus depositional marine environments for the Coastal Plain region).

- As expected, since the soils in all regions did not seemingly have high concentrations of glauconite (as those documented to contain glauconite were not selected for sampled), arsenic and iron concentrations were low and the mean arsenic concentrations did not exceed the RDCSCC.

- Mean compound concentrations, when detected in the urban Coastal soils (BEM, 1998b) were higher than the mean compound concentrations of the rural Coastal soils.

- Overall, the data results were much lower than previous studies completed in New Jersey and around the world (Table 24). This could be attributed to the differences in analytical methodologies in the several of the studies. Or it could be attributed to the biasing of the studies to truly rural, not anthropogenically impacted soils and therefore this would be an expected finding.

9.0 RECOMMENDATIONS FOR APPLICATION AND FUTURE RESEARCH

Based upon the findings of this study, the following recommendations are offered:

- The data in this report should be used to establish a range of values (minimum and maximum) and an appropriate measure of central tendency (arithmetic or geometric mean) for the concentrations of TAL metals and cPAHs in soil and soil characteristic parameters. This can be accomplished at various regional levels, however, it should be noted that the data from this study are strictly applicable only to rural areas, based on the population density criterion specified in the project scope. If some larger regional aggregation (e.g., county-level or province-level) is desired, this can easily be accomplished because the data are linked with GIS, but the data set should be augmented to include less urbanized, less industrialized areas within these larger regions (see below). In such a study, soil concentrations of TAL metals at the upper-end of the foregoing ranges (particularly those that exceed the RDCSCC and NRDCSCC) would be likely to be primarily of anthropogenic origin. Soil concentrations of TAL metals at the lower-end of these ranges would probably be of mixed origin, naturally occurring and anthropogenic. As there are no known natural sources for cPAHs, soil concentrations of cPAHs are solely of anthropogenic origin.

- The ambient soil data from this rural soils study (and the Piedmont and Urban Soils) database should be linked to the NJDEP’s current groundwater database. It is our understanding that NJDEP’s Site Remediation Program (SRP) has developed a database containing regional and site-specific groundwater data, water quality data, and various groundwater indicator parameters, as part of New Jersey’s participation in the National Environmental Performance Partnership System (NEPPS). Linking these soil and groundwater databases would permit NJDEP to evaluate corelationships between statistically elevated ambient concentrations of various constituents in soil data and groundwater concentrations within the same aquifer zone, system, or other regional classification. Also, in areas where groundwater data are lacking, the ambient soil data could be used to impute these missing groundwater data via the use of an appropriate groundwater fate and transport model. Similarly, the groundwater data can be utilized to fill in gaps in the soil data.

- Based on the selection process of this study, only soil series with an areal extent above an identified percentage were sampled. This method, although allowing the soils with the most coverage to be sampled, neglected to evaluate soils that may have a significance based on their origin. For example, in the case of the Coastal Plain region, soils known to contain arsenic containing glauconite and iron are present, primarily along Inner Coastal Plain (Tedrow, 1986), but were not sampled as part of this study (since the areal extent of such soils fell below four percent). Sampling of soils, defined as rural, and derived from parent material known or suspected to contain a higher than expected natural concentration of metals should be sampled. Results of such studies should be correlated to the data obtained from this study as well from the studies completed in the urban Piedmont and urban Coastal Plain regions.

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TABLES

TABLE 1

RURAL SOIL SAMPLE LOCATIONS VALLEY AND RIDGE PHYSIOGRAPHIC PROVINCE

SAMPLE ID	SOIL GROUP	GEOGRAPHIC REGION		STATE PLANE COORDINATES	
		MUNICIPALITY	COUNTY	LONGITUDE	LATITUDE
VR-1	Swartswood Nassau Wurtsboro Oquaga Gro	WANTAGE TWP	SUSSEX	463045.9015	895817.0503
VR-2	Swartswood Nassau Wurtsboro Oquaga Gro	WANTAGE TWP	SUSSEX	456848.4461	851158.9157
VR-3	Swartswood Nassau Wurtsboro Oquaga Gro	SANDYSTON TWP	SUSSEX	427137.1157	868475.3353
VR-4	Swartswood Nassau Wurtsboro Oquaga Gro	MONTAGUE TWP	SUSSEX	424949.7785	892536.0445
VR-6	Swartswood Nassau Wurtsboro Oquaga Gro	SANDYSTON TWP	SUSSEX	400706.7911	851888.0281
VR-7	Swartswood Nassau Wurtsboro Oquaga Gro	WALPACK TWP	SUSSEX	374458.7447	822723.5320
VR-8	Swartswood Nassau Wurtsboro Oquaga Gro	FRELINGHUYSEN TWP	WARREN	386853.6555	792283.0892
VR-9	Swartswood Nassau Wurtsboro Oquaga Gro	HARDWICK TWP	WARREN	372453.6855	805771.6687
VR-10	Swartswood Nassau Wurtsboro Oquaga Gro	BLAIRSTOWN TWP	WARREN	343471.4676	794288.1483
VR-11	Swartswood Nassau Wurtsboro Oquaga Gro	FREDON TWP	SUSSEX	403623.2407	801761.5504
VR-12	Swartswood Nassau Wurtsboro Oquaga Gro	HAMPTON TWP	SUSSEX	418023.2107	816161.5204
VR-14	Swartswood Nassau Wurtsboro Oquaga Gro	HOPE TWP	WARREN	349486.6449	749083.1794
VR-15	Swartswood Nassau Wurtsboro Oquaga Gro	KNOWLTON TWP	WARREN	328889.2195	775513.5040
VR-16	Bath - Norwich	WANTAGE TWP	SUSSEX	449751.7326	883198.0796
VR-17	Bath - Norwich	FRANKFORD TWP	SUSSEX	433967.2297	852899.8600
VR-18	Bath - Norwich	FRELINGHUYSEN TWP	WARREN	381908.6579	780523.2234
VR-19	Bath - Norwich	BLAIRSTOWN TWP	WARREN	360467.6352	774370.5821
VR-20	Bath - Norwich	WHITE TWP	WARREN	331941.7529	732047.8678
VR-21	Washington Wassaic Group	MONTAGUE TWP	SUSSEX	434826.9899	910909.1790
VR-22	Washington Wassaic Group	HAMPTON TWP	SUSSEX	414269.0209	826621.5060
VR-23	Washington Wassaic Group	GREEN TWP	SUSSEX	417259.2709	777469.2709
VR-24	Washington Wassaic Group	HOPE TWP	WARREN	360444.5202	761209.7863
VR-25	Washington Wassaic Group	WHITE TWP	WARREN	352595.1138	731120.3953

TABLE 1

RURAL SOIL SAMPLE LOCATIONS HIGHLANDS PHYSIOGRAPHIC PROVINCE

SAMPLE ID	SOIL GROUP	GEOGRAPHIC REGION		STATE PLANE COORDINATES	
		MUNICIPALITY	COUNTY	LONGITUDE	LATITUDE
HI-26	Parker - Edneyville	ALLAMUCHY TWP	WARREN	406355.1477	748725.4724
HI-27	Parker - Edneyville	FRELINGHUYSEN TWP	WARREN	378047.2982	759382.1579
HI-28	Parker - Edneyville	WHITE TWP	WARREN	333181.0661	708566.6084
HI-30	Parker - Edneyville	CHESTER TWP	MORRIS	439758.4116	721685.7480
HI-31	Parker - Edneyville	MORRIS TWP	MORRIS	480852.3814	712203.9289
HI-32	Parker - Edneyville	HOLLAND TWP	HUNTERDON	303814.4115	640952.2450
HI-33	Parker - Edneyville	BETHLEHEM TWP	HUNTERDON	356413.1089	679283.6078
HI-34	Parker - Edneyville	TEWKSBURY TWP	HUNTERDON	407953.7820	671640.8161
HI-35	Rockaway - Whitman	WEST MILFORD TWP	PASSAIC	542594.1444	849194.4998
HI-36	Rockaway - Whitman	RINGWOOD BORO	PASSAIC	566208.8561	836507.7615
HI-37	Rockaway - Whitman	WEST MILFORD TWP	PASSAIC	534863.5294	814185.5132
HI-38	Rockaway - Whitman	WANAQUE BORO	PASSAIC	555516.4967	799855.6273
HI-39	Rockaway - Whitman	VERNON TWP	SUSSEX	487831.1638	884627.6530
HI-41	Rockaway - Whitman	HARDYSTON TWP	SUSSEX	475470.7681	825079.7361
HI-42	Rockaway - Whitman	SPARTA TWP	SUSSEX	450822.9919	813584.5622
HI-43	Rockaway - Whitman	BYRAM TWP	SUSSEX	440929.6150	781451.5957
HI-44	Rockaway - Whitman	GREEN TWP	SUSSEX	411717.8599	767688.6447
HI-45	Washington Wassaic Group	VERNON TWP	SUSSEX	504345.1021	873899.3129
HI-46	Washington Wassaic Group	HARDYSTON TWP	SUSSEX	476127.2655	845738.0803
HI-47	Washington Wassaic Group	LIBERTY TWP	WARREN	365330.5005	744175.2724
HI-48	Washington Wassaic Group	HACKETTSTOWN TOWN	WARREN	396696.9788	733559.8399
HI-49	Washington Wassaic Group	GREENWICH TWP	WARREN	324423.0237	681527.4449
HI-50	Washington Wassaic Group	FRANKLIN TWP	WARREN	346789.4234	695537.1822

TABLE 1

RURAL SOIL SAMPLE LOCATIONS COASTAL PLAIN PHYSIOGRAPHIC PROVINCE

SAMPLE ID	SOIL GROUP	GEOGRAPHIC REGION		STATE PLANE COORDINATES	
		MUNICIPALITY	COUNTY	LONGITUDE	LATITUDE
CP-51	Atsion	SOUTHAMPTON TWP	BURLINGTON	434052.6477	392741.4014
CP-52	Atsion	PEMBERTON TWP	BURLINGTON	487231.6386	412410.2389
CP-53	Atsion	SHAMONG TWP	BURLINGTON	428305.2157	327453.0442
CP-54	Atsion	BASS RIVER TWP	BURLINGTON	497700.2566	325394.9812
CP-55	Atsion	WASHINGTON TWP	BURLINGTON	482137.3045	294156.2942
CP-56	Atsion	MANCHESTER TWP	OCEAN	519447.0433	400232.9793
CP-57	Downer	LACEY TWP	OCEAN	561200.1942	382461.1908
CP-58	Downer	BARNEGAT TWP	OCEAN	540409.0327	341178.6878
CP-59	Downer	WOODLAND TWP	BURLINGTON	453499.2669	378386.4670
CP-60	Downer	UPPER TWP	CAPE_MAY	398170.3759	167776.0639
CP-61	Downer	MONROE TWP	GLOUCESTER	375250.4241	291637.3090
CP-62	Downer	HAMILTON TWP	ATLANTIC	427057.0318	251137.6178
CP-64	Downer	ESTELL MANOR CITY	ATLANTIC	409674.3547	200446.9888
CP-65	Downer	QUINTON TWP	SALEM	251162.6066	253286.2176
CP-66	Downer	LAWRENCE TWP	CUMBERLAND	296585.2830	192675.8553
CP-67	Downer	DEERFIELD TWP	CUMBERLAND	324954.4905	222238.1880
CP-68	Downer	MAURICE RIVER TWP	CUMBERLAND	367527.3127	154853.6007
CP-69	Evesboro	EAST BRUNSWICK TWP	MIDDLESEX	510449.3664	566521.4886
CP-70	Evesboro	HAMILTON TWP	MERCER	442820.6008	500675.1952
CP-71	Evesboro	PLUMSTED TWP	OCEAN	500423.6818	455225.4764
CP-72	Evesboro	PEMBERTON TWP	BURLINGTON	464464.7244	395646.7986
CP-73	Evesboro	SHAMONG TWP	BURLINGTON	415253.5296	339579.5697
CP-74	Lakehurst	PLUMSTED TWP	OCEAN	495811.2045	425454.2178
CP-75	Lakehurst	LACEY TWP	OCEAN	537668.4890	374479.1820
CP-76	Lakehurst	WATERFORD TWP	CAMDEN	409334.4796	333436.3885
CP-77	Lakehurst	BASS RIVER TWP	BURLINGTON	508340.9939	294427.6009
CP-78	Lakehurst	MULLICA TWP	ATLANTIC	456250.3277	266719.4087
CP-79	Lakehurst	EVESHAM TWP	BURLINGTON	381526.8326	368421.8605
CP-80	Lakehurst	ESTELL MANOR CITY	ATLANTIC	421426.8515	194337.7050
CP-81	Lakewood	MANCHESTER TWP	OCEAN	510539.3260	415617.4388
CP-82	Lakewood	PEMBERTON TWP	BURLINGTON	482213.6433	401492.3553
CP-83	Lakewood	WASHINGTON TWP	BURLINGTON	454864.9251	330808.9369

TABLE 1

RURAL SOIL SAMPLE LOCATIONS COASTAL PLAIN PHYSIOGRAPHIC PROVINCE

SAMPLE ID	SOIL GROUP	GEOGRAPHIC REGION		STATE PLANE COORDINATES	
		MUNICIPALITY	COUNTY	LONGITUDE	LATITUDE
CP-84	Lakewood	BERKELEY TWP	OCEAN	545868.6782	404132.4433
CP-85	Lakewood	WINSLOW TWP	CAMDEN	386595.5106	287619.3378
CP-86	Sassafras	PILESGROVE TWP	SALEM	275239.7075	307440.5583
CP-87	Sassafras	DEERFIELD TWP	CUMBERLAND	306317.3576	232724.3624
CP-88	Sassafras	FAIRFIELD TWP	CUMBERLAND	303083.7011	209179.1498
CP-89	Sassafras	UPPER TWP	CAPE_MAY	399365.1855	163955.7503
CP-90	Sassafras	MILLSTONE TWP	MONMOUTH	515852.0435	499235.9876
CP-91	Aura	FRANKLIN TWP	GLOUCESTER	357593.6386	280137.4915
CP-92	Aura	WINSLOW TWP	CAMDEN	372682.1076	328848.0149
CP-93	Aura	LACEY TWP	OCEAN	515582.5518	371187.6087
CP-94	Aura	GALLOWAY TWP	ATLANTIC	478511.8432	256624.1428
CP-95	Aura	MULLICA TWP	ATLANTIC	433734.7583	276941.1531
78A-CP*	Lakehurst	MULLICA TWP	ATLANTIC	456250.3277	266719.4087
85ACP*	Lakewood	WINSLOW TWP	CAMDEN	386595.5106	287619.3378
89CPA*	Sassafras	UPPER TWP	CAPE_MAY	399365.1855	163955.7503
92A-CP	Aura	WINSLOW TWP	CAMDEN	372682.1076	328848.0149

*Duplicate Samples

TABLE 2
AREAL COVERAGES OF RURAL SOIL TYPES
VALLEY & RIDGE PHYSIOGRAPHIC PROVINCE

TOTAL RURAL ACREAGE = 229840.77

SOIL GROUPS[1]	ACREAGE	NUMBER OF SAMPLES ALLOTED[2,3,4]	% OF ACREAGE WITHIN PROVINCE
Swartswood/Nassau/Wusrtboro/Oquaga	115188.45	13	51.86%
Washington/ Wassaic	41385.82	5	18.63%
Bath/Norwich	20694.11	5	9.32%
Chippewa	10237.62	0	4.61%
Bartley	10136.45	0	4.56%
Glacial	7739.80	0	3.48%
Albia/Verango	5139.78	0	2.31%
Annandale	3376.80	0	1.52%
Wooster	2447.75	0	1.10%
Lyons	2319.12	0	1.04%
Parker/Edneyville	1989.85	0	0.90%
Hero	1565.33	0	0.70%
Raynham	1201.94	0	0.54%
Middlebury	1168.66	0	0.53%
Hoosic	1157.30	0	0.52%
Unadilla	1156.85	0	0.52%
Steinsburg	1029.28	0	0.46%
Colonie/Cokesbury	735.45	0	0.33%
Valois	409.25	0	0.18%
Rockaway/Whitman	256.65	0	0.12%
Preakness	150.80	0	0.07%
Riverhead	151.22	0	0.07%
Califon	129.33	0	0.06%
Ottsville	59.78	0	0.03%
Hibernia	13.41	0	0.01%

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[1] Soil classification with similar geologic origin have been combined due to similar chemical characteristics.

[2] Soils that attribute to over 5 percent of the total rural extent for the Valley and Ridge physiographic province were used in this study.

[3] Soil types that attribute to less than 5 percent were not sampled in this study.

[4] A minimum of five samples was assigned for each representative soil classification

TABLE 3
AREAL COVERAGES OF RURAL SOIL TYPES
HIGHLANDS PHYSIOGRAPHIC PROVINCE

TOTAL RURAL ACREAGE = 254975.97

SOIL GROUPS[1]	ACREAGE	NUMBER OF SAMPLES ALLOTED[2,3,4]	% OF ACREAGE WITHIN PROVINCE
Rockaway/Whitman	70508.24	9	28.54%
Parker/Edneyville	70256.81	8	28.44%
Washington/ Wassaic	39223.54	6	15.88%
Annandale	13236.35	0	5.36%
Califon	13062.75	0	5.29%
Bath/Norwich	8386.53	0	3.39%
Bartley	7940.87	0	3.21%
Glacial	7939.13	0	3.21%
Colonie/Cokesbury	6897.97	0	2.79%
Hibernia	6235.90	0	2.52%
Lyons	1897.45	0	0.77%
Riverhead	1666.19	0	0.67%
Duffield	1584.18	0	0.64%
Turbotville	1540.93	0	0.62%
Preakness	928.01	0	0.38%
Ottsville	875.95	0	0.35%
Pattenburg	843.04	0	0.34%
Swartswood/Nassau/Wusrtboro/Oquaga	676.14	0	0.27%
Hero	368.63	0	0.15%
Albia/Verango	308.65	0	0.12%
Middlebury	228.90	0	0.09%
Chenango	119.81	0	0.05%
Pen	118.68	0	0.05%
Parsippany	66.71	0	0.03%
Chippewa	12.82	0	0.01%
Lansdown	33.76	0	0.01%
Hoosic	6.69	0	0.00%
Raynham	11.36	0	0.00%

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[1] Soil classification with similar geologic origin have been combined due to similar chemical characteristics.

[2] Soils that attribute to over 6 percent of the total rural extent for the Highlands physiographic province were used in this study.

[3] Soil types that attribute to less than 6 percent were not sampled in this study.

[4] A minimum of five samples was assigned for each representative soil classification

TABLE 4
AREAL COVERAGES OF RURAL SOIL TYPES
COASTAL PLAIN PHYSIOGRAPHIC PROVINCE

TOTAL RURAL ACREAGE = 1226566.99

SOIL GROUPS	ACREAGE	NUMBER OF SAMPLES ALLOTED[1,2,3]	% OF ACREAGE WITHIN PROVINCE
Downer	196009.526	11	15.98%
Lakehurst	107477.826	7	8.76%
Atsion	85891.219	6	7.00%
Sassafras	80909.164	5	6.60%
Lakewood	69368.092	5	5.66%
Evesboro	66779.259	5	5.44%
Aura	51651.462	5	4.21%
Woodmansie	47671.319	0	3.89%
Hammonton	46003.072	0	3.75%
Woodstown	36508.583	0	2.98%
Klej	35172.791	0	2.87%
Mullica	28349.680	0	2.31%
Berryland	25387.994	0	2.07%
Othello	24304.607	0	1.98%
Pocomoke	20763.255	0	1.69%
Chillum	20649.110	0	1.68%
Matapeake	20419.385	0	1.66%
Fort Mott	19521.872	0	1.59%
Mannington	18731.709	0	1.53%
Freehold	17317.444	0	1.41%
Keyport	16950.679	0	1.38%
Haledon	16855.413	0	1.37%
Collington	14195.585	0	1.16%
Lawrenceville	13993.542	0	1.14%
Marlton	13651.676	0	1.11%
Shrewsbury	12644.646	0	1.03%
Adelphia	11504.452	0	0.94%
Leon	10457.122	0	0.85%
Lansdale	8096.472	0	0.66%
Fallsington	7135.604	0	0.58%
Pemberton	6394.986	0	0.52%

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[1] Soils that attribute to over 4 percent of the total rural extent for the Coastal Plain physiographic province were used in this study.

[2] Soil types that attribute to less than 4 percent were not sampled in this study.

[3] A minimum of five samples was assigned for each representative soil classification

TABLE 4

AREAL COVERAGES OF RURAL SOIL TYPES COASTAL PLAIN PHYSIOGRAPHIC PROVINCE

TOTAL RURAL ACREAGE = 1226566.99

SOIL GROUPS	ACREAGE	NUMBER OF SAMPLES ALLOTED[4,5,6]	% OF ACREAGE WITHIN PROVINCE
Doylestown	6286.929	0	0.51%
Nixonton	6069.828	0	0.49%
Plummer	5891.977	0	0.48%
Sharptown	5532.970	0	0.45%
Westphalia	5110.113	0	0.42%
Phalanx	4833.813	0	0.39%
Holmdel	4842.916	0	0.39%
Galestown	4451.598	0	0.36%
Tinton	4151.364	0	0.34%
Chiocone	4173.993	0	0.34%
Colemantown	3862.180	0	0.31%
Woolwich	3234.693	0	0.26%
Swedesboro	2597.792	0	0.21%
Mattapax	2147.143	0	0.18%
Kresson	1871.958	0	0.15%
St. Johns	1732.062	0	0.14%
Elkton	1495.535	0	0.12%
Matawan	1518.076	0	0.12%
Keansburg	1332.382	0	0.11%
Fripp	1346.141	0	0.11%
Dragston & Woodstown	1044.390	0	0.09%
Pasmments	969.110	0	0.08%
Pasquotank	446.367	0	0.04%
Donlonton	351.713	0	0.03%
Portsmouth	387.048	0	0.03%
Appoquinimink	106.433	0	0.01%
Weeksville	10.915	0	0.00%

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[4] Soils that attribute to over 4 percent of the total rural extent for the Coastal Plain physiographic province were used in this study.

[5] Soil types that attribute to less than 4 percent were not sampled in this study.

[6] A minimum of five samples was assigned for each representative soil classification

TABLE 5
CRITICAL DISTANCES TO POINT SOURCES

DESCRIPTION	CRITICAL DISTANCE
Nearest Hazardous Waste Site (non-BUST)	Greater than 1/8 mile (approximately 660 feet)
Asphalted Surfaces/Railroads	Greater than 250 feet
Fill Material	Samples were not collected from fill material
Herbicide/Pesticide Impacted Areas	Samples were not collected from pesticide/herbicide impacted areas

TABLE 6
ANALYTICAL METHODS/QUALITY ASSURANCE SUMMARY

Matrix	Analytical Parameter	Analytical Methodology *	No. of Samples	No. of Field Blanks	No. of Trip Blanks	No. of Duplicates	Total Analyses	Container Volume and Type **	Preservation	HT to Extract/ Prep (Days)	HT to Analysis (Days)
Soil	cPAHs	USEPA SW-846 Method 8270	90	3	NA	4	97	8-oz amber glass	4 C	14	40
Soil	TAL Mercury	USEPA SW-846 Method 7471	90	3	NA	4	97	8-oz amber glass	4 C	NA	28
Soil	Other TAL Metals	USEPA SW-846 Method 6010/7000 Series *	90	3	NA	4	97	8-oz amber glass	4 C	NA	180
Soil	Total Organic Carbon (TOC)	USEPA Region II Lloyd Kahn Method	90	0	NA	4	94	8-oz amber glass	4 C	NA	14
Soil	pH	USEPA SW-846 Method 9045	90	0	NA	4	94	8-oz amber glass	4 C	NA	***

* Arsenic by 7060, Lead by 7421, Selenium by 7740, Thallium by 7841
ASTM - American Society for Testing and Materials
cPAHs - Carcinogenic Polycyclic Aromatic Hydrocarbons
C - Celsius
HT - Holding Time

** All containers have Teflon-lined lids
TAL - Target Analyte List
TOC - Total Organic Carbon
TOCMP - Total Organic Compounds, used synonomously and interchangeably with LOI
USEPA - United States Environmental Protection Agency

*** Field Analysis
MSD - Matrix Spike Duplicate
MS - Matrix Spike
NA - Not Applicable

TAL Metals: Aluminum, Antimony, Arsenic, Barium, Baryllium, Cadmium, Calcium, Chromium, Cobalt, Copper, Iron, Lead, Magnesium, Mercury, Potassium, Selenium, Silver, Sodium, Thallium, Vanadium, Zinc
cPAHs: Benzo(b)flouranthene, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(k)flouranthene, Dibenz(a,h)anthracene, Indeno(1,2,3-cd)pyrene, Chrysene.

TABLE 7
ANALYTICAL METHOD DETECTION LIMIT SUMMARY

Analyte	CAS No.	Matrix	Method	MDL
Aluminum	7429-90-5	Soil	6010	20
Antimony	744-36-0	Soil	6010	6
Arsenic	7440-38-2	Soil	7060	1
Barium	7440-39-3	Soil	6010	20
Beryllium	7440-41-7	Soil	6010	0.5
Cadmium	7440-43-9	Soil	6010	0.5
Calcium	7440-70-2	Soil	6010	500
Chromium	7440-47-3	Soil	6010	1
Cobalt	7440-48-4	Soil	6010	5
Copper	7440-50-8	Soil	6010	2.5
Iron	7439-89-6	Soil	6010	10
Lead	7439-92-1	Soil	7471	10
Magnesium	7439-95-4	Soil	6010	500
Mercury	7439-97-6	Soil	7471	0.1
Nickel	7440-02-0	Soil	6010	4
Potassium	7440-09-7	Soil	6010	500
Selenium	7782-49-2	Soil	7740	1
Silver	7440-22-4	Soil	6010	1
Sodium	7440-23-5	Soil	6010	500
Thallium	7440-28-0	Soil	7841	1
Vanadium	7440-62-2	Soil	6010	5
Zinc	7440-66-6	Soil	6010	2
Benzo(a)anthracene	56-55-3	Soil	8270	0.029
Benzo(a)pyrene	50-32-8	Soil	8270	0.037
Benzo(b)fluoranthene	207-08-9	Soil	8270	0.04
Chrysene	218-01-9	Soil	8270	0.022
Dibenz(a,h)anthracene	53-70-3	Soil	8270	0.037
Indeno(1,2,3-cd)pyrene	193-39-5	Soil	8270	0.018
Total Organic Carbon	NA	Soil	Llyod Kahn	NA
pH	NA	Soil	9045	NA

Notes:

NA - Not Applicable
mg/kg- milligrams per kilograms

TABLE 8

SUMMARY OF RURAL SOIL SAMPLES WITH COMPOUND CONCENTRATIONS EXCEEDING THE NJDEP RESIDENTIAL DIRECT CONTACT SOIL CLEANUP CRITERIA

Analyte	Frequency of RDCSCC Exceedences	RDCSCC (mg/kg)	Sample ID and Concentrations Above RDCSCC (mg/kg)		Overall Highlands Mean Concentration (mg/kg)	Overall Study Mean Concentration (mg/kg)
Beryllium	1/90	2	HI-35	2.8	0.73	0.37
Benzo(a)pyrene	1/90	0.66	HI-34	0.68	0.05	0.02

Notes:

mg/kg - milligrams per kilogram
RDCSCC – Residential Direct Contact Soil Cleanup Criteria

TABLE 9

SUMMARY OF VALLEY & RIDGE RURAL SOIL DATA

	Sample ID:	NJDEP NRDC Cleanup Criteria	NJDEP RDC Cleanup Criteria	**VR-01**	**VR-02**	**VR-03**	**VR-04**	**VR-06**	**VR-07A**	**VR-08A**
Analyte	Date:	03-May-1999	03-May-1999	13-Dec-2000	13-Dec-2000	12-Dec-2000	13-Dec-2000	14-Dec-2000	05-Dec-2000	05-Dec-2000
Metals										
Silver		4100	110	0.092 U	0.080 U	0.085 U	0.095 U	0.076 U	0.079 U	0.083 U
Aluminum		NA	NA	21400	8160	16300	8860	5480	9520	19300
Arsenic		20	20	5.5	4.2	5.3	4.0	2.3	5.0	5.1
Barium		47000	700	75.4	28.7	53.8	42.6	1.2 U	32.7	75.4
Beryllium		2	2	0.66	0.046 U	0.048 U	0.72	0.043 U	0.023 U	0.61
Calcium		NA	NA	8.7 U	7.6 U	1180	9.0 U	7.2 U	3.6 U	3.8 U
Cadmium		100	39	0.039 U	0.034 U	0.036 U	0.040 U	0.033 U	0.034 U	0.035 U
Cobalt		NA	NA	8.0	0.068 U	8.2	12.4	0.065 U	0.056 U	11
Chromium		NA	120000	21.8	7.0	16.2	6.8	7.8	10.4	17.5
Copper		600	600	22.5	6.1	19.3	9.0	5.7	23.8	18.9
Iron		NA	NA	25900	8680	22600	6420	8850	14000	29200
Mercury		270	14	0.077	0.076	0.054	0.17	0.098	0.20 L	0.11 L
Potassium		NA	NA	1570	5.1 U	973	6.0 U	4.8 U	817	1040
Magnesium		NA	NA	5210	835	4960	4.6 U	3.7 U	1560 J	5630 J
Manganese		NA	NA	404	146	496	797	20.4	228 L	1200 L
Sodium		NA	NA	39 U	34 U	36 U	41 U	33 U	9.7 U	10 U
Nickel		2400	250	20.7	4.6	17	6.1	0.41 U	10.2	19.3
Lead		600	400	36.6	33.5	17.1	52.4	57.1	27.1 J	37 J
Antimony		340	14	0.54 U	0.47 U	0.50 U	0.55 U	0.44 U	0.19 U L	0.20 U L
Selenium		3100	63	0.58 U	0.50 U	0.53 U	0.59 U	0.48 U	0.35 U	0.37 U
Thallium		2	2	0.60 U	0.52 U	0.56 U	0.62 U	0.50 U	0.41 U	0.42 U
Vanadium		7100	370	28.4	12.6	20.9	11.7	15	17.9	21.9
Zinc		1500	1500	84.5	41.8	65.6	37.9	13.7	38.4	85.6

Analyte concentrations in mg/kg (ppm)

Analyses were performed by Accutest, using standard analytical methodology

L	Result is likely biased low
J	Result is an estimated concentration
U	Analyte analyzed for but undetected at the corresponding detection limit
NA	Not applicable

TABLE 9

SUMMARY OF VALLEY & RIDGE RURAL SOIL DATA

	Sample ID:	NJDEP NRDC Cleanup Criteria	NJDEP RDC Cleanup Criteria	**VR-09**	**VR-10**	**VR-11A**	**VR-12A**	**VR-14**	**VR-15**	**VR-16A**
Analyte	Date:	03-May-1999	03-May-1999	05-Dec-2000	07-Dec-2000	06-Dec-2000	06-Dec-2000	11-Dec-2000	11-Dec-2000	29-Dec-2000
Metals										
Silver		4100	110	0.095 U	0.092 U	0.078 U	0.081 U	0.10 U	0.095 U	0.16 U
Aluminum		NA	NA	5790	1310 J	19700	15300	21300	17800	20200
Arsenic		20	20	3.5	1.3 J	4.5	4.0	5.4	5.0	7.0
Barium		47000	700	0.16 U	0.16 U	72.8	65.6	103	122	93.8
Beryllium		2	2	0.027 U	0.026 U	0.022 U	0.023 U	0.028 U	0.86	0.063 U
Calcium		NA	NA	4.4 U	4.2 U	3.6 U	2390	1070	866	3200
Cadmium		100	39	0.041 U	0.039 U	0.034 U	0.035 U	0.043 U	0.040 U	0.095 U
Cobalt		NA	NA	0.068 U	0.066 U	6.8	10.1	10.5	11.5	9.1
Chromium		NA	120000	7.0	3.7	17	15.5	18	14.3	22
Copper		600	600	6.4	8.6 J	15.9	22.5	19.7 J	21.6 J	26.6
Iron		NA	NA	6210	1530 J	20900	22700	29500 J	13700 J	24100
Mercury		270	14	0.11 L	0.12 L	0.085 L	0.091 L	0.14	0.15	NA
Potassium		NA	NA	4.5 U	4.4 U	961	1180	1660	1140	1930
Magnesium		NA	NA	1.6 U J	1.5 U	4190 J	5620 J	7570	1710	5110
Manganese		NA	NA	63.6 L	14.7	439 L	735 L	1210 J	1590 J	703
										13 U
Sodium		NA	NA	12 U	11 U	9.7 U	10 U	12 U	12 U	
Nickel		2400	250	0.18 U	0.17 U	17	20.1	24.5	15.7	22.5
Lead		600	400	31.6 J	60.4	31.1 J	24.7 J	25	54.4	42
Antimony		340	14	0.23 U L	0.22 U L	0.19 U L	0.20 U L	0.24 U L	0.23 U L	0.38 U L
Selenium		3100	63	0.42 U	0.41 U	0.35 U	0.36 U	0.44 U	0.42 U	0.73 U
										0.52 U
Thallium		2	2	0.49 U	0.47 U	0.40 U	0.42 U	0.51 U	0.49 U	
Vanadium		7100	370	13.5	0.092 U	25.1	15.1	26.3	25	27.2
Zinc		1500	1500	24.4	38.2	75.8	92.9	93.8	97.5	123

Analyte concentrations in mg/kg (ppm)

Analyses were performed by Accutest, using standard analytical methodology

L	Result is likely biased low
J	Result is an estimated concentration
U	Analyte analyzed for but undetected at the corresponding detection limit
NA	Not applicable

TABLE 9

SUMMARY OF VALLEY & RIDGE RURAL SOIL DATA

Analyte	Sample ID: Date:	NJDEP NRDC Cleanup Criteria 03-May-1999	NJDEP RDC Cleanup Criteria 03-May-1999	**VR-17** 22-Dec-2000	**VR-18** 18-Dec-2000	**VR-19** 07-Dec-2000	**VR-20A** 29-Dec-2000	**VR-21** 18-Dec-2000	**VR-22A** 06-Dec-2000	**VR-23** 20-Dec-2000	**VR-24** 11-Dec-2000
Metals											
Silver		4100	110	0.15 U	0.14 U	0.074 U	0.13 U	0.15 U	0.080 U	0.14 U	0.080 U
Aluminum		NA	NA	18100	28600	13500 J	17000	9220	10600	15900	6980
Arsenic		20	20	3.6	4.6	3.9	7.7	6.6	3.9	7.4	9.9
Barium		47000	700	76.7	104	58.8	68.5	0.25 U	54	60.2	47.1
Beryllium		2	2	0.75	1.0	0.021 U	0.052 U	0.060 U	0.023 U	1.2	0.023 U
Calcium		NA	NA	8.8 U	8.7 U	874	1800	8.9 U	3.7 U	1140	62100
Cadmium		100	39	0.088 U	0.087 U	0.032 U	0.078 U	0.089 U	0.034 U	0.082 U	0.034 U
Cobalt		NA	NA	10.1	13.9	0.053 U	7.3	0.15 U	0.057 U	9.6	0.057 U
Chromium		NA	120000	18.8	25.2	11.6	17.2	10.2	12	17.6	8.0
Copper		600	600	28.4	31.2	13	17.2	8.5 J	11.1	19	12.8 J
Iron		NA	NA	25000	36100	14500 J	18700	9940	12600	24500	14800 J
Mercury		270	14	0.047	0.068	0.055 L	NA	0.15	0.059 L	0.019 U	0.097
Potassium		NA	NA	1660	1780	927	1160	6.3 U	921	1560	682
Magnesium		NA	NA	5290	8310	2460	2780	846	2040 J	2600	36600
Manganese		NA	NA	765	1160	379	470	60.6	352 L	536	622 J
Sodium		NA	NA	12 U	12 U	9.1 U	11 U	12 U	9.8 U	11 U	9.9 U
Nickel		2400	250	22.5	29.8	11	16.6	0.31 U	11.3	19.1	8.0
Lead		600	400	14.3	39.4	19.3	29.7	42.4	14.8 J	19.2	21.7
Antimony		340	14	0.35 U L	0.35 U L	0.18 U L	0.31 U L	0.36 U L	0.19 U L	0.33 U L	0.20 U L
Selenium		3100	63	0.67 U	0.67 U	0.33 U	0.60 U	0.69 U	0.35 U	0.63 U	0.36 U
Thallium		2	2	0.48 U	0.48 U	0.38 U	0.43 U	0.49 U	0.41 U	0.45 U	0.41 U
Vanadium		7100	370	20.4	33.5	18.4	30	20.7	16	31.8	17
Zinc		1500	1500	81.3	122	50.1	90.9	43.4	48.6	116	49.7

Analyte concentrations in mg/kg (ppm)

Analyses were performed by Accutest, using standard analytical methodology

L	Result is likely biased low
J	Result is an estimated concentration
U	Analyte analyzed for but undetected at the corresponding detection limit
NA	Not applicable

TABLE 9

SUMMARY OF VALLEY & RIDGE RURAL SOIL DATA

Analyte	Sample ID: Date:	NJDEP NRDC Cleanup Criteria 03-May-1999	NJDEP RDC Cleanup Criteria 03-May-1999	**VR-25** 21-Dec-2000	
Metals					
Silver		4100	110	0.15	U
Aluminum		NA	NA	14300	
Arsenic		20	20	4.9	
Barium		47000	700	73.8	
Beryllium		2	2	0.92	J
Calcium		NA	NA	1570	
Cadmium		100	39	0.091	U
Cobalt		NA	NA	0.15	U
Chromium		NA	120000	12.4	
Copper		600	600	16.2	
Iron		NA	NA	13900	
Mercury		270	14	0.11	
Potassium		NA	NA	946	
Magnesium		NA	NA	2130	
Manganese		NA	NA	373	
Sodium		NA	NA	13	U
Nickel		2400	250	12.3	
Lead		600	400	40	
Antimony		340	14	0.36	U L
Selenium		3100	63	0.70	U
Thallium		2	2	0.50	U
Vanadium		7100	370	24.6	
Zinc		1500	1500	86.2	

Analyte concentrations in mg/kg (ppm)

Analyses were performed by Accutest, using standard analytical methodology

L	Result is likely biased low
J	Result is an estimated concentration
U	Analyte analyzed for but undetected at the corresponding detection limit
NA	Not applicable

TABLE 9

SUMMARY OF VALLEY & RIDGE RURAL SOIL DATA

	Sample ID:	**FB-VR 12.12.00**	
Analyte	Date:	12-Dec-2000	
Metals			
Silver		0.70	U
Aluminum		48	U
Arsenic		2.3	U
Barium		1.2	U
Beryllium		0.20	U
Calcium		32	U
Cadmium		0.30	U
Cobalt		0.50	U
Chromium		0.50	U
Copper		0.60	U
Iron		13	U
Mercury		0.10	U
Potassium		33	U
Magnesium		12	U
Manganese		0.40	U
Sodium		86	U
Nickel		1.3	U
Lead		1.3	U
Antimony		1.7	U
Selenium		3.1	U
Thallium		3.6	U
Vanadium		0.70	U
Zinc		1.4	U

Analyte concentrations in µg/L (ppb)

Analyses were performed by Accutest, using standard analytical methodology

U	Analyte analyzed for but undetected at the corresponding detection limit

TABLE 9

SUMMARY OF VALLEY & RIDGE RURAL SOIL DATA

Analyte	Sample ID: Date:	NJDEP NRDC Cleanup Criteria 03-May-1999	NJDEP RDC Cleanup Criteria 03-May-1999	**VR-01** 13-Dec-2000	**VR-02** 13-Dec-2000	**VR-03** 12-Dec-2000	**VR-04** 13-Dec-2000	**VR-06** 14-Dec-2000	**VR-07A** 05-Dec-2000
General Chemistry/Indicator Parameters/PHCs									
pH, pH Units		NA	NA	4.2	3.9	5.4	4.1	3.5	4.3
Total Solids, Percent		NA	NA	78	87.6	84.2	77.9	87.7	82
Total Organic Carbon, mg/kg (ppm)		NA	NA	42700	32400	36900	117000	52900	37400

Analyte concentrations in units specified

Analyses were performed by Accutest, using standard analytical methodology

L	Result is likely biased low
NA	Not applicable

TABLE 9

SUMMARY OF VALLEY & RIDGE RURAL SOIL DATA

	Sample ID:	NJDEP NRDC Cleanup Criteria	NJDEP RDC Cleanup Criteria	**VR-08A**	**VR-09**	**VR-10**	**VR-11A**	**VR-12A**	**VR-14**
Analyte	Date:	03-May-1999	03-May-1999	05-Dec-2000	05-Dec-2000	07-Dec-2000	06-Dec-2000	06-Dec-2000	11-Dec-2000
General Chemistry/Indicator Parameters/PHCs									
pH, pH Units		NA	NA	3.8	3.5	3.8	4.5	6.3	5.1
Total Solids, Percent		NA	NA	87.3	79.4	76.9	83.5	87.3	69.5
Total Organic Carbon, mg/kg (ppm)		NA	NA	19500	63600	169000	72400	69300	43200

Analyte concentrations in units specified

Analyses were performed by Accutest, using standard analytical methodology

L	Result is likely biased low
NA	Not applicable

TABLE 9

SUMMARY OF VALLEY & RIDGE RURAL SOIL DATA

Analyte	Sample ID: Date:	NJDEP NRDC Cleanup Criteria 03-May-1999	NJDEP RDC Cleanup Criteria 03-May-1999	**VR-15** 11-Dec-2000	**VR-16A** 29-Dec-2000	**VR-17** 22-Dec-2000	**VR-18** 18-Dec-2000	**VR-19** 07-Dec-2000
General Chemistry/Indicator Parameters/PHCs								
pH, pH Units		NA	NA	4.3	6.4	5.0	4.3	5.6
Total Solids, Percent		NA	NA	74	63.3	70.3	67.5	85.2
Total Organic Carbon, mg/kg (ppm)		NA	NA	83700	60200	29300 L	41200 L	34800

Analyte concentrations in units specified

Analyses were performed by Accutest, using standard analytical methodology

L	Result is likely biased low
NA	Not applicable

TABLE 9

SUMMARY OF VALLEY & RIDGE RURAL SOIL DATA

Analyte	Sample ID: Date:	NJDEP NRDC Cleanup Criteria 03-May-1999	NJDEP RDC Cleanup Criteria 03-May-1999	**VR-20A** 29-Dec-2000	**VR-21** 18-Dec-2000	**VR-22A** 06-Dec-2000	**VR-23** 20-Dec-2000	**VR-24** 11-Dec-2000	**VR-25** 21-Dec-2000
General Chemistry/Indicator Parameters/PHCs									
pH, pH Units		NA	NA	6.3	3.6	5.3	6.1	7.1	5.3
Total Solids, Percent		NA	NA	76.8	67.1	88.9	75.5	87.3	67.4
Total Organic Carbon, mg/kg (ppm)		NA	NA	28200	103000 L	63700	25300 L	23200	51500 L

Analyte concentrations in units specified

Analyses were performed by Accutest, using standard analytical methodology

L	Result is likely biased low
NA	Not applicable

TABLE 9

SUMMARY OF VALLEY & RIDGE RURAL SOIL DATA

Analyte	Sample ID:	**FB-VR 12.12.00**	
	Date:	12-Dec-2000	
General Chemistry/Indicator Parameters/PHCs			
pH, pH Units		6.0	
Total Organic Carbon, µg/L (ppb)		1000	U

Analyte concentrations in units specified

Analyses were performed by Accutest, using standard analytical methodology

U	Analyte analyzed for but undetected at the corresponding detection limit

TABLE 9

SUMMARY OF VALLEY & RIDGE RURAL SOIL DATA

Analyte	Sample ID: Date:	NJDEP NRDC Cleanup Criteria 03-May-1999	NJDEP RDC Cleanup Criteria 03-May-1999	**VR-01** 13-Dec-2000	**VR-02** 13-Dec-2000	**VR-03** 12-Dec-2000	**VR-04** 13-Dec-2000	**VR-06** 14-Dec-2000	**VR-07A** 05-Dec-2000
PAHs by HPLC									
Benzo(a)anthracene		4	0.9	0.013 U	0.011 U	0.012 U	0.013 U	0.011 U	0.17
Benzo(a)pyrene		0.66	0.66	0.013 U	0.011 U	0.012 U	0.013 U	0.011 U	0.012 U
Benzo(b)fluoranthene		4	0.9	0.013 U	0.011 U	0.012 U	0.013 U	0.011 U	0.012 U
Benzo(k)fluoranthene		4	0.9	0.013 U	0.011 U	0.012 U	0.013 U	0.011 U	0.012 U
Chrysene		40	9	0.013 U	0.011 U	0.012 U	0.013 U	0.011 U	0.012 U
Dibenz(a,h)anthracene		0.66	0.66	0.013 U	0.011 U	0.012 U	0.013 U	0.011 U	0.012 U
Indeno(1,2,3-c,d)pyrene		4	0.9	0.013 U	0.011 U	0.012 U	0.013 U	0.011 U	0.012 U

Analyte concentrations in mg/kg (ppm)

Analyses were performed by Accutest, using SW846 8310

J	Result is detected below the reporting limit and/or is an estimated concentration
U	Analyte analyzed for but undetected at the corresponding quantitation limit

TABLE 9

SUMMARY OF VALLEY & RIDGE RURAL SOIL DATA

	Sample ID:	NJDEP NRDC Cleanup Criteria	NJDEP RDC Cleanup Criteria	**VR-08A**	**VR-09**	**VR-10**	**VR-11A**	**VR-12A**	**VR-14**	**VR-15**
Analyte	Date:	03-May-1999	03-May-1999	05-Dec-2000	05-Dec-2000	07-Dec-2000	06-Dec-2000	06-Dec-2000	11-Dec-2000	11-Dec-2000
PAHs by HPLC										
Benzo(a)anthracene		4	0.9	0.011 U	0.012 U	0.013 U	0.012 U	0.011 U	0.014 U	0.013 U
Benzo(a)pyrene		0.66	0.66	0.011 U	0.012 U	0.013 U	0.012 U	0.011 U	0.014 U	0.013 U
Benzo(b)fluoranthene		4	0.9	0.011 U	0.012 U	0.013 U	0.012 U	0.011 U	0.014 U	0.013 U
Benzo(k)fluoranthene		4	0.9	0.011 U	0.012 U	0.013 U	0.012 U	0.011 U	0.014 U	0.013 U
Chrysene		40	9	0.011 U	0.012 U	0.013 U	0.012 U	0.011 U	0.014 U	0.013 U
Dibenz(a,h)anthracene		0.66	0.66	0.011 U	0.012 U	0.013 U	0.012 U	0.011 U	0.014 U	0.013 U
Indeno(1,2,3-c,d)pyrene		4	0.9	0.011 U	0.012 U	0.013 U	0.012 U	0.011 U	0.014 U	0.013 U

Analyte concentrations in mg/kg (ppm)

Analyses were performed by Accutest, using SW846 8310

J	Result is detected below the reporting limit and/or is an estimated concentration
U	Analyte analyzed for but undetected at the corresponding quantitation limit

TABLE 9

SUMMARY OF VALLEY & RIDGE RURAL SOIL DATA

	Sample ID:	NJDEP NRDC Cleanup Criteria	NJDEP RDC Cleanup Criteria	**VR-16A**	**VR-17**	**VR-18**	**VR-19**	**VR-20A**	**VR-21**
Analyte	Date:	03-May-1999	03-May-1999	29-Dec-2000	22-Dec-2000	18-Dec-2000	07-Dec-2000	29-Dec-2000	18-Dec-2000
PAHs by HPLC									
Benzo(a)anthracene		4	0.9	0.015 U	0.014 U	0.015 U	0.012 U	0.014	0.027
Benzo(a)pyrene		0.66	0.66	0.015 U	0.014 U	0.015 U	0.012 U	0.012 U	0.015 U
Benzo(b)fluoranthene		4	0.9	0.015 U	0.014 U	0.015 U	0.012 U	0.012 U	0.029
Benzo(k)fluoranthene		4	0.9	0.015 U	0.014 U	0.015 U	0.012 U	0.012 U	0.015 U
Chrysene		40	9	0.015 U	0.014 U	0.015 U	0.012 U	0.018	0.051
Dibenz(a,h)anthracene		0.66	0.66	0.015 U	0.014 U	0.015 U	0.012 U	0.012 U	0.015 U
Indeno(1,2,3-c,d)pyrene		4	0.9	0.015 U	0.014 U	0.015 U	0.012 U	0.012 U	0.015 U

Analyte concentrations in mg/kg (ppm)

Analyses were performed by Accutest, using SW846 8310

J	Result is detected below the reporting limit and/or is an estimated concentration
U	Analyte analyzed for but undetected at the corresponding quantitation limit

TABLE 9

SUMMARY OF VALLEY & RIDGE RURAL SOIL DATA

Analyte	Sample ID: Date:	NJDEP NRDC Cleanup Criteria 03-May-1999	NJDEP RDC Cleanup Criteria 03-May-1999	**VR-22A** 06-Dec-2000		**VR-23** 20-Dec-2000		**VR-24** 11-Dec-2000		**VR-25** 21-Dec-2000	
PAHs by HPLC											
Benzo(a)anthracene		4	0.9	0.011	U	0.054		0.011	U	0.015	U
Benzo(a)pyrene		0.66	0.66	0.011	U	0.013	U	0.011	U	0.015	U
Benzo(b)fluoranthene		4	0.9	0.011	U	0.013	U	0.011	U	0.016	
Benzo(k)fluoranthene		4	0.9	0.011	U	0.013	U	0.011	U	0.015	U
Chrysene		40	9	0.011	U	0.013	U	0.011	U	0.023	
Dibenz(a,h)anthracene		0.66	0.66	0.011	U	0.013	U	0.011	U	0.015	U
Indeno(1,2,3-c,d)pyrene		4	0.9	0.011	U	0.013	U	0.011	U	0.037	

Analyte concentrations in mg/kg (ppm)

Analyses were performed by Accutest, using SW846 8310

J	Result is detected below the reporting limit and/or is an estimated concentration
U	Analyte analyzed for but undetected at the corresponding quantitation limit

TABLE 9

SUMMARY OF VALLEY & RIDGE RURAL SOIL DATA

	Sample ID:	**FB-VR 12.12.00**	
Analyte	Date:	12-Dec-2000	
PAHs by HPLC			
Benzo(a)anthracene		0.15	U
Benzo(a)pyrene		0.15	U
Benzo(b)fluoranthene		0.15	U
Benzo(k)fluoranthene		0.15	U
Chrysene		0.15	U
Dibenz(a,h)anthracene		0.15	U
Indeno(1,2,3-c,d)pyrene		0.15	U

Analyte concentrations in µg/L (ppb)

Analyses were performed by Accutest, using SW846 8310

U	Analyte analyzed for but undetected at the corresponding quantitation limit

TABLE 10

SUMMARY OF HIGHLANDS RURAL SOIL DATA

	Sample ID:	NJDEP NRDC Cleanup Criteria	NJDEP RDC Cleanup Criteria	**HI-26**	**HI-27**	**HI-28**	**HI-30**	**HI-31**	**HI-32**	**HI-33**	**HI-34**
Analyte	Date:	03-May-1999	03-May-1999	20-Dec-2000	26-Dec-2000	08-May-2001	28-Dec-2000	28-Dec-2000	08-May-2001	02-Jun-2001	28-Dec-2000
Metals											
Silver		4100	110	0.12 U	0.14 U	0.089 U	0.16 U	0.15 U	0.17 U	0.17 U	0.14 U
Aluminum		NA	NA	15300	16900 J	14100 K	24300 J	17400 J	21300 K	19600	29600 J
Arsenic		20	20	2.7	4.3	4.8	3.3	7.5	4.5	4.7	4.4
Barium		47000	700	64.2	70.6 J	69.6	124 J	58.1 J	84.8	70.7 J	176 J
Beryllium		2	2	0.90	1.0	0.60 B	0.83	0.061 U	0.63 B	0.70 B	0.94
Calcium		NA	NA	1060	728 J	1590 J	2330 J	9.2 U J	578 BJ	2870	4750 J
Cadmium		100	39	0.074 U	0.082 U	0.33 B	0.093 U	0.092 U	0.15 B	0.15 B	0.081 U
Cobalt		NA	NA	6.8	9.4	7.4 J	9.0	0.15 U	5.7 BJ	12.9	14.6
Chromium		NA	120000	13.7	12.7 J	15 J	21.1 J	18.4 J	10.2 J	34.2 J	34.4 J
Copper		600	600	8.8 J	12.5	10.9 J	21.8	26	12.9 J	19 J	34.2
Iron		NA	NA	15900	15100 J	17800 J	20800 J	19300 J	25300 J	23100 J	30600 J
Mercury		270	14	0.020 U	0.085	0.069	0.096	0.16	0.025 B	0.14	0.082
Potassium		NA	NA	626	5.8 U J	860 K	1470 J	1070 J	1260 K	867 K	4680 J
Magnesium		NA	NA	2100	2110 J	2090 J	2340 J	1210 J	2400 J	3100	6520 J
Manganese		NA	NA	386	1170 J	407 J	530 J	206 J	285 J	469 J	375 J
Sodium		NA	NA	10 U	11 U	71.1 B	13 U	13 U	32 U	50.8 B	11 U
Nickel		2400	250	10.6	12.4	10.2 J	12.4	12.9	7.7 BJ	14.8 J	19.8
Lead		600	400	19.7	21.4 J	22.8 J	48.1 J	56.7 J	14.7 J	22.6	29.1 J
Antimony		340	14	0.30 U L	0.33 U L	0.27 U L	0.37 U L	0.37 U L	0.50 U L	0.53 U L	0.32 U L
Selenium		3100	63	0.57 U	0.63 U	0.69 B	0.71 U	0.70 U	0.71 B	0.71 B	0.62 U
Thallium		2	2	0.41 U	0.45 U	0.48 U	0.51 U	0.51 U	0.90 U	0.68 U	0.45 U
Vanadium		7100	370	29	22.8	30.3 J	37	53.8	22.1 J	44.6	56.5
Zinc		1500	1500	55	69.7 J	76 J	100 J	52.5 J	48.4 J	64	75.1 J

Analyte concentrations in mg/kg (ppm)

Analyses were performed by Accutest, using standard analytical methodology

B	Reported value is between contract required detection limit and instrument detection limit
K	Result is likely biased high
L	Result is likely biased low
J	Result is an estimated concentration
U	Analyte analyzed for but undetected at the corresponding detection limit
NA	Not applicable
N	Exceeds NJDEP Non-Residential Direct Contact
R	Exceeds NJDEP Residential Direct Contact

TABLE 10

SUMMARY OF HIGHLANDS RURAL SOIL DATA

	Sample ID:	NJDEP NRDC Cleanup Criteria	NJDEP RDC Cleanup Criteria	**HI-35**	**HI-36**	**HI-37**	**HI-38**	**HI-39**	**HI-41**	**HI-42**
Analyte	Date:	03-May-1999	03-May-1999	04-May-2001	02-Jan-2001	02-Jan-2001	04-May-2001	29-Dec-2000	04-May-2001	04-May-2001
Metals										
Silver		4100	110	0.21 U	0.21 U	0.20 U	58.9	0.14 U	0.26 B	0.21 B
Aluminum		NA	NA	29400 J	12100	13600	16800 J	15900	29500 J	19400 J
Arsenic		20	20	10	4.0	7.1	9.4	4.9	9.6	5.4
Barium		47000	700	96.8 J	58.5	0.34 U	29.6 BJ	38.8	43.9 J	60.4 J
Beryllium		2	2	*2.8 NR*	0.083 U	0.080 U	0.12 B	0.79	0.30 B	0.49 B
Calcium		NA	NA	1160 BJ	4660	12 U	642 BJ	8.2 U	546 BJ	1010 J
Cadmium		100	39	0.22 B	0.12 U	0.12 U	0.29 B	0.082 U	0.22 B	0.21 B
Cobalt		NA	NA	7.5 BJ	0.21 U	0.20 U	4.3 BJ	0.14 U	3.4 BJ	10 J
Chromium		NA	120000	15.3 J	26.7	19.7	19.6 J	15.5	17 J	18.4 J
Copper		600	600	17.8 J	32.4	14.5	28 J	11.4	13.1 J	13.7 J
Iron		NA	NA	17600 J	18600	17400	19900 J	17400	20700 J	22200 J
Mercury		270	14	0.14	NA	NA	0.36	NA	0.077	0.079
Potassium		NA	NA	586 B	1400	8.5 U	545 B	756	518 B	868
Magnesium		NA	NA	1950 J	3960	1240	1650 J	2710	1330 J	3960 J
Manganese		NA	NA	1480 J	502	101	73.4 J	185	103 J	328 J
					17 U	17 U		12 U		
Sodium		NA	NA	40 U			120 B		94.4 B	88.6 B
Nickel		2400	250	15.5 J	21.5	11.2	11.3 J	10.6	8.2 J	11.4 J
Lead		600	400	47.7 J	63.5	55.2	101 J	19.4	48 J	26.6 J
Antimony		340	14	0.62 U L	0.50 U L	0.48 U L	0.49 BL	0.33 U L	0.32 U L	0.30 U L
Selenium		3100	63	0.78 B	0.95 U	0.93 U	2.0	0.63 U	1.0 B	0.46 B
					0.68 U	0.66 U		0.45 U		
Thallium		2	2	1.1 U			0.73 U		0.59 U	0.54 U
Vanadium		7100	370	32.3 J	35.9	33.2	57.1 J	24.3	42.2 J	49.7 J
Zinc		1500	1500	92.1 J	86.8	38.5	39.3 J	62.5	98.2 J	106 J

Analyte concentrations in mg/kg (ppm)

Analyses were performed by Accutest, using standard analytical methodology

B	Reported value is between contract required detection limit and instrument detection limit
K	Result is likely biased high
L	Result is likely biased low
J	Result is an estimated concentration
U	Analyte analyzed for but undetected at the corresponding detection limit
NA	Not applicable
N	Exceeds NJDEP Non-Residential Direct Contact
R	Exceeds NJDEP Residential Direct Contact

TABLE 10

SUMMARY OF HIGHLANDS RURAL SOIL DATA

	Sample ID:	NJDEP NRDC Cleanup Criteria	NJDEP RDC Cleanup Criteria	**HI-43**	**HI-44**	**HI-45**	**HI-46**	**HI-47**	**HI-48**	**HI-49**
Analyte	Date:	03-May-1999	03-May-1999	07-May-2001	20-Dec-2000	02-Jun-2001	27-Dec-2000	26-Dec-2000	07-May-2001	08-May-2001
Metals										
Silver		4100	110	0.13 B	0.14 U	0.18 U	0.13 U	0.14 U	0.13 B	0.18 U
Aluminum		NA	NA	12200 J	11800	14000	13500 J	14300 J	16700 J	20200 K
Arsenic		20	20	3.5	2.0	9.8	10.3	4.4	4.3	8.0
Barium		47000	700	42.2 J	68.2	85.1 J	66.1 J	70.3 J	75.3 J	96
Beryllium		2	2	1.1	0.058 U	0.86	0.89	0.85 J	0.73	1.4
Calcium		NA	NA	681 J	1470	3950	5980 J	2230 J	3460 J	2530 J
Cadmium		100	39	0.17 B	0.087 U	0.33 B	0.078 U	0.084 U	0.27 B	0.44 B
Cobalt		NA	NA	5.6 BJ	7.7	5.7 B	7.6	0.14 U	6.3 J	12.9 BJ
Chromium		NA	120000	8.7 J	12.5	16.9 J	17.7 J	13.9 J	23.9 J	26.4 J
Copper		600	600	8.5 J	12.6	16 J	17.9	14.3	29.2 J	26.2 J
Iron		NA	NA	15000 J	18100	17200 J	20300 J	15300 J	18700 J	28500 J
Mercury		270	14	0.088	0.12	0.17	0.048	0.060	0.30	0.16
Potassium		NA	NA	441 B	982	1140 K	2120 J	1010 J	955	1400 K
Magnesium		NA	NA	1400 J	2390	3160	5250 J	2510 J	1860 J	4040 J
Manganese		NA	NA	300 J	641	816 J	696 J	534 J	308 J	842 J
Sodium		NA	NA	60.8 B	12 U	32 U	11 U	12 U	54.3 B	67.3 B
Nickel		2400	250	6.0 J	8.5	14.4 J	15.4	11.6	10.2 J	19.7 J
Lead		600	400	17.1 J	19.3	38.2	14.9 J	17.7 J	15.7 J	59.6 J
Antimony		340	14	0.26 U L	0.35 U L	0.54 U L	0.31 U L	0.34 U L	0.24 U L	0.54 U L
Selenium		3100	63	0.26 U	0.67 U	0.76 B	0.60 U	0.64 U	0.27 B	1.3 B
Thallium		2	2	0.47 U	0.48 U	0.70 U	0.43 U	0.46 U	0.44 U	0.98 U
Vanadium		7100	370	22.6 J	23.4	29.8	27.7	19.9	29.9 J	41.1 J
Zinc		1500	1500	55.2 J	74.2	125	123 J	66.2 J	61.4 J	113 J

Analyte concentrations in mg/kg (ppm)

Analyses were performed by Accutest, using standard analytical methodology

B	Reported value is between contract required detection limit and instrument detection limit
K	Result is likely biased high
L	Result is likely biased low
J	Result is an estimated concentration
U	Analyte analyzed for but undetected at the corresponding detection limit
NA	Not applicable

N	Exceeds NJDEP Non-Residential Direct Contact
R	Exceeds NJDEP Residential Direct Contact

TABLE 10

SUMMARY OF HIGHLANDS RURAL SOIL DATA

	Sample ID:	NJDEP NRDC Cleanup Criteria	NJDEP RDC Cleanup Criteria	**HI-50**	
Analyte	Date:	03-May-1999	03-May-1999	07-May-2001	
Metals					
Silver		4100	110	0.16	U
Aluminum		NA	NA	27300	J
Arsenic		20	20	10	
Barium		47000	700	71.5	J
Beryllium		2	2	0.73	B
Calcium		NA	NA	890	BJ
Cadmium		100	39	0.16	B
Cobalt		NA	NA	10.6	BJ
Chromium		NA	120000	24.1	J
Copper		600	600	22.9	J
Iron		NA	NA	28600	J
Mercury		270	14	0.040	
Potassium		NA	NA	1070	B
Magnesium		NA	NA	1850	J
Manganese		NA	NA	558	J
Sodium		NA	NA	30	U
Nickel		2400	250	16.4	J
Lead		600	400	27.6	J
Antimony		340	14	0.47	U L
Selenium		3100	63	0.47	U
Thallium		2	2	0.85	U
Vanadium		7100	370	41.6	J
Zinc		1500	1500	63.9	J

Analyte concentrations in mg/kg (ppm)

Analyses were performed by Accutest, using standard analytical methodology

B	Reported value is between contract required detection limit and instrument detection limit
K	Result is likely biased high
L	Result is likely biased low
J	Result is an estimated concentration
U	Analyte analyzed for but undetected at the corresponding detection limit
NA	Not applicable
N	Exceeds NJDEP Non-Residential Direct Contact
R	Exceeds NJDEP Residential Direct Contact

TABLE 10

SUMMARY OF HIGHLANDS RURAL SOIL DATA

Analyte					
	Sample ID:	FB 00.12.27		FBHI050401	
	Date:	27-Dec-2000		04-May-2001	
Metals					
Silver		1.0	U	1.6	U
Aluminum		32	U	60	U
Arsenic		4.3	U	3.2	U
Barium		1.7	U	2.6	U
Beryllium		0.40	U	0.50	U
Calcium		60	U	97.1	B
Cadmium		0.60	U	0.60	U
Cobalt		1.0	U	0.60	U
Chromium		1.9	U	1.0	U
Copper		2.3	U	2.3	U
Iron		61	U	52	U
Mercury		0.10	U	0.10	U
Potassium		42	U	55	U
Magnesium		19	U	62	U
Manganese		6.2	U	0.99	B
Sodium		84	U	280	U
Nickel		2.1	U	2.7	U
Lead		1.8	U	2.7	U
Antimony		2.4	U	3.0	U
Selenium		4.6	U	3.5	U
Thallium		3.3	U	6.3	U
Vanadium		0.90	U	2.6	U
Zinc		6.7	U	17	U

Analyte concentrations in µg/L (ppb)

Analyses were performed by Accutest, using standard analytical methodology

B	Reported value is between contract required detection limit and instrument detection limit
U	Analyte analyzed for but undetected at the corresponding detection limit

TABLE 10

SUMMARY OF HIGHLANDS RURAL SOIL DATA

	Sample ID:	NJDEP NRDC Cleanup Criteria	NJDEP RDC Cleanup Criteria	**HI-26**	**HI-27**	**HI-27** Run 2	**HI-28**	**HI-30**	**HI-30** Run 2	**HI-31**
Analyte	Date:	03-May-1999	03-May-1999	20-Dec-2000	26-Dec-2000	26-Dec-2000	08-May-2001	28-Dec-2000	28-Dec-2000	28-Dec-2000
General Chemistry/Indicator Parameters/PHCs										
pH, pH Units		NA	NA	5.3	4.2	NA	6.7 H	5.7	NA	3.3
Total Solids, Percent		NA	NA	77.7	70.1	72.5	81.4	54.1	58	66.6
Total Organic Carbon, mg/kg (ppm)		NA	NA	19600 L	32200	NA	13700	42700	NA	159000

Analyte concentrations in units specified

Analyses were performed by Accutest, using standard analytical methodology

H	Sample was analyzed after Holiding Time was exceeded. Result is a minimum estimated value. Use for screening purposes only.
L	Result is likely biased low
NA	Not applicable

TABLE 10

SUMMARY OF HIGHLANDS RURAL SOIL DATA

	Sample ID:	NJDEP NRDC Cleanup Criteria	NJDEP RDC Cleanup Criteria	**HI-31** Run 2	**HI-32**	**HI-33**	**HI-34**	**HI-34** Run 2	**HI-35**
Analyte	Date:	03-May-1999	03-May-1999	28-Dec-2000	08-May-2001	02-Jun-2001	28-Dec-2000	28-Dec-2000	04-May-2001
General Chemistry/Indicator Parameters/PHCs									
pH, pH Units		NA	NA	NA	7.0 H	5.4 H	6.6	NA	5.2 H
Total Solids, Percent		NA	NA	65.9	85.7	63.1	71.4	69	65.6
Total Organic Carbon, mg/kg (ppm)		NA	NA	NA	6610	40500	48300	NA	62900

Analyte concentrations in units specified

Analyses were performed by Accutest, using standard analytical methodology

H	Sample was analyzed after Holiding Time was exceeded. Result is a minimum estimated value. Use for screening purposes only.
L	Result is likely biased low
NA	Not applicable

TABLE 10

SUMMARY OF HIGHLANDS RURAL SOIL DATA

Analyte	Sample ID: Date:	NJDEP NRDC Cleanup Criteria 03-May-1999	NJDEP RDC Cleanup Criteria 03-May-1999	**HI-36** 02-Jan-2001	**HI-37** 02-Jan-2001	**HI-38** 04-May-2001	**HI-39** 29-Dec-2000	**HI-41** 04-May-2001	**HI-42** 04-May-2001	**HI-43** 07-May-2001
General Chemistry/Indicator Parameters/PHCs										
pH, pH Units		NA	NA	6.2	4.5	3.9 H	4.7	4.3 H	4.9 H	4.9 H
Total Solids, Percent		NA	NA	48.7	49.7	57.1	72.9	70.2	75.5	80.2
Total Organic Carbon, mg/kg (ppm)		NA	NA	41100	53900	135000	30300	49900	24800	17400

Analyte concentrations in units specified

Analyses were performed by Accutest, using standard analytical methodology

H	Sample was analyzed after Holiding Time was exceeded. Result is a minimum estimated value. Use for screening purposes only.
L	Result is likely biased low
NA	Not applicable

TABLE 10

SUMMARY OF HIGHLANDS RURAL SOIL DATA

	Sample ID:	NJDEP NRDC Cleanup Criteria	NJDEP RDC Cleanup Criteria	**HI-44**	**HI-45**	**HI-46**	**HI-46** Run 2	**HI-47**	**HI-47** Run 2	**HI-48**
Analyte	Date:	03-May-1999	03-May-1999	20-Dec-2000	02-Jun-2001	27-Dec-2000	27-Dec-2000	26-Dec-2000	26-Dec-2000	07-May-2001
General Chemistry/Indicator Parameters/PHCs										
pH, pH Units		NA	NA	5.0	6.6 H	6.5	NA	5.6	NA	6.4 H
Total Solids, Percent		NA	NA	69.1	63.1	69.7	70.2	75.2	73.5	83.9
Total Organic Carbon, mg/kg (ppm)		NA	NA	46800 L	30400	32100	NA	44400	NA	26200

Analyte concentrations in units specified

Analyses were performed by Accutest, using standard analytical methodology

H	Sample was analyzed after Holiding Time was exceeded. Result is a minimum estimated value. Use for screening purposes only.
L	Result is likely biased low
NA	Not applicable

TABLE 10

SUMMARY OF HIGHLANDS RURAL SOIL DATA

Analyte	Sample ID: / Date:	NJDEP NRDC Cleanup Criteria 03-May-1999	NJDEP RDC Cleanup Criteria 03-May-1999	**HI-49** 08-May-2001		**HI-50** 07-May-2001	
General Chemistry/Indicator Parameters/PHCs							
pH, pH Units		NA	NA	6.5	H	5.6	H
Total Solids, Percent		NA	NA	79.9		92	
Total Organic Carbon, mg/kg (ppm)		NA	NA	21800		16400	

Analyte concentrations in units specified

Analyses were performed by Accutest, using standard analytical methodology

H	Sample was analyzed after Holiding Time was exceeded. Result is a minimum estimated value. Use for screening purposes only.
L	Result is likely biased low
NA	Not applicable

TABLE 10

SUMMARY OF HIGHLANDS RURAL SOIL DATA

Analyte	Sample ID:	**FB 00.12.27**		**FBHI050401**	
	Date:	27-Dec-2000		04-May-2001	
General Chemistry/Indicator Parameters/PHCs					
pH, pH Units		5.5		4.8	H
Total Organic Carbon, µg/L (ppb)		1000	U	1000	U

Analyte concentrations in units specified

Analyses were performed by Accutest, using standard analytical methodology

H	Sample was analyzed after Holiding Time was exceeded. Result is a minimum estimated value. Use for screening purposes only.
U	Analyte analyzed for but undetected at the corresponding detection limit

TABLE 10

SUMMARY OF HIGHLANDS RURAL SOIL DATA

	Sample ID:	NJDEP NRDC Cleanup Criteria	NJDEP RDC Cleanup Criteria	**HI-26**	**HI-27**	**HI-28**	**HI-30**	**HI-31**	**HI-32**	**HI-33**
Analyte	Date:	03-May-1999	03-May-1999	20-Dec-2000	26-Dec-2000	08-May-2001	28-Dec-2000	28-Dec-2000	08-May-2001	02-Jun-2001
PAHs by HPLC										
Benzo(a)anthracene		4	0.9	0.013 U	0.014 U	0.012 U	0.050	0.077	0.011 U	0.11
Benzo(a)pyrene		0.66	0.66	0.013 U	0.014 U	0.012 U	0.057	0.015 U	0.011 U	0.10
Benzo(b)fluoranthene		4	0.9	0.013 U	0.014 U	0.012 U	0.057	0.021	0.011 U	0.19
Benzo(k)fluoranthene		4	0.9	0.013 U	0.014 U	0.012 U	0.031	0.034	0.011 U	0.061
Chrysene		40	9	0.013 U	0.014 U	0.012 U	0.079	0.019	0.011 U	0.14
Dibenz(a,h)anthracene		0.66	0.66	0.013 U	0.014 U	0.012 U	0.017 U	0.015 U	0.011 U	0.015 U
Indeno(1,2,3-c,d)pyrene		4	0.9	0.013 U	0.014 U	0.012 U	0.028	0.015 U	0.011 U	0.086

Analyte concentrations in mg/kg (ppm)

Analyses were performed by Accutest, using SW846 8310

J	Result is detected below the reporting limit and/or is an estimated concentration
U	Analyte analyzed for but undetected at the corresponding quantitation limit
N	Exceeds NJDEP Non-Residential Direct Contact
R	Exceeds NJDEP Residential Direct Contact

TABLE 10

SUMMARY OF HIGHLANDS RURAL SOIL DATA

	Sample ID:	NJDEP NRDC Cleanup Criteria	NJDEP RDC Cleanup Criteria	**HI-34**	**HI-35**	**HI-36**	**HI-37**	**HI-38**	**HI-39**
Analyte	Date:	03-May-1999	03-May-1999	28-Dec-2000	04-May-2001	02-Jan-2001	02-Jan-2001	04-May-2001	29-Dec-2000
PAHs by HPLC									
Benzo(a)anthracene		4	0.9	0.79	0.019	0.020 U	0.019 U	0.017 U	0.013 U
Benzo(a)pyrene		0.66	0.66	*0.68* *NR*	0.015 U	0.020 U	0.019 U	0.017 U	0.013 U
Benzo(b)fluoranthene		4	0.9	0.89	0.015 U	0.020 U	0.019 U	0.017 U	0.013 U
Benzo(k)fluoranthene		4	0.9	0.34	0.015 U	0.020 U	0.019 U	0.017 U	0.013 U
Chrysene		40	9	0.66	0.015 U	0.020 U	0.019 U	0.017 U	0.013 U
Dibenz(a,h)anthracene		0.66	0.66	0.014 U	0.015 U	0.020 U	0.019 U	0.017 U	0.013 U
Indeno(1,2,3-c,d)pyrene		4	0.9	0.59	0.015 U	0.020 U	0.019 U	0.017 U	0.013 U

Analyte concentrations in mg/kg (ppm)

Analyses were performed by Accutest, using SW846 8310

J	Result is detected below the reporting limit and/or is an estimated concentration
U	Analyte analyzed for but undetected at the corresponding quantitation limit

N	Exceeds NJDEP Non-Residential Direct Contact
R	Exceeds NJDEP Residential Direct Contact

TABLE 10

SUMMARY OF HIGHLANDS RURAL SOIL DATA

Analyte	Sample ID: Date:	NJDEP NRDC Cleanup Criteria 03-May-1999	NJDEP RDC Cleanup Criteria 03-May-1999	**HI-41** 04-May-2001	**HI-42** 04-May-2001	**HI-43** 07-May-2001	**HI-44** 20-Dec-2000	**HI-45** 02-Jun-2001	**HI-46** 27-Dec-2000	**HI-47** 26-Dec-2000
PAHs by HPLC										
Benzo(a)anthracene		4	0.9	0.014 U	0.013 U	0.012 U	0.026	0.016 U	0.014 U	0.035
Benzo(a)pyrene		0.66	0.66	0.014 U	0.013 U	0.012 U	0.023	0.016 U	0.014 U	0.014 U
Benzo(b)fluoranthene		4	0.9	0.014 U	0.013 U	0.012 U	0.032	0.016 U	0.014 U	0.014 U
Benzo(k)fluoranthene		4	0.9	0.014 U	0.013 U	0.012 U	0.014 U	0.016 U	0.014 U	0.014 U
Chrysene		40	9	0.014 U	0.013 U	0.012 U	0.027	0.016 U	0.014 U	0.014 U
Dibenz(a,h)anthracene		0.66	0.66	0.014 U	0.013 U	0.012 U	0.014 U	0.016 U	0.014 U	0.014 U
Indeno(1,2,3-c,d)pyrene		4	0.9	0.014 U	0.013 U	0.012 U	0.047	0.016 U	0.014 U	0.016

Analyte concentrations in mg/kg (ppm)

Analyses were performed by Accutest, using SW846 8310

J	Result is detected below the reporting limit and/or is an estimated concentration
U	Analyte analyzed for but undetected at the corresponding quantitation limit
N	Exceeds NJDEP Non-Residential Direct Contact
R	Exceeds NJDEP Residential Direct Contact

TABLE 10

SUMMARY OF HIGHLANDS RURAL SOIL DATA

Analyte	Sample ID: Date:	NJDEP NRDC Cleanup Criteria 03-May-1999	NJDEP RDC Cleanup Criteria 03-May-1999	**HI-48** 07-May-2001		**HI-49** 08-May-2001		**HI-50** 07-May-2001	
PAHs by HPLC									
Benzo(a)anthracene		4	0.9	0.012	U	0.12		0.011	U
Benzo(a)pyrene		0.66	0.66	0.012	U	0.091		0.011	U
Benzo(b)fluoranthene		4	0.9	0.012	U	0.16		0.011	U
Benzo(k)fluoranthene		4	0.9	0.012	U	0.021		0.011	U
Chrysene		40	9	0.012	U	0.14		0.011	U
Dibenz(a,h)anthracene		0.66	0.66	0.012	U	0.012	U	0.011	U
Indeno(1,2,3-c,d)pyrene		4	0.9	0.012	U	0.040		0.011	U

Analyte concentrations in mg/kg (ppm)

Analyses were performed by Accutest, using SW846 8310

J	Result is detected below the reporting limit and/or is an estimated concentration
U	Analyte analyzed for but undetected at the corresponding quantitation limit
N	Exceeds NJDEP Non-Residential Direct Contact
R	Exceeds NJDEP Residential Direct Contact

TABLE 10

SUMMARY OF HIGHLANDS RURAL SOIL DATA

	Sample ID:	**FB 00.12.27**		**FBHI050401**	
Analyte	Date:	27-Dec-2000		04-May-2001	
PAHs by HPLC					
Benzo(a)anthracene		0.15	U	0.15	U
Benzo(a)pyrene		0.15	U	0.15	U
Benzo(b)fluoranthene		0.15	U	0.15	U
Benzo(k)fluoranthene		0.15	U	0.15	U
Chrysene		0.15	U	0.15	U
Dibenz(a,h)anthracene		0.15	U	0.15	U
Indeno(1,2,3-c,d)pyrene		0.15	U	0.15	U

Analyte concentrations in µg/L (ppb)

Analyses were performed by Accutest, using SW846 8310

J	Result is detected below the reporting limit and/or is an estimated concentration
U	Analyte analyzed for but undetected at the corresponding quantitation limit

TABLE 11

SUMMARY OF COASTAL PLAIN RURAL SOIL DATA

	Sample ID:	NJDEP NRDC Cleanup Criteria	NJDEP RDC Cleanup Criteria	**78A-CP**	**85ACP**	**89CPA**	**92A-CP**	**CP-51**	**CP-52**	**CP-53**	**CP-54**
Analyte	Date:	03-May-1999	03-May-1999	27-May-2001	09-Jun-2001	09-Jun-2001	15-Jun-2001	12-Jun-2001	08-Dec-2000	12-Jun-2001	12-Jun-2001
Metals											
Silver		4100	110	0.18 U	0.15 U	0.16 U	0.17 U	0.30 U	0.098 U	0.30 U	0.22 U
Aluminum		NA	NA	286	243	924	1150	762	442 J	628	350
Arsenic		20	20	0.58 B	0.30 U	0.58 B	0.97 B	3.2	0.32 U	0.70 B	0.44 U
Barium		47000	700	5.7 B	1.6 B	5.0 B	6.4 B	8.1 B	0.17 U	13.5 B	5.6 B
Beryllium		2	2	0.057 U	0.048 U	0.050 U	0.053 U	0.094 U	0.028 U	0.093 U	0.068 U
Calcium		NA	NA	102 B	21.5 B	32.6 B	31.4 B	195 B	4.5 U	353 B	102 B
Cadmium		100	39	0.069 B	0.057 U	0.060 U	0.064 U	0.11 U	0.042 U	0.11 U	0.15 B
Cobalt		NA	NA	0.22 B	0.40 B	0.28 B	0.24 B	0.38 B	0.070 U	0.35 B	0.24 B
Chromium		NA	120000	1.4	1.4	1.3	2.5	5.2	1.6	1.0 B	0.59 B
Copper		600	600	2.3 B	1.8 B	1.8 B	3.0	7.3	5.7 J	5.1	2.9 B
Iron		NA	NA	448	528	822	1300	1670	916 J	778	429
Mercury		270	14	0.031 B	0.024 U	0.024 U	0.024 U	0.043 B	0.054 L	0.051 B	0.055
Potassium		NA	NA	37.5 B	19.8 B	51.1 B	54.4 B	288 B	4.6 U	60.6 B	33.4 B
Magnesium		NA	NA	30 B	18 B	47 B	58 B	202 B	1.6 U	61.2 B	19.6 B
Manganese		NA	NA	9.1	7.2 J	6.1 J	5.3	6.7	6.2	8.3	2.5
Sodium		NA	NA	32 U	46.4 B	44.2 B	82.4 B	71.7 B	12 U	77.9 B	55.5 B
Nickel		2400	250	0.60 B	0.29 B	0.55 B	0.34 B	0.67 B	0.18 U	0.85 B	0.45 B
Lead		600	400	10 J	6.9	10	12.5	59.3	28	19.7	9.6
Antimony		340	14	0.34 U L	0.29 U L	0.30 U L	0.32 U	0.56 U	0.24 U L	0.56 U	0.41 U
Selenium		3100	63	0.40 U	0.33 U	0.35 U	0.37 U	0.67 B	0.43 U	0.73 B	0.48 U
Thallium		2	2	0.71 U	0.60 U	0.63 U	0.67 U	1.2 U	0.50 U	1.2 U	0.86 U
Vanadium		7100	370	2.1 B	3.2 B	4.3 B	5.2 B	5.4 B	0.098 U	3.5 B	1.9 B
Zinc		1500	1500	2.9 J	1.6 U	2.2	3.1	6.1	11.5	15	6.3

Analyte concentrations in mg/kg (ppm)

Analyses were performed by Accutest, using standard analytical methodology

L	Result is likely biased low
J	Result is an estimated concentration
B	Reported value is between contract required detection limit and instrument detection limit
U	Analyte analyzed for but undetected at the corresponding detection limit

TABLE 11

SUMMARY OF COASTAL PLAIN RURAL SOIL DATA

	Sample ID:	NJDEP NRDC Cleanup Criteria	NJDEP RDC Cleanup Criteria	**CP-55**	**CP-56**	**CP-57**	**CP-58**	**CP-59**	**CP-60**	**CP-61**	**CP-62**
Analyte	Date:	03-May-1999	03-May-1999	27-May-2001	08-Dec-2000	19-Dec-2000	19-May-2001	08-Dec-2000	09-Jun-2001	09-Jun-2001	27-May-2001
Metals											
Silver		4100	110	0.58 U	0.078 U	0.076 U	0.14 U	0.076 U	0.18 U	0.16 U	0.31 U
Aluminum		NA	NA	1340	534 J	6690	1990	2270 J	2360	783	1400
Arsenic		20	20	2.6 B	0.26 U	1.2	1.7	1.2	1.3	0.71 B	0.91 B
Barium		47000	700	51.6 B	0.13 U	1.2 U	10.3 B	0.13 U	9.5 B	4.4 B	10.6 B
Beryllium		2	2	0.18 U	0.022 U	0.044 U	0.025 U	0.022 U	0.055 U	0.052 U	0.098 U
Calcium		NA	NA	2620	3.6 U	7.2 U	213 B	3.5 U	186 B	29.9 B	197 B
Cadmium		100	39	0.25 B	0.033 U	0.033 U	0.11 B	0.032 U	0.066 U	0.062 U	0.12 U
Cobalt		NA	NA	0.51 B	0.056 U	0.065 U	0.42 B	0.054 U	0.45 B	0.32 B	0.32 B
Chromium		NA	120000	3.0 B	1.5	8.2	3.2	4.1	2.8	1.8	2.6
Copper		600	600	16.5	3.7 J	6.6 J	5.5	5.7 J	2.9	2.5 B	5.3
Iron		NA	NA	1830	594 J	5880	2200	2910 J	2600	927	1460
Mercury		270	14	0.28	0.018 U L	0.039	0.083	0.053 L	0.033 B	0.032 B	0.096
Potassium		NA	NA	983 B	3.7 U	4.9 U	156 B	3.6 U	90.6 B	33.1 B	145 B
Magnesium		NA	NA	521 B	1.3 U	3.7 U	140 B	1.2 U	151 B	51.3 B	106 B
Manganese		NA	NA	30.7	5.5	16.7	11.9	19.7	9.9 J	6.9 J	14.6
Sodium		NA	NA	100 U	9.6 U	33 U	71.4 B	9.3 U	48.1 B	55.2 B	57.4 B
Nickel		2400	250	3.8 B	0.14 U	0.41 U	2.2 B	0.14 U	1.2 B	0.45 B	1.3 B
Lead		600	400	41.7 J	15.2	10.3	30.4	27.9	10.8	9.4	9.8 J
Antimony		340	14	1.6 BL	0.19 U L	0.45 U L	0.48 BL	0.18 U L	0.33 U L	0.31 U L	0.59 U L
Selenium		3100	63	1.5 B	0.35 U	0.48 U	0.58 B	0.34 U	0.38 U	0.36 U	0.68 U
Thallium		2	2	2.3 U	0.40 U	0.50 U	0.55 U	0.39 U	0.69 U	0.65 U	1.2 U
Vanadium		7100	370	7.9 B	0.078 U	14	9.5	9.7	8.7	4.9 B	5.0 B
Zinc		1500	1500	36.9 J	4.1 J	8.6	12.2	7.9	5.3	2.2	5.5 J

Analyte concentrations in mg/kg (ppm)

Analyses were performed by Accutest, using standard analytical methodology

L	Result is likely biased low
J	Result is an estimated concentration
B	Reported value is between contract required detection limit and instrument detection limit
U	Analyte analyzed for but undetected at the corresponding detection limit

TABLE 11

SUMMARY OF COASTAL PLAIN RURAL SOIL DATA

	Sample ID:	NJDEP NRDC Cleanup Criteria	NJDEP RDC Cleanup Criteria	**CP-64**	**CP-65**	**CP-66**	**CP-67**	**CP-68**	**CP-69**	**CP-70A**
Analyte	Date:	03-May-1999	03-May-1999	09-Jun-2001	09-Jun-2001	09-Jun-2001	09-Jun-2001	09-Jun-2001	30-Nov-2000	30-Nov-2000
Metals										
Silver		4100	110	0.18 U	0.19 U	0.20 U	0.19 U	0.18 U	0.079 U	0.093 U
Aluminum		NA	NA	1620	4230	4390	1620	5900	5250	9560
Arsenic		20	20	0.59 B	3.0	2.4	1.1 B	1.5	4.1	8.2
Barium		47000	700	6.0 B	16.8 B	14.9 B	6.7 B	7.8 B	0.14 U	43.1
Beryllium		2	2	0.056 U	0.19 B	0.083 B	0.060 U	0.057 B	0.023 U	0.027 U
Calcium		NA	NA	60.4 B	70.4 B	106 B	65.3 B	59.4 B	3.6 U	4.3 U
Cadmium		100	39	0.068 U	0.071 U	0.077 U	0.072 U	0.066 U	0.034 U	0.040 U
Cobalt		NA	NA	0.48 B	2.2 B	0.91 B	0.47 B	0.61 B	0.057 U	0.067 U
Chromium		NA	120000	2.8	5.7	5.0	2.6	4.9	5.4	12.4
Copper		600	600	3.5	4.1	4.0	2.6 B	3.4	10.1	15.2 J
Iron		NA	NA	1790	4970	3810	1860	3120	4760	11700
Mercury		270	14	0.047	0.044	0.061	0.033 B	0.053	0.10 J	0.31 J
Potassium		NA	NA	71.7 B	135 B	228 B	127 B	130 B	3.8 U	4.4 U
Magnesium		NA	NA	94.4 B	250 B	324 B	126 B	224 B	1.3 U	943
Manganese		NA	NA	12.2 J	252 J	18.4 J	11.2 J	10.6 J	14.6 J	171 J
Sodium		NA	NA	66.3 B	65.6 B	75.8 B	51 B	76 B	9.8 U	12 U
Nickel		2400	250	0.81 B	2.6 B	2.5 B	0.92 B	2.2 B	0.15 U	8.1
Lead		600	400	13.9	20.6	18	16.2	14.1	36.6	250
Antimony		340	14	0.34 U L	0.35 U L	0.41 BL	0.36 U L	0.33 U L	0.19 U L	0.23 U L
Selenium		3100	63	0.39 U	0.41 U	0.45 U	0.42 U	0.38 U	1.1	0.41 U
Thallium		2	2	0.71 U	0.74 U	0.81 U	0.76 U	0.69 U	0.41 U	0.48 U
Vanadium		7100	370	8.0	11.1	13.7	8.1	12.8	20.8	22.5
Zinc		1500	1500	3.8	9.3	9.2	3.9	6.4	11.6	44

Analyte concentrations in mg/kg (ppm)

Analyses were performed by Accutest, using standard analytical methodology

L	Result is likely biased low
J	Result is an estimated concentration
B	Reported value is between contract required detection limit and instrument detection limit
U	Analyte analyzed for but undetected at the corresponding detection limit

TABLE 11

SUMMARY OF COASTAL PLAIN RURAL SOIL DATA

	Sample ID:	NJDEP NRDC Cleanup Criteria	NJDEP RDC Cleanup Criteria	**CP-71**	**CP-72**	**CP-73**	**CP-74**	**CP-75**	**CP-76**	**CP-77**
Analyte	Date:	03-May-1999	03-May-1999	30-Nov-2000	08-Dec-2000	12-Jun-2001	19-May-2001	19-Dec-2000	15-Jun-2001	27-May-2001
Metals										
Silver		4100	110	0.081 U	0.074 U	0.22 U	0.39 U	0.11 U	0.19 U	0.18 U
Aluminum		NA	NA	851	866 J	1970	4910	1580	3260	913
Arsenic		20	20	1.7	0.24 U	1.1 B	11.4	0.48 U	14.4	1.2
Barium		47000	700	0.14 U	0.13 U	5.6 B	78.6	140	122	6.5 B
Beryllium		2	2	0.023 U	0.021 U	0.068 U	0.11 B	0.045 U	0.13 B	0.056 U
Calcium		NA	NA	3.7 U	3.4 U	76.4 B	1150 B	6.7 U	4200	118 B
Cadmium		100	39	0.035 U	0.032 U	0.082 U	0.33 B	0.067 U	1.0	0.067 U
Cobalt		NA	NA	0.058 U	0.053 U	0.38 B	0.78 B	0.11 U	1.3 B	0.29 B
Chromium		NA	120000	3.5	2.9	2.9	14.1	3.4	12.3	2.2
Copper		600	600	4.3	3.6 J	3.5	24.4	6.4 J	35.1	5.0
Iron		NA	NA	1800	1240 J	2770	23500	1610	37800	1200
Mercury		270	14	0.041 J	0.017 U L	0.042	0.36	0.016 U	0.31	0.037
Potassium		NA	NA	3.8 U	3.5 U	71.2 B	573 B	4.7 U	286 B	81.1 B
Magnesium		NA	NA	1.3 U	1.2 U	108 B	384 B	2.1 U	414 B	76.1 B
Manganese		NA	NA	6.8 J	14.4	11	14.3	13.2	300	9.4
Sodium		NA	NA	10 U	9.1 U	82.8 B	478 B	9.4 U	154 B	42.7 B
Nickel		2400	250	0.15 U	0.14 U	0.82 B	5.1 B	0.24 U	3.5 B	1.3 B
Lead		600	400	23.2	14.9	17	69	12.4	328	28.7 J
Antimony		340	14	0.20 U L	0.18 U L	0.41 U	1.2 U L	0.27 U L	0.36 U	0.41 BL
Selenium		3100	63	0.36 U	0.33 U	0.48 U	3.0 B	0.52 U	0.42 U	0.39 U
Thallium		2	2	0.42 U	0.38 U	0.86 U	1.6 U	0.37 U	0.76 U	0.70 U
Vanadium		7100	370	6.3	6.2	8.1	24.3	0.10 U	14.6	6.7
Zinc		1500	1500	7.3	4.0 J	5.5	30.4	5.8	232	7.0 J

Analyte concentrations in mg/kg (ppm)

Analyses were performed by Accutest, using standard analytical methodology

L	Result is likely biased low
J	Result is an estimated concentration
B	Reported value is between contract required detection limit and instrument detection limit
U	Analyte analyzed for but undetected at the corresponding detection limit

TABLE 11

SUMMARY OF COASTAL PLAIN RURAL SOIL DATA

	Sample ID:	NJDEP NRDC Cleanup Criteria	NJDEP RDC Cleanup Criteria	**CP-78**	**CP-79**	**CP-80**	**CP-81**	**CP-82**	**CP-83**	**CP-84**
Analyte	Date:	03-May-1999	03-May-1999	27-May-2001	15-Jun-2001	09-Jun-2001	12-Jun-2001	08-Dec-2000	12-Jun-2001	19-Dec-2000
Metals										
Silver		4100	110	0.18 U	0.14 U	0.17 U	0.17 U	0.068 U	0.16 U	0.11 U
Aluminum		NA	NA	265	639	558	650	299 J	666	239
Arsenic		20	20	0.77 B	1.4	0.36 B	0.49 B	0.22 U	0.83 B	0.48 U
Barium		47000	700	6.2 B	23.3 B	3.6 B	2.2 B	0.12 U	3.6 B	0.19 U
Beryllium		2	2	0.056 U	0.025 U	0.054 U	0.054 U	0.019 U	0.051 U	0.044 U
Calcium		NA	NA	103 B	327 B	223 B	32.5 B	3.1 U	75.2 B	6.6 U
Cadmium		100	39	0.067 U	0.079 B	0.064 U	0.064 U	0.029 U	0.061 U	0.066 U
Cobalt		NA	NA	0.14 B	0.57 B	0.45 B	0.28 B	0.048 U	0.43 B	0.11 U
Chromium		NA	120000	1.1 B	2.4	1.6	1.6	2.0	2.1	0.21 U
Copper		600	600	2.2 B	8.1	1.6 B	2.4 B	3.4 J	2.8	5.5 J
Iron		NA	NA	473	1320	737	911	612 J	1270	487
Mercury		270	14	0.024 U	0.097	0.023 U	0.024 U	0.017 U L	0.022 U	0.015 U
Potassium		NA	NA	37.3 B	86 B	48.3 B	23.2 B	3.2 U	19.8 B	4.7 U
Magnesium		NA	NA	28.1 B	96 B	42.8 B	33.6 B	1.1 U	28.8 B	2.1 U
Manganese		NA	NA	8.1	22.2	11.9 J	4.4	6.6	7.5	6.3
Sodium		NA	NA	53.5 B	50.7 B	62.9 B	54.1 B	8.4 U	48.1 B	9.2 U
Nickel		2400	250	0.43 B	2.3 B	0.46 B	0.29 U	0.13 U	0.28 U	0.23 U
Lead		600	400	12 J	56	9.1	9.9	11.5	11.3	9.0
Antimony		340	14	0.47 BL	1.2 B	0.32 U L	0.32 U	0.16 U L	0.31 U	0.26 U L
Selenium		3100	63	0.39 U	0.41 B	0.37 U	0.38 U	0.30 U	0.36 U	0.51 U
Thallium		2	2	0.70 U	0.55 U	0.67 U	0.68 U	0.35 U	0.78 B	0.36 U
Vanadium		7100	370	2.1 B	7.7	5.2 B	4.4 B	0.068 U	5.3	0.10 U
Zinc		1500	1500	2.6 J	11.7	2.4	2.2	2.6 J	2.2	4.2

Analyte concentrations in mg/kg (ppm)

Analyses were performed by Accutest, using standard analytical methodology

L	Result is likely biased low
J	Result is an estimated concentration
B	Reported value is between contract required detection limit and instrument detection limit
U	Analyte analyzed for but undetected at the corresponding detection limit

TABLE 11

SUMMARY OF COASTAL PLAIN RURAL SOIL DATA

	Sample ID:	NJDEP NRDC Cleanup Criteria	NJDEP RDC Cleanup Criteria	**CP-85**	**CP-86**	**CP-87**	**CP-88**	**CP-89**	**CP-90**	**CP-91**
Analyte	Date:	03-May-1999	03-May-1999	09-Jun-2001	15-Jun-2001	09-Jun-2001	09-Jun-2001	09-Jun-2001	30-Nov-2000	09-Jun-2001
Metals										
Silver		4100	110	0.18 U	0.24 U	0.20 U	0.19 U	0.19 U	0.084 U	0.18 U
Aluminum		NA	NA	339	17400	10200	4180	1250	6790	7480
Arsenic		20	20	0.54 B	9.3	5.8	1.6	0.92 B	6.3	2.9
Barium		47000	700	2.1 B	56.9	39.4	14 B	11.6 B	0.14 U	81.3
Beryllium		2	2	0.058 U	0.51 B	0.34 B	0.089 B	0.058 U	0.024 U	0.15 B
Calcium		NA	NA	39.9 B	348 B	142 B	102 B	76.4 B	3.9 U	117 B
Cadmium		100	39	0.070 U	0.14 B	0.076 U	0.070 U	0.070 U	0.036 U	0.069 U
Cobalt		NA	NA	0.42 B	3.8 B	1.7 B	0.80 B	0.34 B	0.060 U	1.4 B
Chromium		NA	120000	1.5	20.8	10.5	4.5	2.0	21.2	8.9
Copper		600	600	2.3 B	12	8.5	3.4	3.1	8.8	6.2
Iron		NA	NA	698	17400	7510	4020	1240	11900	7990
Mercury		270	14	0.024 U	0.15	0.12	0.024 U	0.052	0.067 J	0.098
Potassium		NA	NA	29 B	1020	340 B	174 B	80.3 B	732	300 B
Magnesium		NA	NA	27.7 B	1180	640	294 B	67.8 B	698	495 B
Manganese		NA	NA	8.2 J	256	31 J	17.2 J	8.1 J	36.2 J	33.5 J
Sodium		NA	NA	56 B	154 B	95.8 B	67.6 B	55.8 B	10 U	82.4 B
Nickel		2400	250	0.33 B	7.1	5.8	2.4 B	1.1 B	0.16 U	3.9 B
Lead		600	400	10.2	35.1	36.2	12.1	26.3	32.6	28
Antimony		340	14	0.39 BL	0.45 U	0.40 BL	0.43 BL	0.35 U L	0.20 U L	0.51 BL
Selenium		3100	63	0.41 U	0.52 U	0.44 U	0.41 U	0.41 U	0.37 U	0.40 U
Thallium		2	2	0.73 U	0.94 U	0.80 U	0.74 U	0.74 U	0.43 U	0.72 U
Vanadium		7100	370	4.2 B	29.6	20.2	10.7	6.3	22.4	20.4
Zinc		1500	1500	2.0 B	41.4	19.1	8.1	5.5	21.2	12.9

Analyte concentrations in mg/kg (ppm)

Analyses were performed by Accutest, using standard analytical methodology

L	Result is likely biased low
J	Result is an estimated concentration
B	Reported value is between contract required detection limit and instrument detection limit
U	Analyte analyzed for but undetected at the corresponding detection limit

TABLE 11

SUMMARY OF COASTAL PLAIN RURAL SOIL DATA

	Sample ID:	NJDEP NRDC Cleanup Criteria	NJDEP RDC Cleanup Criteria	**CP-92**	**CP-93**	**CP-94**	**CP-95**
Analyte	Date:	03-May-1999	03-May-1999	15-Jun-2001	12-Jun-2001	27-May-2001	27-May-2001
Metals							
Silver		4100	110	0.20 U	0.18 U	0.22 U	0.22 U
Aluminum		NA	NA	990	2240	964	1350
Arsenic		20	20	0.97 B	0.92 B	0.98 B	1.8
Barium		47000	700	5.4 B	8.5 B	8.0 B	25.5 B
Beryllium		2	2	0.063 U	0.057 U	0.069 U	0.069 U
Calcium		NA	NA	36.1 B	210 B	144 B	126 B
Cadmium		100	39	0.076 U	0.069 U	0.082 U	0.11 B
Cobalt		NA	NA	0.13 B	0.53 B	0.31 B	0.47 B
Chromium		NA	120000	2.0	4.0	2.1	3.5
Copper		600	600	3.3	3.3	3.2 B	6.6
Iron		NA	NA	1130	2520	1100	1910
Mercury		270	14	0.029 U	0.027 U	0.040 B	0.087
Potassium		NA	NA	51.4 B	101 B	127 B	124 B
Magnesium		NA	NA	52.1 B	135 B	81.7 B	77.6 B
Manganese		NA	NA	4.6	11.6	10.1	11.7
Sodium		NA	NA	75.9 B	47.5 B	39 U	39 U
Nickel		2400	250	0.34 U	0.93 B	1.4 B	1.6 B
Lead		600	400	10.4	14.8	25.3 J	49.5 J
Antimony		340	14	0.38 U	0.34 U	0.41 U L	0.49 BL
Selenium		3100	63	0.44 U	0.40 U	0.48 U	0.48 U
Thallium		2	2	0.79 U	0.72 U	0.86 U	0.87 U
Vanadium		7100	370	4.5 B	10	5.1 B	8.6
Zinc		1500	1500	2.7	5.0	10.2 J	9.6 J

TABLE 11

SUMMARY OF COASTAL PLAIN RURAL SOIL DATA

Analyte	Sample ID:	**FB 00.12.01**	
	Date:	30-Nov-2000	
Metals			
Silver		0.70	U
Aluminum		48	U
Arsenic		2.3	U
Barium		1.8	U
Beryllium		0.20	U
Calcium		32	U
Cadmium		0.30	U L
Cobalt		0.50	U L
Chromium		0.50	U
Copper		0.60	U L
Iron		13	U
Mercury		0.10	U
Potassium		55	U
Magnesium		12	U
Manganese		0.40	U
Sodium		86	U
Nickel		1.3	U
Lead		1.3	U
Antimony		1.7	U
Selenium		3.1	U
Thallium		3.6	U L
Vanadium		0.70	U
Zinc		1.4	U

Analyte concentrations in µg/L (ppb)

Analyses were performed by Accutest, using standard analytical methodology

L	Result is likely biased low
U	Analyte analyzed for but undetected at the corresponding detection limit

TABLE 11

SUMMARY OF COASTAL PLAIN RURAL SOIL DATA

	Sample ID:	NJDEP NRDC Cleanup Criteria	NJDEP RDC Cleanup Criteria	**78A-CP**	**85ACP**	**89CPA**	**92A-CP**	**CP-51**	**CP-52**	**CP-53**
Analyte	Date:	03-May-1999	03-May-1999	27-May-2001	09-Jun-2001	09-Jun-2001	15-Jun-2001	12-Jun-2001	08-Dec-2000	12-Jun-2001
General Chemistry/Indicator Parameters/PHCs										
pH, pH Units		NA	NA	4.0 H	4.4 H	4.1 H	4.0 H	4.0 H	3.4	3.6 H
Total Solids, Percent		NA	NA	85.6	95.5	91.7	94.5	59.3	74	56
Total Organic Carbon, mg/kg (ppm)		NA	NA	8930	5200	13000	8180	29600	75300	68600

Analyte concentrations in units specified

Analyses were performed by Accutest, using standard analytical methodology

L	Result is likely biased low
H	Sample was analyzed after Holiding Time was exceeded. Result is a minimum estimated value. Use for screening purposes only.

TABLE 11

SUMMARY OF COASTAL PLAIN RURAL SOIL DATA

Analyte	Sample ID: Date:	NJDEP NRDC Cleanup Criteria 03-May-1999	NJDEP RDC Cleanup Criteria 03-May-1999	**CP-54** 12-Jun-2001	**CP-55** 27-May-2001	**CP-56** 08-Dec-2000	**CP-57** 19-Dec-2000	**CP-58** 19-May-2001	**CP-59** 08-Dec-2000	**CP-60** 09-Jun-2001
General Chemistry/Indicator Parameters/PHCs										
pH, pH Units		NA	NA	3.8 H	4.0 H	4.2	4.6	3.3 H	4.2	3.9 H
Total Solids, Percent		NA	NA	76	28.4	88.8	89.2	82.2	91.5	85.8
Total Organic Carbon, mg/kg (ppm)		NA	NA	31300	450000	16400	7110 L	85300	31600	30000

Analyte concentrations in units specified

Analyses were performed by Accutest, using standard analytical methodology

L	Result is likely biased low
H	Sample was analyzed after Holiding Time was exceeded. Result is a minimum estimated value. Use for screening purposes only.

TABLE 11

SUMMARY OF COASTAL PLAIN RURAL SOIL DATA

Sample ID:	NJDEP NRDC Cleanup Criteria	NJDEP RDC Cleanup Criteria	**CP-61**		**CP-62**		**CP-64**		**CP-65**		**CP-66**		**CP-67**		**CP-68**	
Analyte / Date:	03-May-1999	03-May-1999	09-Jun-2001		27-May-2001		09-Jun-2001		09-Jun-2001		09-Jun-2001		09-Jun-2001		09-Jun-2001	
General Chemistry/Indicator Parameters/PHCs																
pH, pH Units	NA	NA	3.9	H	3.4	H	3.8	H	4.5	H	3.7	H	3.9	H	3.5	H
Total Solids, Percent	NA	NA	93.9		50.2		87.1		89.3		83.1		86.4		85.4	
Total Organic Carbon, mg/kg (ppm)	NA	NA	8850		24200		15700		7860		35000		13000		24000	

Analyte concentrations in units specified

Analyses were performed by Accutest, using standard analytical methodology

L	Result is likely biased low
H	Sample was analyzed after Holiding Time was exceeded. Result is a minimum estimated value. Use for screening purposes only.

TABLE 11

SUMMARY OF COASTAL PLAIN RURAL SOIL DATA

Analyte	Sample ID: Date:	NJDEP NRDC Cleanup Criteria 03-May-1999	NJDEP RDC Cleanup Criteria 03-May-1999	**CP-69** 30-Nov-2000	**CP-70A** 30-Nov-2000	**CP-71** 30-Nov-2000	**CP-72** 08-Dec-2000	**CP-73** 12-Jun-2001	**CP-74** 19-May-2001
General Chemistry/Indicator Parameters/PHCs									
pH, pH Units		NA	NA	3.6	3.9	3.5	3.8	4.3 H	3.7 H
Total Solids, Percent		NA	NA	80.9	75.1	86.4	93.6	78.1	29.4
Total Organic Carbon, mg/kg (ppm)		NA	NA	33100	57800	23000	11800	13800	272000

Analyte concentrations in units specified

Analyses were performed by Accutest, using standard analytical methodology

L	Result is likely biased low
H	Sample was analyzed after Holiding Time was exceeded. Result is a minimum estimated value. Use for screening purposes only.

TABLE 11

SUMMARY OF COASTAL PLAIN RURAL SOIL DATA

Analyte	Sample ID: Date:	NJDEP NRDC Cleanup Criteria 03-May-1999	NJDEP RDC Cleanup Criteria 03-May-1999	**CP-75** 19-Dec-2000	**CP-76** 15-Jun-2001	**CP-77** 27-May-2001	**CP-78** 27-May-2001	**CP-79** 15-Jun-2001	**CP-80** 09-Jun-2001	**CP-81** 12-Jun-2001
General Chemistry/Indicator Parameters/PHCs										
pH, pH Units		NA	NA	3.8	5.6 H	3.2 H	4.2 H	3.7 H	4.0 H	4.6 H
Total Solids, Percent		NA	NA	89	81.9	89.4	90	80.7	89.9	90.5
Total Organic Carbon, mg/kg (ppm)		NA	NA	15100 L	75700	22600	13000	77300	16000	10100

Analyte concentrations in units specified

Analyses were performed by Accutest, using standard analytical methodology

L	Result is likely biased low
H	Sample was analyzed after Holiding Time was exceeded. Result is a minimum estimated value. Use for screening purposes only.

TABLE 11

SUMMARY OF COASTAL PLAIN RURAL SOIL DATA

	Sample ID:	NJDEP NRDC Cleanup Criteria	NJDEP RDC Cleanup Criteria	**CP-82**	**CP-83**	**CP-84**	**CP-85**	**CP-86**	**CP-87**	**CP-88**
Analyte	Date:	03-May-1999	03-May-1999	08-Dec-2000	12-Jun-2001	19-Dec-2000	09-Jun-2001	15-Jun-2001	09-Jun-2001	09-Jun-2001
General Chemistry/Indicator Parameters/PHCs										
pH, pH Units		NA	NA	4.0	4.4 H	4.6	4.3 H	4.4 H	4.0 H	4.1 H
Total Solids, Percent		NA	NA	94.8	96	93.2	92.8	66.6	80.4	88.3
Total Organic Carbon, mg/kg (ppm)		NA	NA	4530	8290	8960 L	10300	55000	38800	12200

Analyte concentrations in units specified

Analyses were performed by Accutest, using standard analytical methodology

L	Result is likely biased low
H	Sample was analyzed after Holiding Time was exceeded. Result is a minimum estimated value. Use for screening purposes only.

TABLE 11

SUMMARY OF COASTAL PLAIN RURAL SOIL DATA

Analyte	Sample ID: Date:	NJDEP NRDC Cleanup Criteria 03-May-1999	NJDEP RDC Cleanup Criteria 03-May-1999	**CP-89** 09-Jun-2001	**CP-90** 30-Nov-2000	**CP-91** 09-Jun-2001	**CP-92** 15-Jun-2001	**CP-93** 12-Jun-2001	**CP-94** 27-May-2001	**CP-95** 27-May-2001
General Chemistry/Indicator Parameters/PHCs										
pH, pH Units		NA	NA	3.9 H	4.3	4.2 H	4.0 H	4.2 H	3.5 H	3.4 H
Total Solids, Percent		NA	NA	88.3	79.7	81	81	86.6	72.8	72.6
Total Organic Carbon, mg/kg (ppm)		NA	NA	19500	23200	28000	9380	16300	74100	57400

Analyte concentrations in units specified

Analyses were performed by Accutest, using standard analytical methodology

L	Result is likely biased low
H	Sample was analyzed after Holiding Time was exceeded. Result is a minimum estimated value. Use for screening purposes only.

TABLE 11

SUMMARY OF COASTAL PLAIN RURAL SOIL DATA

	Sample ID:	**FB 00.12.01**
Analyte	Date:	30-Nov-2000
General Chemistry/Indicator Parameters/PHCs		
pH, pH Units		5.3
Total Organic Carbon, µg/L (ppb)		1000 U

Analyte concentrations in units specified

Analyses were performed by Accutest, using standard analytical methodology

U	Analyte analyzed for but undetected at the corresponding detection limit

TABLE 11

SUMMARY OF COASTAL PLAIN RURAL SOIL DATA

Analyte	Sample ID: Date:	NJDEP NRDC Cleanup Criteria 03-May-1999	NJDEP RDC Cleanup Criteria 03-May-1999	**78A-CP** 27-May-2001		**85ACP** 09-Jun-2001		**89CPA** 09-Jun-2001		**92A-CP** 15-Jun-2001		**CP-51** 12-Jun-2001		**CP-52** 08-Dec-2000		**CP-53** 12-Jun-2001	
PAHs by HPLC																	
Benzo(a)anthracene		4	0.9	0.012	U	0.010	U	0.011	U	0.010	U	0.017	U	0.014	U	0.018	U
Benzo(a)pyrene		0.66	0.66	0.012	U	0.010	U	0.011	U	0.010	U	0.017	U	0.014	U	0.018	U
Benzo(b)fluoranthene		4	0.9	0.012	U	0.010	U	0.011	U	0.010	U	0.017	U	0.014	U	0.018	U
Benzo(k)fluoranthene		4	0.9	0.012	U	0.010	U	0.011	U	0.010	U	0.017	U	0.014	U	0.018	U
Chrysene		40	9	0.012	U	0.010	U	0.011	U	0.010	U	0.017	U	0.014	U	0.018	U
Dibenz(a,h)anthracene		0.66	0.66	0.012	U	0.010	U	0.011	U	0.010	U	0.017	U	0.014	U	0.018	U
Indeno(1,2,3-c,d)pyrene		4	0.9	0.012	U	0.010	U	0.011	U	0.010	U	0.017	U	0.014	U	0.018	U

Analyte concentrations in mg/kg (ppm)

Analyses were performed by Accutest, using SW846 8310

J	Result is detected below the reporting limit and/or is an estimated concentration
U	Analyte analyzed for but undetected at the corresponding quantitation limit
NA	Not applicable

TABLE 11

SUMMARY OF COASTAL PLAIN RURAL SOIL DATA

	Sample ID:	NJDEP NRDC Cleanup Criteria	NJDEP RDC Cleanup Criteria	**CP-54**	**CP-55**	**CP-56**	**CP-57**	**CP-58**	**CP-59**	**CP-60**
Analyte	Date:	03-May-1999	03-May-1999	12-Jun-2001	27-May-2001	08-Dec-2000	19-Dec-2000	19-May-2001	08-Dec-2000	09-Jun-2001
PAHs by HPLC										
Benzo(a)anthracene		4	0.9	0.013 U	0.035 U	0.011 U	0.011 U	0.012 U	0.011 U	0.011 U
Benzo(a)pyrene		0.66	0.66	0.013 U	0.035 U	0.011 U	0.011 U	0.012 U	0.011 U	0.011 U
Benzo(b)fluoranthene		4	0.9	0.013 U	0.035 U	0.011 U	0.011 U	0.012 U	0.011 U	0.011 U
Benzo(k)fluoranthene		4	0.9	0.013 U	0.035 U	0.011 U	0.011 U	0.012 U	0.011 U	0.011 U
Chrysene		40	9	0.013 U	0.035 U	0.011 U	0.011 U	0.012 U	0.011 U	0.011 U
Dibenz(a,h)anthracene		0.66	0.66	0.013 U	0.035 U	0.011 U	0.011 U	0.012 U	0.011 U	0.011 U
Indeno(1,2,3-c,d)pyrene		4	0.9	0.013 U	0.035 U	0.011 U	0.011 U	0.012 U	0.011 U	0.011 U

Analyte concentrations in mg/kg (ppm)

Analyses were performed by Accutest, using SW846 8310

J	Result is detected below the reporting limit and/or is an estimated concentration
U	Analyte analyzed for but undetected at the corresponding quantitation limit
NA	Not applicable

TABLE 11

SUMMARY OF COASTAL PLAIN RURAL SOIL DATA

Analyte	Sample ID: Date:	NJDEP NRDC Cleanup Criteria 03-May-1999	NJDEP RDC Cleanup Criteria 03-May-1999	**CP-61** 09-Jun-2001		**CP-62** 27-May-2001		**CP-64** 09-Jun-2001		**CP-65** 09-Jun-2001		**CP-66** 09-Jun-2001		**CP-67** 09-Jun-2001		**CP-68** 09-Jun-2001	
PAHs by HPLC																	
Benzo(a)anthracene		4	0.9	0.010	U	0.020	U	0.011	U	0.011	U	0.012	U	0.011	U	0.012	U
Benzo(a)pyrene		0.66	0.66	0.010	U	0.020	U	0.011	U	0.011	U	0.012	U	0.011	U	0.012	U
Benzo(b)fluoranthene		4	0.9	0.010	U	0.020	U	0.011	U	0.011	U	0.012	U	0.011	U	0.012	U
Benzo(k)fluoranthene		4	0.9	0.010	U	0.020	U	0.011	U	0.011	U	0.012	U	0.011	U	0.012	U
Chrysene		40	9	0.010	U	0.020	U	0.011	U	0.011	U	0.012	U	0.011	U	0.012	U
Dibenz(a,h)anthracene		0.66	0.66	0.010	U	0.020	U	0.011	U	0.011	U	0.012	U	0.011	U	0.012	U
Indeno(1,2,3-c,d)pyrene		4	0.9	0.010	U	0.020	U	0.011	U	0.011	U	0.012	U	0.011	U	0.012	U

Analyte concentrations in mg/kg (ppm)

Analyses were performed by Accutest, using SW846 8310

J	Result is detected below the reporting limit and/or is an estimated concentration
U	Analyte analyzed for but undetected at the corresponding quantitation limit
NA	Not applicable

TABLE 11

SUMMARY OF COASTAL PLAIN RURAL SOIL DATA

	Sample ID:	NJDEP NRDC Cleanup Criteria	NJDEP RDC Cleanup Criteria	**CP-69**	**CP-70A**	**CP-71**	**CP-72**	**CP-73**	**CP-74**
Analyte	Date:	03-May-1999	03-May-1999	30-Nov-2000	30-Nov-2000	30-Nov-2000	08-Dec-2000	12-Jun-2001	19-May-2001
PAHs by HPLC									
Benzo(a)anthracene		4	0.9	0.046 J	0.068 J	0.076 U	0.011 U	0.013 U	0.033 U
Benzo(a)pyrene		0.66	0.66	0.054 J	0.071 J	0.076 U	0.011 U	0.013 U	0.033 U
Benzo(b)fluoranthene		4	0.9	0.055 J	0.078 J	0.076 U	0.011 U	0.013 U	0.033 U
Benzo(k)fluoranthene		4	0.9	0.046 J	0.058 J	0.076 U	0.011 U	0.013 U	0.033 U
Chrysene		40	9	0.068 J	0.097	0.020 J	0.094	0.013 U	0.036
Dibenz(a,h)anthracene		0.66	0.66	0.083 U	0.088 U	0.076 U	0.011 U	0.013 U	0.033 U
Indeno(1,2,3-c,d)pyrene		4	0.9	0.036 J	0.052 J	0.076 U	0.011 U	0.013 U	0.033 U

Analyte concentrations in mg/kg (ppm)

Analyses were performed by Accutest, using SW846 8310

J	Result is detected below the reporting limit and/or is an estimated concentration
U	Analyte analyzed for but undetected at the corresponding quantitation limit
NA	Not applicable

TABLE 11

SUMMARY OF COASTAL PLAIN RURAL SOIL DATA

	Sample ID:	NJDEP NRDC Cleanup Criteria	NJDEP RDC Cleanup Criteria	**CP-75**	**CP-76**	**CP-77**	**CP-78**	**CP-79**	**CP-80**	**CP-81**
Analyte	Date:	03-May-1999	03-May-1999	19-Dec-2000	15-Jun-2001	27-May-2001	27-May-2001	15-Jun-2001	09-Jun-2001	12-Jun-2001
PAHs by HPLC										
Benzo(a)anthracene		4	0.9	0.16	0.054	0.011 U	0.011 U	0.012 U	0.011 U	0.011 U
Benzo(a)pyrene		0.66	0.66	0.060	0.035	0.011 U	0.011 U	0.023	0.011 U	0.011 U
Benzo(b)fluoranthene		4	0.9	0.14	0.032	0.011 U	0.011 U	0.038	0.011 U	0.011 U
Benzo(k)fluoranthene		4	0.9	0.054	0.031	0.011 U	0.011 U	0.024	0.011 U	0.011 U
Chrysene		40	9	0.26	0.067	0.011 U	0.011 U	0.012 U	0.011 U	0.011 U
Dibenz(a,h)anthracene		0.66	0.66	0.011 U	0.012 U	0.011 U	0.011 U	0.012 U	0.011 U	0.011 U
Indeno(1,2,3-c,d)pyrene		4	0.9	0.057	0.019	0.011 U	0.011 U	0.012 U	0.011 U	0.011 U

Analyte concentrations in mg/kg (ppm)

Analyses were performed by Accutest, using SW846 8310

J	Result is detected below the reporting limit and/or is an estimated concentration
U	Analyte analyzed for but undetected at the corresponding quantitation limit
NA	Not applicable

TABLE 11

SUMMARY OF COASTAL PLAIN RURAL SOIL DATA

	Sample ID:	NJDEP NRDC Cleanup Criteria	NJDEP RDC Cleanup Criteria	**CP-82**	**CP-83**	**CP-84**	**CP-85**	**CP-86**	**CP-87**	**CP-88**
Analyte	Date:	03-May-1999	03-May-1999	08-Dec-2000	12-Jun-2001	19-Dec-2000	09-Jun-2001	15-Jun-2001	09-Jun-2001	09-Jun-2001
PAHs by HPLC										
Benzo(a)anthracene		4	0.9	0.010 U	0.010 U	0.011 U	0.010 U	0.015 U	0.012 U	0.011 U
Benzo(a)pyrene		0.66	0.66	0.010 U	0.010 U	0.011 U	0.010 U	0.015 U	0.018	0.011 U
Benzo(b)fluoranthene		4	0.9	0.010 U	0.010 U	0.011 U	0.010 U	0.015 U	0.012 U	0.011 U
Benzo(k)fluoranthene		4	0.9	0.010 U	0.010 U	0.011 U	0.010 U	0.015 U	0.012 U	0.011 U
Chrysene		40	9	0.010 U	0.010 U	0.011 U	0.010 U	0.015 U	0.025	0.011 U
Dibenz(a,h)anthracene		0.66	0.66	0.010 U	0.010 U	0.011 U	0.010 U	0.015 U	0.012 U	0.011 U
Indeno(1,2,3-c,d)pyrene		4	0.9	0.010 U	0.010 U	0.011 U	0.010 U	0.015 U	0.012 U	0.011 U

Analyte concentrations in mg/kg (ppm)

Analyses were performed by Accutest, using SW846 8310

J	Result is detected below the reporting limit and/or is an estimated concentration
U	Analyte analyzed for but undetected at the corresponding quantitation limit
NA	Not applicable

TABLE 11

SUMMARY OF COASTAL PLAIN RURAL SOIL DATA

	Sample ID:	NJDEP NRDC Cleanup Criteria	NJDEP RDC Cleanup Criteria	**CP-89**	**CP-90**	**CP-91**	**CP-92**	**CP-93**	**CP-94**	**CP-95**
Analyte	Date:	03-May-1999	03-May-1999	09-Jun-2001	30-Nov-2000	09-Jun-2001	15-Jun-2001	12-Jun-2001	27-May-2001	27-May-2001
PAHs by HPLC										
Benzo(a)anthracene		4	0.9	0.011 U	0.084 U	0.012 U	0.012 U	0.011 U	0.014 U	0.014 U
Benzo(a)pyrene		0.66	0.66	0.011 U	0.084 U	0.012 U	0.012 U	0.011 U	0.014 U	0.014 U
Benzo(b)fluoranthene		4	0.9	0.011 U	0.084 U	0.012 U	0.012 U	0.011 U	0.014 U	0.014 U
Benzo(k)fluoranthene		4	0.9	0.011 U	0.084 U	0.012 U	0.012 U	0.011 U	0.014 U	0.014 U
Chrysene		40	9	0.034	0.021 J	0.012 U	0.012 U	0.011 U	0.014 U	0.014 U
Dibenz(a,h)anthracene		0.66	0.66	0.011 U	0.084 U	0.012 U	0.012 U	0.011 U	0.014 U	0.014 U
Indeno(1,2,3-c,d)pyrene		4	0.9	0.011 U	0.084 U	0.012 U	0.012 U	0.011 U	0.014 U	0.014 U

Analyte concentrations in mg/kg (ppm)

Analyses were performed by Accutest, using SW846 8310

J	Result is detected below the reporting limit and/or is an estimated concentration
U	Analyte analyzed for but undetected at the corresponding quantitation limit
NA	Not applicable

TABLE 12

SUMMARY STATISTICS FOR TAL METALS WITHIN RURAL SOIL SAMPLES IN THE VALLEY AND RIDGE PHYSIOGRAPHIC PROVINCE

	N	Detects	Mean	Median	Minimum	Maximum	90th Percentile	95th Percentile	Geometric Mean	Standard Deviation
Aluminum	23	23	14114	15300	1310	28600	21080	21390	12111	6524
Antimony	23	0	NA	NA	NA	NA	NA	NA	NA	NA
Arsenic	23	23	4.98	4.90	1.30	9.90	7.32	7.67	4.63	1.84
Barium	23	19	56.98	60.20	0.08	122	101.16	103.90	25.33	34.53
Beryllium	23	8	0.32	0.048	0.01	1.20	0.91	0.99	0.10	0.41
Cadmium	23	0	NA	NA	NA	NA	NA	NA	NA	NA
Calcium	23	10	3316.18	8.90	1.80	62100	2272	3119.00	75.23	12846.09
Chromium	23	23	13.82	14.30	3.70	25.20	21.20	21.98	12.55	5.68
Cobalt	23	12	5.62	7.30	0.53	13.90	11.40	12.31	1.16	5.19
Copper	23	23	16.69	17.20	5.70	31.20	26.04	28.22	14.92	7.40
Iron	23	23	17579.57	14800	1530	36100	28540	29470	14781.15	8808.87
Lead	23	23	33.51	31.60	14.30	60.40	54.00	56.83	30.84	13.61
Magnesium	23	19	4585.32	2600	0.075	36600	7182	8236	1010.38	7400.95
Manganese	23	23	554.97	470	14.67	1590	1192	1209	344.23	422.88
Mercury	23	22	0.10	0.10	0.05	0.20	0.15	0.17	0.09	0.04
Nickel	23	20	13.45	15.70	0.05	29.80	22.50	24.30	7.23	8.62
Potassium	23	17	910.35	961	2.20	1930	1660	1768	285.03	638.42
Selenium	23	0	NA	NA	NA	NA	NA	NA	NA	NA
Silver	23	0	NA	NA	NA	NA	NA	NA	NA	NA
Sodium	23	0	NA	NA	NA	NA	NA	NA	NA	NA
Thallium	23	0	NA	NA	NA	NA	NA	NA	NA	0.25
Vanadium	23	23	20.56	20.70	0.09	33.50	29.68	31.62	16.26	7.67
Zinc	23	23	69.62	75.80	13.70	123	112.30	121.40	61.48	31.53

Notes:

Units are reported in mg/kg for all analytes

NA = not applicable

N = number of samples

Mean = arithmetic mean

LCL_95 = Lower 95th percent confidence limit

UCL_95 = Upper 95th percent confidence limit

TABLE 13
SUMMARY STATISTICS FOR TAL METALS WITHIN RURAL SOIL SAMPLES IN THE HIGHLANDS PHYSIOGRAPHIC PROVINCE

	N	Detects	Mean	Median	Minimum	Maximum	90th Percentile	95th Percentile	Geometric Mean	Standard Deviation
Aluminum	23	23	18486.96	16800	11800	29600	28980	29490	17699.59	5821.38
Antimony	23	0	NA	NA	NA	NA	NA	NA	NA	NA
Arsenic	23	23	6.04	4.80	2.00	10.30	9.96	10	5.47	2.69
Barium	23	22	70.48	69.60	0.16	176	96.64	121.28	54.39	33.95
Beryllium	23	19	0.74	0.73	0.003	2.80	1.08	1.37	0.49	0.58
Cadmium	23	11	0.17	0.15	0.035	0.44	0.32	0.33	0.15	0.10
Calcium	23	20	1875.80	1160	4.10	5980	4518	4741	835.52	1688.58
Chromium	23	23	18.96	17.70	8.70	34.40	26.64	33.45	17.88	6.78
Cobalt	23	18	6.44	6.80	0.07	14.60	12.44	12.90	3.32	4.33
Copper	23	23	18.46	16.00	8.50	34.20	28.96	32.08	17.04	7.65
Iron	23	23	20147.83	18700	15000	30600	27860	28590	19731.55	4418.23
Lead	23	23	35.07	26.60	14.70	101.00	59.02	63.11	29.95	21.68
Magnesium	23	23	2657.83	2340	1210	6520	4024	5129	2399.97	1328.71
Manganese	23	23	491.10	407.00	73.40	1480	836.80	1137.20	385.01	341.35
Mercury	23	23	0.12	0.09	0.02	0.36	0.18	0.30	0.09	0.09
Nickel	23	23	12.72	11.60	6.00	21.50	19.04	19.79	12.15	3.99
Potassium	23	21	1071.23	955.00	2.90	4680	1456	2055	649.59	916.25
Selenium	23	10	0.74	0.69	0.13	2.00	0.99	1.27	0.68	0.35
Silver	23	5	2.72	0.16	0.089	58.90	0.21	0.26	0.20	12.25
Sodium	23	8	38.27	30	5	120	85.10	93.82	27.34	32.08
Thallium	23	0	NA	NA	NA	NA	NA	NA	NA	0.25
Vanadium	23	23	35.08	32.30	19.90	57.10	52.98	56.23	33.39	11.42
Zinc	23	23	75.91	69.70	38.50	125	111.60	122	71.97	25.31

Notes:

Units are reported in mg/kg for all analytes

NA = not applicable

N = number of samples

Mean = arithmetic mean

LCL_95 = Lower 95th percent confidence limit

UCL_95 = Upper 95th percent confidence limit

[1] Result is high compared to median and other values due to an outlier of 58.90 which skews the mean upward. The median value is a more appropriate to review in this case.

TABLE 14

SUMMARY STATISTICS FOR TAL METALS WITHIN RURAL SOIL SAMPLES IN THE COASTAL PLAIN PHYSIOGRAPHIC PROVINCE

	N	Detects	Mean	Median	Minimum	Maximum	90th Percentile	95th Percentile	Geometric Mean	Standard Deviation
Aluminum	44	44	2794.72	1375	239	17400	6760	9248	1554.59	3409.56
Antimony	44	11	0.42	0.36	0.008	1.60	0.56	1.11	0.37	0.28
Arsenic	44	36	2.33	1.15	0.11	14.40	6.15	9.14	1.29	3.11
Barium	44	34	19.45	7.25	0.06	140.00	55.31	80.90	4.86	31.63
Beryllium	44	35	0.08	0.56	0.005	0.51	0.14	0.19	0.06	0.09
Cadmium	44	36	0.10	0.07	0.015	1.00	0.13	0.24	0.74	0.15
Calcium	44	33	271.77	76.40	1.55	4200	341.70	1030.45	55.65	736.84
Chromium	44	44	4.72	2.90	0.21	21.20	11.76	13.85	3.19	4.83
Cobalt	44	32	0.52	0.37	0.02	3.80	1.18	1.66	0.29	0.68
Copper	44	44	6.40	4.20	1.60	35.10	11.43	16.31	4.96	6.19
Iron	44	44	4258	1795	429	37800	10587	16575	2140.75	6957.66
Lead	44	44	34.86	17.50	9.00	328.00	54.05	67.55	21.53	58.58
Magnesium	44	34	186.15	79.65	0.55	1180	513.20	689.30	49.08	263.67
Manganese	44	44	33.95	11.65	2.50	300.00	35.39	239.85	14.46	69.34
Mercury	44	28	0.07	0.04	0.007	0.36	0.14	0.31	0.05	0.08
Nickel	44	30	1.58	0.84	0.065	8.10	3.87	5.70	0.80	1.92
Potassium	44	30	155.25	76	1.60	1020	328	708.15	50.79	238.91
Selenium	44	7	0.53	0.41	0.15	3.00	0.68	1.04	0.47	0.43
Silver	44	0	NA	NA	NA	NA	NA	NA	NA	NA
Sodium	44	28	62.58	54.65	4.20	478	91.90	145.90	41.70	72.79
Thallium	44	1	0.74	0.72	0.15	2.30	1.12	1.20	0.68	0.35
Vanadium	44	40	9.11	7.80	0.04	29.60	20.68	22.49	4.99	7.20
Zinc	44	44	15.17	6.70	2.00	232	27.64	40.73	7.70	34.94

Notes:

Units are reported in mg/kg for all analytes

NA = not applicable

N = number of samples

Mean = arithmetic mean

LCL_95 = Lower 95th percent confidence limit

UCL_95 = Upper 95th percent confidence limit

TABLE 15

SUMMARY STATISTICS FOR CPAHs WITHIN RURAL SOIL SAMPLES IN THE VALLEY AND RIDGE PHYSIOGRAPHIC PROVINCE

	N	Detects	Mean	Median	Minimum	Maximum	90th Percentile	95th Percentile	Geometric Mean	Standard Deviation
Benzo(a)anthracene	23	4	0.02	0.013	0.01	0.17	0.025	0.05	0.02	0.03
Benzo(a)pyrene	23	0	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	23	2	0.01	0.012	0.011	0.03	0.020	0.02	0.013	0.004
Benzo(k)fluoranthene	23	0	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,h)anthracene	23	0	NA	NA	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-c,d)pyrene	23	1	0.01	0.01	0.01	0.04	0.02	0.02	0.01	0.01
Chrysene	23	3	0.01	0.01	0.01	0.05	0.020	0.02	0.013	0.008

Notes:

Units are reported in mg/kg for all analytes

NA = not applicable

N = number of samples

Mean = arithmetic mean

LCL_95 = Lower 95th percent confidence limit

TABLE 16

SUMMARY STATISTICS FOR CPAHs WITHIN RURAL SOIL SAMPLES IN THE HIGHLANDS PHYSIOGRAPHIC PROVINCE

	N	Detects	Mean	Median	Minimum	Maximum	90th Percentile	95th Percentile	Geometric Mean	Standard Deviation
Benzo(a)anthracene	23	8	0.06	0.016	0.005	0.79	0.10	0.12	0.03	0.16
Benzo(a)pyrene	23	5	0.05	0.007	0.01	0.68	0.08	0.10	0.02	0.14
Benzo(b)fluoranthene	23	6	0.07	0.014	0.005	0.89	0.14	0.19	0.02	0.18
Benzo(k)fluoranthene	23	4	0.030	0.01	0.005	0.34	0.03	0.06	0.019	0.07
Dibenzo(a,h)anthracene	23	0	NA	NA	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-c,d)pyrene	23	6	0.05	0.02	0.005	0.59	0.05	0.08	0.02	0.12
Chrysene	23	6	0.06	0.01	0.005	0.66	0.13	0.14	0.02	0.14

Notes:

Units are reported in mg/kg for all analytes

NA = not applicable

N = number of samples

Mean = arithmetic mean

LCL_95 = Lower 95th percent confidence limit

TABLE 17

SUMMARY STATISTICS FOR CPAHs WITHIN RURAL SOIL SAMPLES IN THE COASTAL PLAIN PHYSIOGRAPHIC PROVINCE

	N	Detects	Mean	Median	Minimum	Maximum	90th Percentile	95th Percentile	Geometric Mean	Standard Deviation
Benzo(a)anthracene	44	4	0.022	0.012	0.005	0.160	0.052	0.075	0.016	0.028
Benzo(a)pyrene	44	5	0.020	0.012	0.005	0.084	0.048	0.069	0.016	0.019
Benzo(b)fluoranthene	44	5	0.023	0.012	0.005	0.140	0.049	0.077	0.016	0.020
Benzo(k)fluoranthene	44	5	0.019	0.012	0.005	0.084	0.043	0.057	0.016	0.018
Dibenzo(a,h)anthracene	44	0	NA	NA	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-c,d)pyrene	44	4	0.019	0.012	0.005	0.084	0.036	0.056	0.015	0.017
Chrysene	44	10	0.03	0.01	0.01	0.26	0.06	0.09	0.02	0.04

Notes:

Units are reported in mg/kg for all analytes

NA = not applicable

N = number of samples

Mean = arithmetic mean

LCL_95 = Lower 95th percent confidence limit

TABLE 18

SUMMARY STATISTICS FOR SOIL CHARACTERISTICS WITHIN RURAL SOIL SAMPLES IN THE VALLEY AND RIDGE PHYSIOGRAPHIC PROVINCE

	N	Detects	Mean	Median	Minimum	Maximum	90th Percentile	95th Percentile	Geometric Mean	Standard Deviation
pH	23	23	4.86	4.50	3.50	7.10	6.30	6.39	4.75	1.06
Total Organic Carbon	23	23	56539.13	43200	19500	169000	99140	115600	48651.21	35152.14
Total Solids	23	23	78.46	78.00	63.30	88.90	87.54	87.69	78.06	8.01

Notes:

Units are reported as percentages for all analytes other than pH and total organic carbon, which are expressed in pH units and mg/kg, respectively.

NA = not applicable

N = number of samples

Mean = arithmetic mean

LCL_95 = Lower 95th percent confidence limit

UCL_95 = Upper 95th percent confidence limit

TABLE 19

SUMMARY STATISTICS FOR SOIL CHARACTERISTICS WITHIN RURAL SOIL SAMPLES IN THE HIGHLANDS PHYSIOGRAPHIC PROVINCE

	N	Detects	Mean	Median	Minimum	Maximum	90th Percentile	95th Percentile	Geometric Mean	Standard Deviation
pH	23	23	5.43	5.40	3.30	7.00	6.60	6.69	5.34	1.02
Total Organic Carbon	23	23	43304.78	32200	6610	159000	61100	127790	34081.16	35831.90
Total Solids	23	23	70.56	70.20	48.70	92.00	83.40	85.52	69.65	11.26

Notes:

Units are reported as percentages for all analytes other than pH and total organic carbon, which are expressed in pH units and mg/kg, respectively.

NA = not applicable

N = number of samples

Mean = arithmetic mean

LCL_95 = Lower 95th percent confidence limit

UCL_95 = Upper 95th percent confidence limit

TABLE 20

SUMMARY STATISTICS FOR SOIL CHARACTERISTICS WITHIN RURAL SOIL SAMPLES IN THE COASTAL PLAIN PHYSIOGRAPHIC PROVINCE

	N	Detects	Mean	Median	Minimum	Maximum	90th Percentile	95th Percentile	Geometric Mean	Standard Deviation
pH	44	44	3.98	3.95	3.20	5.60	4.47	4.60	3.95	0.44
Total Organic Carbon	44	44	44570	23100	4530	450000	75580	84100	25055.39	75914.62
Total Solids	44	44	80.35	85.60	28.40	96.00	93.08	93.86	78.27	15.19

Notes:

Units are reported as percentages for all analytes other than pH and total organic carbon, which are expressed in pH units and mg/kg, respectively.

NA = not applicable

N = number of samples

Mean = arithmetic mean

LCL_95 = Lower 95th percent confidence limit

UCL_95 = Upper 95th percent confidence limit

TABLE 21
COMPARISON OF OVERALL VALLEY AND RIDGE MEAN RURAL SOILCONCENTRATIONS AND MEAN RURAL SOIL CONCENTRATIONS BY SOIL TYPE

	Mean	Swatswood (n=13)	Bath (n=5)	Washington (n=5)
Aluminum	14114	13094	19480	11400
Antimony	NA	NA	NA	NA
Arsenic	4.98	4.24	5.36	6.54
Barium	56.99	51.81	80.36	47.07
Beryllium	0.32	0.24	0.38	0.45
Cadmium	NA	NA	NA	NA
Calcium	3316.18	427.55	1178.30	12964.52
Chromium	13.82	12.54	18.96	12.04
Cobalt	5.62	6.06	8.09	2.00
Copper	16.69	15.39	23.28	13.52
Iron	17579.57	16168	23680	15748.00
Lead	33.50	37.54	28.94	27.62
Magnesium	4585.32	2869	4790	8843.20
Manganese	555	564.90	695.40	388.72
Mercury	0.10	0.11	0.06	0.09
Nickel	13.45	12.00	20.48	10.20
Potassium	910.35	720.45	1491.40	823.06
Selenium	NA	NA	NA	NA
Silver	NA	NA	NA	NA
Sodium	NA	NA	NA	NA
Thallium	NA	NA	NA	NA
Vanadium	20.57	17.96	25.90	22.02
Zinc	69.62	60.78	93.46	68.78
Benzo(a)anthracene	0.02	0.02	0.01	0.02
Benzo(a)pyrene	NA	NA	NA	NA
Benzo(b)fluoranthene	0.01	0.01	0.02	0.02
Benzo(k)fluoranthene	NA	NA	NA	NA
Dibenzo(a,h)anthracene	NA	NA	NA	NA
Indeno(1,2,3-c,d)pyrene	0.01	0.01	0.02	0.02
Chrysene	0.01	0.01	0.02	0.02
pH	4.86	4.36	5.52	5.48
Total Organic Carbon	56539.13	64615	38740	53340
Total Solids	78.46	81.18	72.62	77.24

Notes:

Units are reported in mg/kg for TAL Metals and cPAHs, and percentages for all analytes other than pH and Total Organic Carbon, which are expressed in pH units and mg/kg, respectively

NA = Not Applicable

N = Number of Samples

Mean = Arithmetic Mean

Swartswood = Swartswood Nassau Wurtboro Oquaga

Bath = Bath Norwich

Washington = Wasington Wassaic

TABLE 22

COMPARISON OF OVERALL HIGHLANDS MEAN RURAL SOIL CONCENTRATIONS AND MEAN RURAL SOIL CONCENTRATIONS BY SOIL TYPE

	Mean	Parker (n=8)	Rockaway (n=9)	Washington (n=6)
Aluminum	18486.96	19812.50	17855.56	17666.67
Antimony	NA	NA	NA	NA
Arsenic	6.04	4.53	6.21	7.80
Barium	70.48	89.75	48.75	77.38
Beryllium	0.74	0.71	0.65	0.91
Cadmium	0.17	0.13	0.17	0.23
Calcium	1875.84	1739.40	1132.13	3173.33
Chromium	18.96	19.96	17.04	20.48
Cobalt	6.45	8.24	4.34	7.21
Copper	18.46	18.26	16.89	21.08
Iron	20147.83	20987.50	18544.44	21433.33
Lead	35.07	29.39	44.20	28.95
Magnesium	2657.83	2733.75	2287.78	3111.67
Manganese	491.10	478.50	412.60	625.67
Mercury	0.12	0.09	0.14	0.13
Nickel	12.73	12.60	11.58	14.62
Potassium	1071.23	1354.85	678.29	1282.50
Selenium	0.74	0.67	0.85	0.67
Silver	2.72	0.14	6.71	0.15
Sodium	38.27	26.49	51.31	34.43
Thallium	NA	NA	NA	NA
Vanadium	35.08	37.01	35.63	31.67
Zinc	75.91	67.59	72.53	92.08
Benzo(a)anthracene	0.06	0.14	0.02	0.04
Benzo(a)pyrene	0.05	0.11	0.02	0.03
Benzo(b)fluoranthene	0.07	0.15	0.02	0.04
Benzo(k)fluoranthene	0.03	0.07	0.02	0.01
Dibenzo(a,h)anthracene	NA	NA	NA	NA
Indeno(1,2,3-c,d)pyrene	0.05	0.10	0.02	0.02
Chrysene	0.06	0.12	0.02	0.04
pH	5.44	5.53	4.84	6.20
Total Organic Carbon	43304.78	45326.25	51344.44	28550.00
Total Solids	70.56	71.26	65.44	77.30

Notes:

Units are reported in mg/kg for TAL Metals and cPAHs, and percentages for all analytes other than pH and Total Organic Carbon, which are expressed in pH units and mg/kg, respectively

NA = Not Applicable

N = Number of Samples

Mean = Arithmetic Mean

Parker = Parker-Edneyville

Rockaway = Roackaway Whitman

Washington = Washington Wassaic

TABLE 23

COMPARISON OF OVERALL COASTAL PLAIN MEAN RURAL SOIL CONCENTRATIONS AND MEAN RURAL SOIL CONCENTRATIONS BY SOIL TYPE

	Mean	**Astion (n=6)**	**Downer (n=11)**	**Evesboro (n=5)**	**Lakehurst (n=7)**	**Lakewood (n=5)**	**Sassafrass (n=5)**	**Aura (n=5)**
Aluminum	2794	676	3023	3699.40	1732.14	438.60	7964	2604.80
Antimony	0.42	0.59	0.38	0.24	0.60	0.29	0.37	0.43
Arsenic	2.33	1.25	1.42	3.07	4.29	0.51	4.78	1.51
Barium	19.45	13.18	8.03	9.82	54.31	1.64	24.41	25.74
Beryllium	0.08	0.08	0.07	0.03	0.07	0.05	0.20	0.08
Cadmium	0.10	0.12	0.07	0.05	0.24	0.06	0.08	0.08
Calcium	271.77	546.35	90.74	18.28	875.39	31.46	134.46	126.62
Chromium	4.72	2.15	3.97	5.42	5.30	1.48	11.80	4.10
Cobalt	0.52	0.27	0.57	0.12	0.52	0.26	1.34	0.57
Copper	6.40	6.87	4.19	7.34	11.83	3.28	7.16	4.52
Iron	4258	1036.17	2866.09	4454	9520	795.60	8414	2930
Lead	34.86	28.92	16.49	68.34	73.60	10.38	28.46	25.60
Magnesium	186.15	134.45	133.78	210.96	149.01	18.66	575.96	168.28
Manganese	33.95	9.98	34.92	43.56	54.16	6.60	69.70	14.30
Mercury	0.07	0.08	0.05	0.10	0.12	0.02	0.08	0.06
Nickel	1.58	1.02	1.34	1.87	1.90	0.25	3.31	1.64
Potassium	155.25	228.88	102.26	17.34	159.49	15.98	469.26	140.68
Selenium	0.54	0.69	0.44	0.54	0.79	0.39	0.43	0.44
Silver	NA	NA	NA	NA	NA	NA	NA	NA
Sodium	62.58	54.45	55.37	24.74	121.60	35.16	76.64	56.76
Thallium	0.74	1.08	0.70	0.51	0.76	0.58	0.73	0.79
Vanadium	9.11	3.15	9.59	12.78	8.67	2.81	17.84	9.72
Zinc	15.17	13.32	6.76	14.48	41.70	2.64	19.06	8.08
Benzo(a)anthracene	0.023	0.020	0.010	0.040	0.040	0.010	0.030	0.010
Benzo(a)pyrene	0.021	0.020	0.010	0.050	0.026	0.010	0.030	0.010
Benzo(b)fluoranthene	0.023	0.020	0.010	0.050	0.039	0.010	0.030	0.010
Benzo(k)fluoranthene	0.012	0.020	0.010	0.040	0.030	0.010	0.030	0.010
Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-c,d)pyrene	0.020	0.020	0.010	0.040	0.022	0.010	0.030	0.010
Chrysene	0.03	0.020	0.010	0.060	0.060	0.010	0.020	0.010
pH	3.98	3.83	3.88	3.82	4.03	4.38	4.14	3.86
Total Organic Carbon	44570	111866.67	25692.73	27900	70242.86	8436	29740	37036
Total Solids	80.35	63.75	84.01	82.82	78.61	93.46	80.66	78.80

Notes:

Units are reported in mg/kg for TAL Metals and cPAHs, and percentages for all analytes other than pH and Total Organic Carbon, which are expressed in pH units and mg/kg, respectively

NA = Not Applicable

N = Number of Samples

Mean = Arithmetic Mean

TABLE 24

ARITHMETIC MEAN RURAL SOIL CONCENTRATIONS BY ANALYTE FROM VARIOUS DATA SETS

	Mean Rural Valley & Ridge (2002)	**Mean Rural Highlands (2002)**	**Mean Rural Coastal Plain (2002)**	**ANNOVA Results[3] -Valley & Ridge and Highlands**		
				F-Value	**p-Value**	**Significant?**
Aluminum	14114	18486.96	2794.72	5.753064	0.020765	YES
Antimony	NC	NC	0.42	5.683748	0.021501	NC
Arsenic	4.98	6.04	2.33	2.414284	0.127397	YES
Barium	56.99	70.48	19.45	1.78629	0.188249	NO
Beryllium	0.32	0.74	0.08	8.08267	0.006753	YES
Cadmium	NC	0.17	0.10	29.76747	2.11E-06	NC
Calcium	3316.18	1875.84	271.77	0.284234	0.596622	NO
Chromium	13.82	18.96	4.72	7.742653	0.007915	YES
Cobalt	5.62	6.45	0.52	0.341334	0.562044	NO
Copper	16.69	18.46	6.40	0.63231	0.430778	NO
Iron	17579.57	20147.83	4258	1.562109	0.217964	NO
Lead	33.51	35.07	34.86	0.085036	0.771955	NO
Magnesium	4585.32	2657.83	186.15	1.51134	0.2254169	NO
Manganese	555	491.10	33.95	0.317633	0.575895	NO
Mercury	0.10	0.12	0.07	0.610762	0.43922	NO
Nickel	13.45	12.73	1.58	0.133878	0.716198	NO
Potassium	910.35	1071.23	155.25	0.477337	0.49326	NO
Selenium	NC	0.74	0.54	9.231058	0.003994	NC
Silver	NC	2.72	NC	1.045983	0.312024	NC
Sodium	NC	38.27	62.58	9.394976	0.00371	NC
Thallium	NC	NC	0.74	9.298603	0.003874	NC
Vanadium	20.57	35.08	9.11	25.56113	8.02E-06	YES
Zinc	69.62	75.91	15.17	0.557032	0.459428	NO
Benzo(a)anthracene	0.02	0.06	0.02	1.392566	0.244313	NO
Benzo(a)pyrene	NC	0.05	0.02	1.884341	0.176798	NC
Benzo(b)fluoranthene	0.01	0.07	0.02	2.095939	0.154779	NO
Benzo(k)fluoranthene	NC	0.03	0.02	1.903771	0.174629	NC
Dibenzo(a,h)anthracene	NC	NC	NC	7.417274	0.009228	NC
Indeno(1,2,3-c,d)pyrene	0.01	0.05	0.02	1.631479	0.208198	NO
Chrysene	0.01	0.06	0.03	2.151688	0.149525	NO
pH	4.86	5.43	3.98	3.556943	0.065909	NO
Total Organic Carbon	56539.13	43304.78	44570	1.598872	0.21272	NO
Total Solids	78.46	70.56	80.35	7519618	0.008792	YES

NOTES:

[1] Data colletected in this study consisting of 91 samples collected in Coastal Plain physiographic province

[2] Data collected in previous BEM study consisting of 67 samples collected in Piedmont physiogrphic province

[3] ANOVA Is used to test for statisically significant differences between mean values of the three provinces evaluated in this study.

Significant?=Yes denotes a statistical significance at the 95th percent confidence level

[4] Data collected by NJDEP in 1993 consisting of 19 urban soil samples in New Jersey

[5] Data collected by NJDEP in 1993 consisting of 72 samples from all land-use categories in New Jersey

[6] Rutgers University data representing a compilation of research and thesis data over man years (Ugolini, 1964). Sample size unknown. Total metals determined using perchlorate extraction

[7] USGS-C data are soils collected from the eastern portion of the United States. Sample sizes range from 1,248 to 1,319 with the exception of antimony which was 354 (Shacklette, 1984). Total metals determined using x-ray methods

[8] USGS-E data are soils collected from the estern portion of the United States (Shacklette, 1984) Samples size is approximately 50 percent of those cited in [6]. Total metals determined using x-ray methods

[9] World data were compiled from various locations around the world by Vinogradov (1959). Sample size is unknown and metal extraction method is unknown.

Units are reported in mg/kg for TAL Metals, cPAHs and TOC and percentages for all other analytes except pH (which is expressed in pH units)

NA = Not Available

NC = Not computed because data were composed entirely of non-detects

TABLE 24

ARITHMETIC MEAN RURAL SOIL CONCENTRATIONS BY ANALYTE FROM VARIOUS DATA SETS

	Mean Rural Valley & Ridge (2002)	Mean Rural Highlands (2002)	Mean Rural Coastal Plain (2002)	ANNOVA Results[3] -Valley & Ridge and Coastal Plain		
				F-Value	p-Value	Significant?
Aluminum	14114	18486.96	2794.72	87.57945	1.16E-13	YES
Antimony	NC	NC	0.42	3.144852	0.080851	NC
Arsenic	4.98	6.04	2.33	14.0933	0.000374	YES
Barium	56.99	70.48	19.45	19.97342	3.21E-05	YES
Beryllium	0.32	0.74	0.08	13.6261	0.000459	YES
Cadmium	NC	0.17	0.10	2.476838	0.12039	NC
Calcium	3316.18	1875.84	271.77	2.490444	0.119394	NO
Chromium	13.82	18.96	4.72	47.49099	2.70E-09	YES
Cobalt	5.62	6.45	0.52	41.61146	1.60E-08	YES
Copper	16.69	18.46	6.40	36.4554	8.34E-08	YES
Iron	17579.57	20147.83	4258	45.98743	4.21E-09	YES
Lead	33.51	35.07	34.86	0.011812	0.913789	NO
Magnesium	4585.32	2657.83	186.15	15.72847	0.000185	YES
Manganese	555	491.10	33.95	64.36123	2.66E-11	YES
Mercury	0.10	0.12	0.07	1.72327	0.194035	NO
Nickel	13.45	12.73	1.58	77.12502	1.20E-12	YES
Potassium	910.35	1071.23	155.25	49.01501	1.73E-09	YES
Selenium	NC	0.74	0.54	0.128043	0.721629	NC
Silver	NC	2.72	NC	14.82486	0.000272	NC
Sodium	NC	38.27	62.58	9.001093	0.003823	NC
Thallium	NC	NC	0.74	12.6246	0.000715	NC
Vanadium	20.57	35.08	9.11	36.5708	8.03E-08	YES
Zinc	69.62	75.91	15.17	39.15462	3.48E-08	YES
Benzo(a)anthracene	0.02	0.06	0.02	0.007752	0.930112	NO
Benzo(a)pyrene	NC	0.05	0.02	3.920129	0.051948	NC
Benzo(b)fluoranthene	0.01	0.07	0.02	2.922495	0.092123	NO
Benzo(k)fluoranthene	NC	0.03	0.02	3.642863	0.060727	NC
Dibenzo(a,h)anthracene	NC	NC	NC	2.483062	0.119933	NC
Indeno(1,2,3-c,d)pyrene	0.01	0.05	0.02	2.051008	0.156897	NO
Chrysene	0.01	0.06	0.03	1.723686	0.193836	NO
pH	4.86	5.43	3.98	22.88402	1.30E-05	YES
Total Organic Carbon	56539.13	43304.78	44570	0.511472	0.477063	NO
Total Solids	78.46	70.56	80.35	0.310589	0.579233	NO

NOTES:

[1] Data colletected in this study consisting of 91 samples collected in Coastal Plain physiographic province

[2] Data collected in previous BEM study consisting of 67 samples collected in Piedmont physiogrphic province

[3] ANOVA Is used to test for statisically significant differences between mean values of the three provinces evaluated in this study.

Significant?=Yes denotes a statistical significance at the 95th percent confidence level

[4] Data collected by NJDEP in 1993 consisting of 19 urban soil samples in New Jersey

[5] Data collected by NJDEP in 1993 consisting of 72 samples from all land-use categories in New Jersey

[6] Rutgers University data representing a compilation of research and thesis data over man years (Ugolini, 1964). Sample size unknown. Total metals determined using perchlorate extraction

[7] USGS-C data are soils collected from the eastern portion of the United States. Sample sizes range from 1,248 to 1,319 with the exception of antimony which was 354 (Shacklette, 1984). Total metals determined using x-ray methods

[8] USGS-E data are soils collected from the estern portion of the United States (Shacklette, 1984) Samples size is approximately 50 percent of those cited in [6]. Total metals determined using x-ray methods

[9] World data were compiled from various locations around the world by Vinogradov (1959). Sample size is unknown and metal extraction method is unknown.

Units are reported in mg/kg for TAL Metals, cPAHs and TOC and percentages for all other analytes except pH (which is expressed in pH units)

NA = Not Available

NC = Not computed because data were composed entirely of non-detects

TABLE 24

ARITHMETIC MEAN RURAL SOIL CONCENTRATIONS BY ANALYTE FROM VARIOUS DATA SETS

				ANNOVA Results[3] -Valley & Ridge and Coastal Plain		
	Mean Rural Valley & Ridge (2002)	**Mean Rural Highlands (2002)**	**Mean Rural Coastal Plain (2002)**	**F-Value**	**p-Value**	**Significant?**
Aluminum	14114	18486.96	2794.72	87.57945	1.16E-13	YES
Antimony	NC	NC	0.42	3.144852	0.080851	NC
Arsenic	4.98	6.04	2.33	14.0933	0.000374	YES
Barium	56.99	70.48	19.45	19.97342	3.21E-05	YES
Beryllium	0.32	0.74	0.08	13.6261	0.000459	YES
Cadmium	NC	0.17	0.10	2.476838	0.12039	NC
Calcium	3316.18	1875.84	271.77	2.490444	0.119394	NO
Chromium	13.82	18.96	4.72	47.49099	2.70E-09	YES
Cobalt	5.62	6.45	0.52	41.61146	1.60E-08	YES
Copper	16.69	18.46	6.40	36.4554	8.34E-08	YES
Iron	17579.57	20147.83	4258	45.98743	4.21E-09	YES
Lead	33.51	35.07	34.86	0.011812	0.913789	NO
Magnesium	4585.32	2657.83	186.15	15.72847	0.000185	YES
Manganese	555	491.10	33.95	64.36123	2.66E-11	YES
Mercury	0.10	0.12	0.07	1.72327	0.194035	NO
Nickel	13.45	12.73	1.58	77.12502	1.20E-12	YES
Potassium	910.35	1071.23	155.25	49.01501	1.73E-09	YES
Selenium	NC	0.74	0.54	0.128043	0.721629	NC
Silver	NC	2.72	NC	14.82486	0.000272	NC
Sodium	NC	38.27	62.58	9.001093	0.003823	NC
Thallium	NC	NC	0.74	12.6246	0.000715	NC
Vanadium	20.57	35.08	9.11	36.5708	8.03E-08	YES
Zinc	69.62	75.91	15.17	39.15462	3.48E-08	YES
Benzo(a)anthracene	0.02	0.06	0.02	0.007752	0.930112	NO
Benzo(a)pyrene	NC	0.05	0.02	3.920129	0.051948	NC
Benzo(b)fluoranthene	0.01	0.07	0.02	2.922495	0.092123	NO
Benzo(k)fluoranthene	NC	0.03	0.02	3.642863	0.060727	NC
Dibenzo(a,h)anthracene	NC	NC	NC	2.483062	0.119933	NC
Indeno(1,2,3-c,d)pyrene	0.01	0.05	0.02	2.051008	0.156897	NO
Chrysene	0.01	0.06	0.03	1.723686	0.193836	NO
pH	4.86	5.43	3.98	22.88402	1.30E-05	YES
Total Organic Carbon	56539.13	43304.78	44570	0.511472	0.477063	NO
Total Solids	78.46	70.56	80.35	0.310589	0.579233	NO

NOTES:

[1] Data colletected in this study consisting of 91 samples collected in Coastal Plain physiographic province

[2] Data collected in previous BEM study consisting of 67 samples collected in Piedmont physiogrphic province

[3] ANOVA Is used to test for statisically significant differences between mean values of the three provinces evaluated in this study.

Significant?=Yes denotes a statistical significance at the 95th percent confidence level

[4] Data collected by NJDEP in 1993 consisting of 19 urban soil samples in New Jersey

[5] Data collected by NJDEP in 1993 consisting of 72 samples from all land-use categories in New Jersey

[6] Rutgers University data representing a compilation of research and thesis data over man years (Ugolini, 1964). Sample size unknown. Total metals determined using perchlorate extraction

[7] USGS-C data are soils collected from the eastern portion of the United States. Sample sizes range from 1,248 to 1,319 with the exception of antimony which was 354 (Shacklette, 1984). Total metals determined using x-ray methods

[8] USGS-E data are soils collected from the estern portion of the United States (Shacklette, 1984) Samples size is approximately 50 percent of those cited in [6] Total metals determined using x-ray methods

[9] World data were compiled from various locations around the world by Vinogradov (1959). Sample size is unknown and metal extraction method is unknown.

Units are reported in mg/kg for TAL Metals, cPAHs and TOC and percentages for all other analytes except pH (which is expressed in pH units)

NA = Not Available

NC = Not computed because data were composed entirely of non-detects

TABLE 24

ARITHMETIC MEAN RURAL SOIL CONCENTRATIONS BY ANALYTE FROM VARIOUS DATA SETS

	Mean Rural Valley & Ridge (2002)	Mean Rural Highlands (2002)	Mean Rural Coastal Plain (2002)	ANNOVA Results[3] -Highlands and Coastal Plain		
				F-Value	p-Value	Significant?
Aluminum	14114	18486.96	2794.72	194.12	3.43E-21	YES
Antimony	NC	NC	0.42	0.191655	0.662994	NC
Arsenic	4.98	6.04	2.33	23.5101	8.09E-06	YES
Barium	56.99	70.48	19.45	37.391511	6.14E-08	YES
Beryllium	0.32	0.74	0.08	54.2676	3.89E-10	YES
Cadmium	NC	0.17	0.10	4.029503	0.048872	YES
Calcium	3316.18	1875.84	271.77	29.34869	9.44E-07	YES
Chromium	13.82	18.96	4.72	98.81862	1.13E-14	YES
Cobalt	5.62	6.45	0.52	79.59969	6.80E-13	YES
Copper	16.69	18.46	6.40	48.62949	1.93E-09	YES
Iron	17579.57	20147.83	4258	98.71948	1.15E-14	YES
Lead	33.51	35.07	34.86	0.000264	0.987094	NO
Magnesium	4585.32	2657.83	186.15	143.3896	4.25E-18	YES
Manganese	555	491.10	33.95	74.07051	2.45E-12	YES
Mercury	0.10	0.12	0.07	3.444862	0.068203	YES
Nickel	13.45	12.73	1.58	240.4445	1.60E-23	YES
Potassium	910.35	1071.23	155.25	39.36918	3.25E-08	YES
Selenium	NC	0.74	0.54	3.892305	0.052763	NO
Silver	NC	2.72	NC	1.911197	0.171562	NC
Sodium	NC	38.27	62.58	2.315964	0.132902	NO
Thallium	NC	NC	0.74	2.846953	0.096341	NC
Vanadium	20.57	35.08	9.11	129.8345	3.84E-17	YES
Zinc	69.62	75.91	15.17	54.41464	3.74E-10	YES
Benzo(a)anthracene	0.02	0.06	0.02	2.575095	0.113406	NO
Benzo(a)pyrene	NC	0.05	0.02	2.270225	0.136726	NO
Benzo(b)fluoranthene	0.01	0.07	0.02	2.714149	0.104288	NO
Benzo(k)fluoranthene	NC	0.03	0.02	1.336035	0.251965	NO
Dibenzo(a,h)anthracene	NC	NC	NC	1.477424	0.228574	NC
Indeno(1,2,3-c,d)pyrene	0.01	0.05	0.02	2.129416	0.149312	NO
Chrysene	0.01	0.06	0.03	1.860487	0.177273	NO
pH	4.86	5.43	3.98	67.32694	1.26E-11	YES
Total Organic Carbon	56539.13	43304.78	44570	0.005693	0.940086	NO
Total Solids	78.46	70.56	80.35	7.408495	0.008323	YES

NOTES:

[1] Data colletected in this study consisting of 91 samples collected in Coastal Plain physiographic province

[2] Data collected in previous BEM study consisting of 67 samples collected in Piedmont physiogrphic province

[3] ANOVA Is used to test for statisically significant differences between mean values of the three provinces evaluated in this study.

Significant?=Yes denotes a statistical significance at the 95th percent confidence level

[4] Data collected by NJDEP in 1993 consisting of 19 urban soil samples in New Jersey

[5] Data collected by NJDEP in 1993 consisting of 72 samples from all land-use categories in New Jersey

[6] Rutgers University data representing a compilation of research and thesis data over man years (Ugolini, 1964). Sample size unknown. Total metals determined using perchlorate extraction

[7] USGS-C data are soils collected from the eastern portion of the United States. Sample sizes range from 1,248 to 1,319 with the exception of antimony which was 354 (Shacklette, 1984). Total metals determined using x-ray methods

[8] USGS-E data are soils collected from the estern portion of the United States (Shacklette, 1984) Samples size is approximately 50 percent of those cited in [6] Total metals determined using x-ray methods

[9] World data were compiled from various locations around the world by Vinogradov (1959). Sample size is unknown and metal extraction method is unknown.

Units are reported in mg/kg for TAL Metals, cPAHs and TOC and percentages for all other analytes except pH (which is expressed in pH units)

NA = Not Available

NC = Not computed because data were composed entirely of non-detects

TABLE 24

ARITHMETRIC MEAN RURAL SOIL CONCENTRATIONS BY ANALYTE FROM VARIOUS DATA SETS

	Mean Rural Valley & Ridge (2002)	Mean Rural Highlands (2002)	Mean Rural Coastal Plain (2002)	Coastal Plain[1]	Urban Piedmont[2]	NJDEP Urban[4]	All Land Use[5]	Rutgers[6]	USGS-C[7]	USGS-E[8]	World[9]
Aluminum	14114	18486.96	2794.72	6734	10781	NA	NA	NA	NA	NA	NA
Antimony	NC	NC	0.42	NC	2.20	0.07	0.03	NA	NA	NA	NA
Arsenic	4.98	6.04	2.33	7.90	10.00	8.30	4.50	7.20	7.20	7.40	5.00
Barium	56.99	70.48	19.45	36.00	109	NA	NA	NA	NA	NA	NA
Beryllium	0.32	0.74	0.08	0.36	0.58	1.10	0.94	NA	0.92	0.09	6.00
Cadmium	NC	0.17	0.10	0.36	0.33	0.65	0.25	NA	NA	NA	NA
Calcium	3316.18	1875.84	271.77	1312	2572	NA	NA	NA	NA	NA	NA
Chromium	13.82	18.96	4.72	18.70	20.30	12.10	11.00	19.90	25.00	22.00	200
Cobalt	5.62	6.45	0.52	3.50	7.40	NA	NA	NA	NA	NA	NA
Copper	16.69	18.46	6.40	15.00	38.70	42.20	17.90	15.60	54.00	22.00	20.00
Iron	17579.57	20147.83	4258	11909	15536	NA	NA	NA	NA	NA	NA
Lead	33.51	35.07	34.86	59.70	139.00	178.00	63.20	28.60	19.00	17.00	NA
Magnesium	4585.32	2657.83	186.15	1056	2948	NA	NA	NA	NA	NA	NA
Manganese	555	491.10	33.95	111	485	335	229	553	550	640	850
Mercury	0.10	0.12	0.07	0.18	0.33	0.50	0.18	NA	0.09	0.12	NA
Nickel	13.45	12.73	1.58	5.20	15.50	16.60	10.20	20.90	19.00	18.00	40.00
Potassium	910.35	1071.23	155.25	1022	888	NA	NA	NA	NA	NA	NA
Selenium	NC	0.74	0.54	NC	0.50	0.06	0.07	NA	39.00	0.45	0.001
Silver	NC	2.72	NC	0.68	0.37	0.24	0.14	NA	NA	NA	NA
Sodium	NC	38.27	62.58	NC	110.00	NA	NA	NA	NA	NA	NA
Thallium	NC	NC	0.74	0.67	0.15	0.10	0.07	NA	NA	NA	NA
Vanadium	20.57	35.08	9.11	21.10	32.30	22.60	17.90	48.70	66.00	66.00	100
Zinc	69.62	75.91	15.17	53.40	93.00	162	0.69	71.30	52.00	52.00	NA
Benzo(a)anthracene	0.02	0.06	0.02	0.14	0.60	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	NC	0.05	0.02	0.14	0.61	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	0.01	0.07	0.02	0.35	0.72	NA	NA	NA	NA	NA	NA
Benzo(k)fluoranthene	NC	0.03	0.02	0.35	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,h)anthracene	NC	NC	NC	0.03	0.25	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-c,d)pyrene	0.01	0.05	0.02	0.07	0.27	NA	NA	NA	NA	NA	NA
Chrysene	0.01	0.06	0.03	0.15	NA	NA	NA	NA	NA	NA	NA
pH	4.86	5.43	3.98	6.40	6.00	NA	NA	NA	NA	NA	NA
Total Organic Carbon	56539.13	43304.78	44570	21883	9211	NA	NA	NA	NA	NA	NA
Total Solids	78.46	70.56	80.35	86.30	NA	NA	NA	NA	NA	NA	NA

NOTES:

[1] Data colletected in this study consisting of 91 samples collected in Coastal Plain physiographic province

[2] Data collected in previous BEM study consisting of 67 samples collected in Piedmont physiogrphic province

[3] ANOVA Is used to test for statisically significant differences between mean values of the three provinces evaluated in this study.

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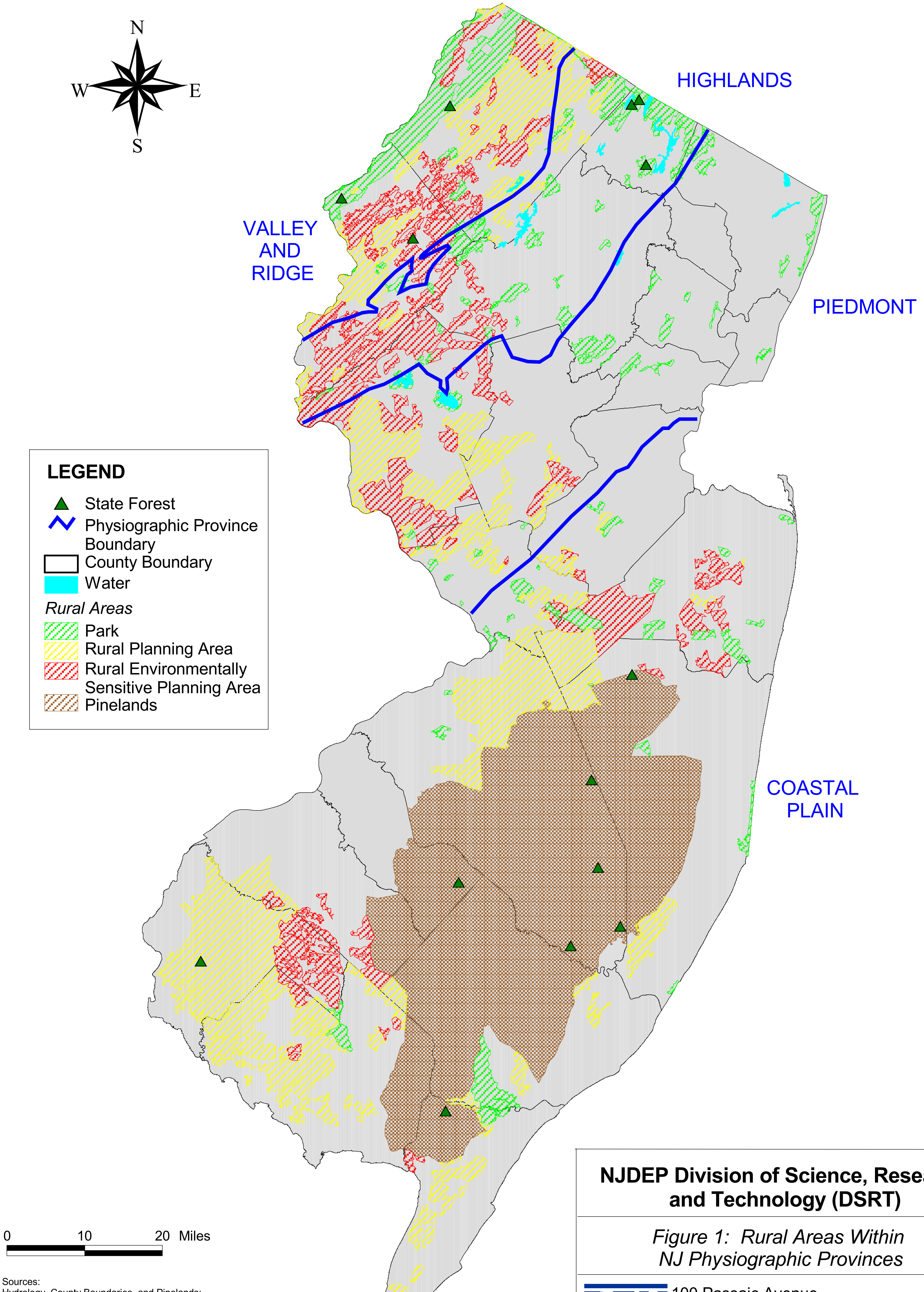
Units are reported in mg/kg for TAL Metals, cPAHs and TOC and percentages for all other analytes except pH (which is expressed in pH units)

NA = Not Available

NC = Not computed because data were composed entirely of non-detects

FIGURES



Sources:
Hydrology, County Boundaries, and Pinelands: NJDEP GIS Resource Data, 1996.
Rural and Park Areas: NJ OSP GIS Data, 1997.
State Forests: GNIS, ADCI, 1996.

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Figure 1: Rural Areas Within NJ Physiographic Provinces

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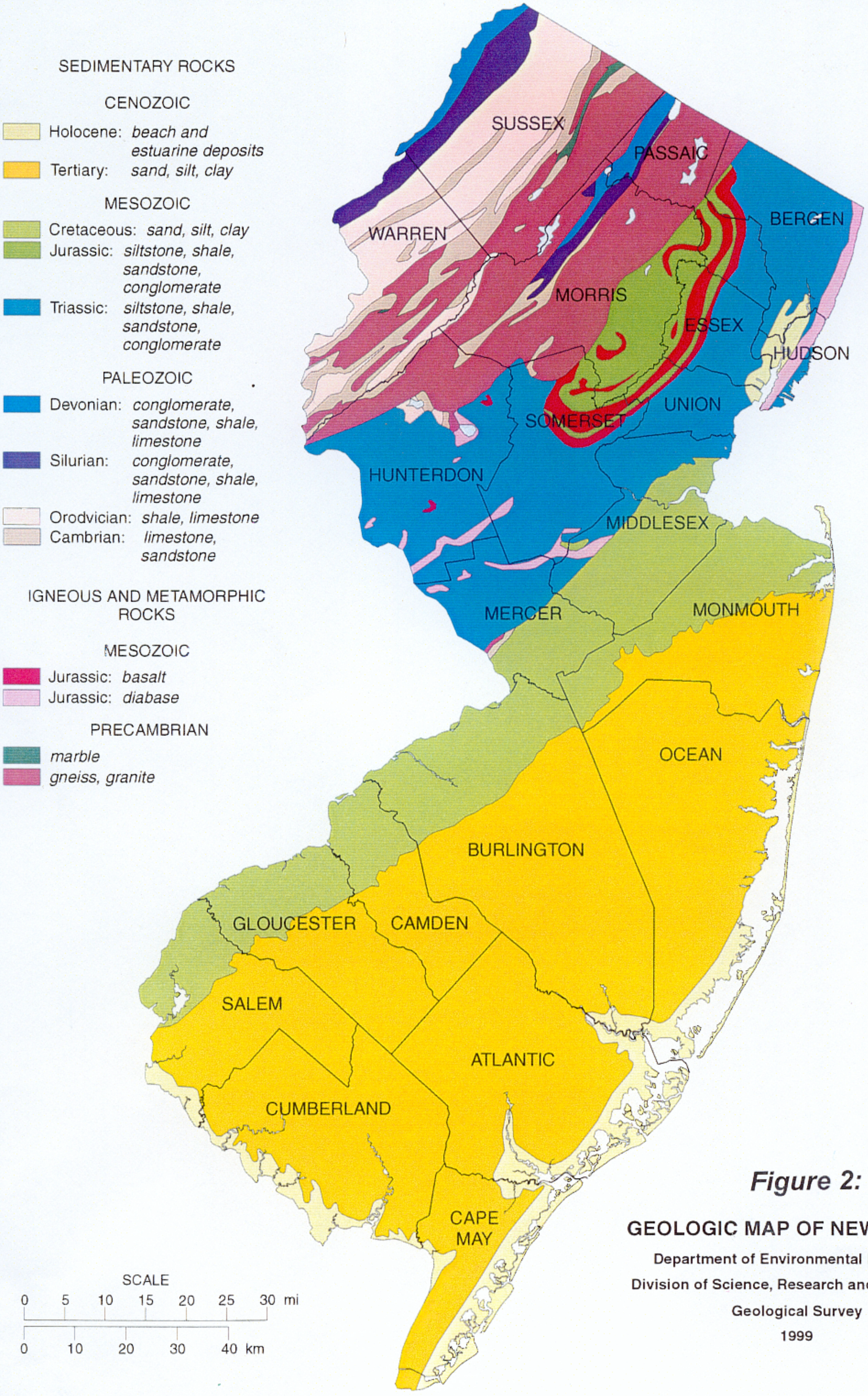
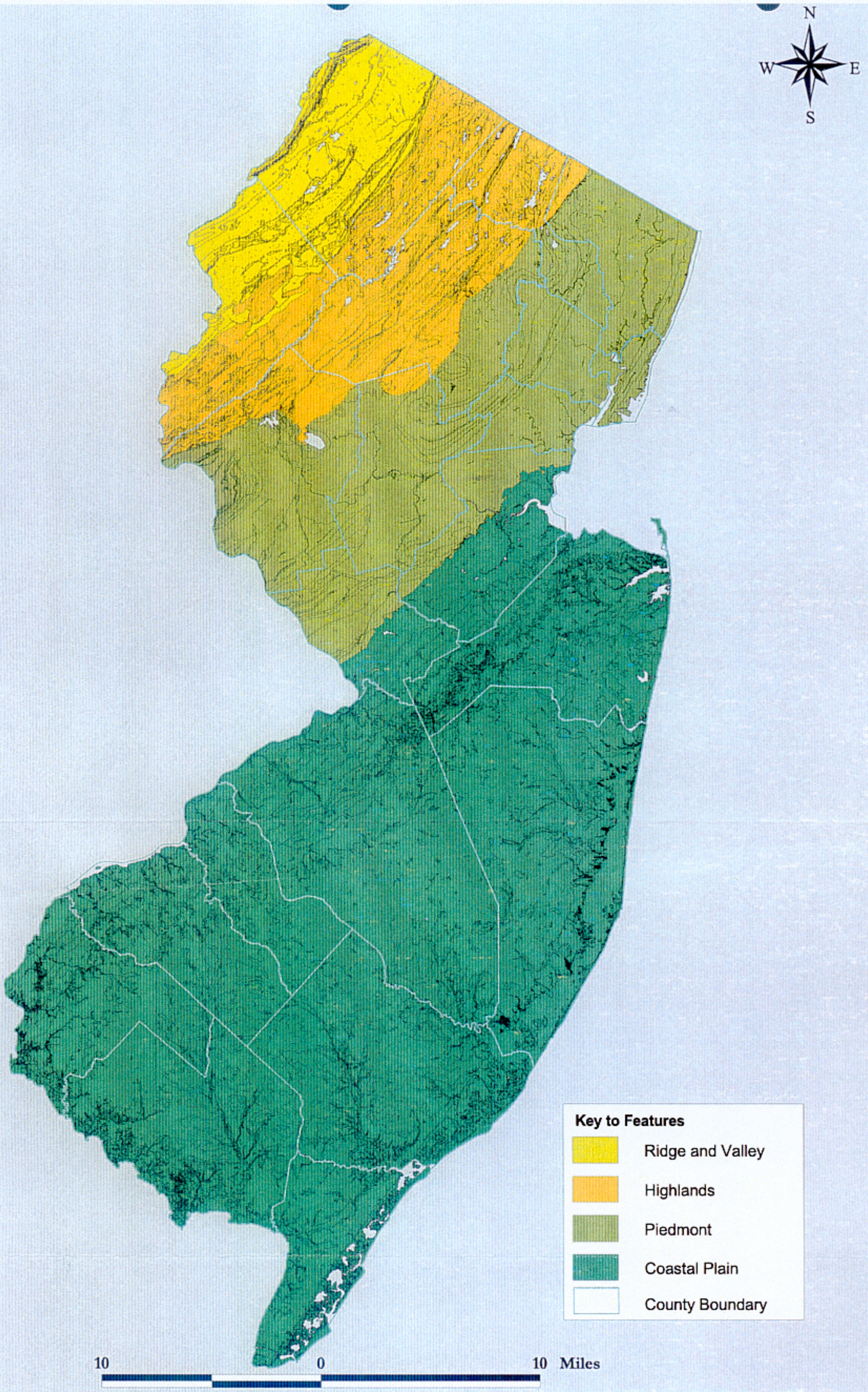


Figure 2:

GEOLOGIC MAP OF NEW JERSEY

Department of Environmental Protection
Division of Science, Research and Technology
Geological Survey
1999



Characterization of Ambient Levels of Selected Metals and PAHs in New Jersey Soils: Year 3 - Rural Areas of New Jersey Valley and Ridge, Highlands and Coastal Plain Physiographic Provinces

Physiographic Provinces of New Jersey

Figure: 3
Date: 10/5/01
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00-0140 CNEO

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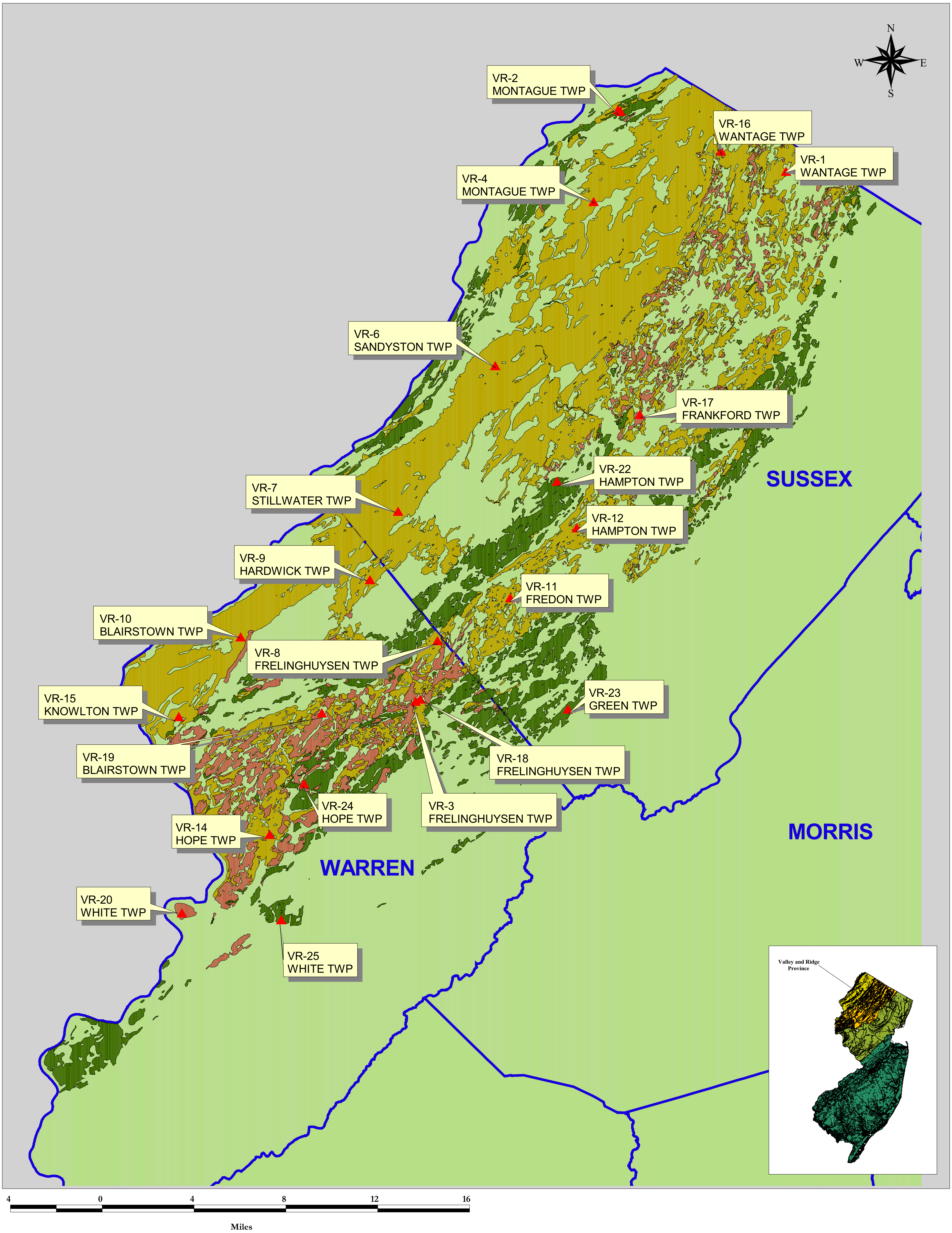
Data Source:
County Boundary, Bedrock Geology:
NJDEP GIS Resouce Data, 1996

Map Prepared by using BEM's Geographic Information System



Key to Features

- ▲ Sample Locations
- ☐ County Boundary

Selected Valley/Ridge soil groups greater than 20,000 acres

- 🟥 Bath - Norwich
- 🟨 Swartswood Nassau Wurtsboro Oquaga Group
- 🟩 Washington Wassaic Group
- 🟩 Soil Group Not Sampled

Characterization of Ambient Levels of Selected Metals and PAHs in New Jersey Soils: Year 3 - Rural Areas of New Jersey Valley and Ridge, Highlands and Coastal Plain Physiographic Provinces

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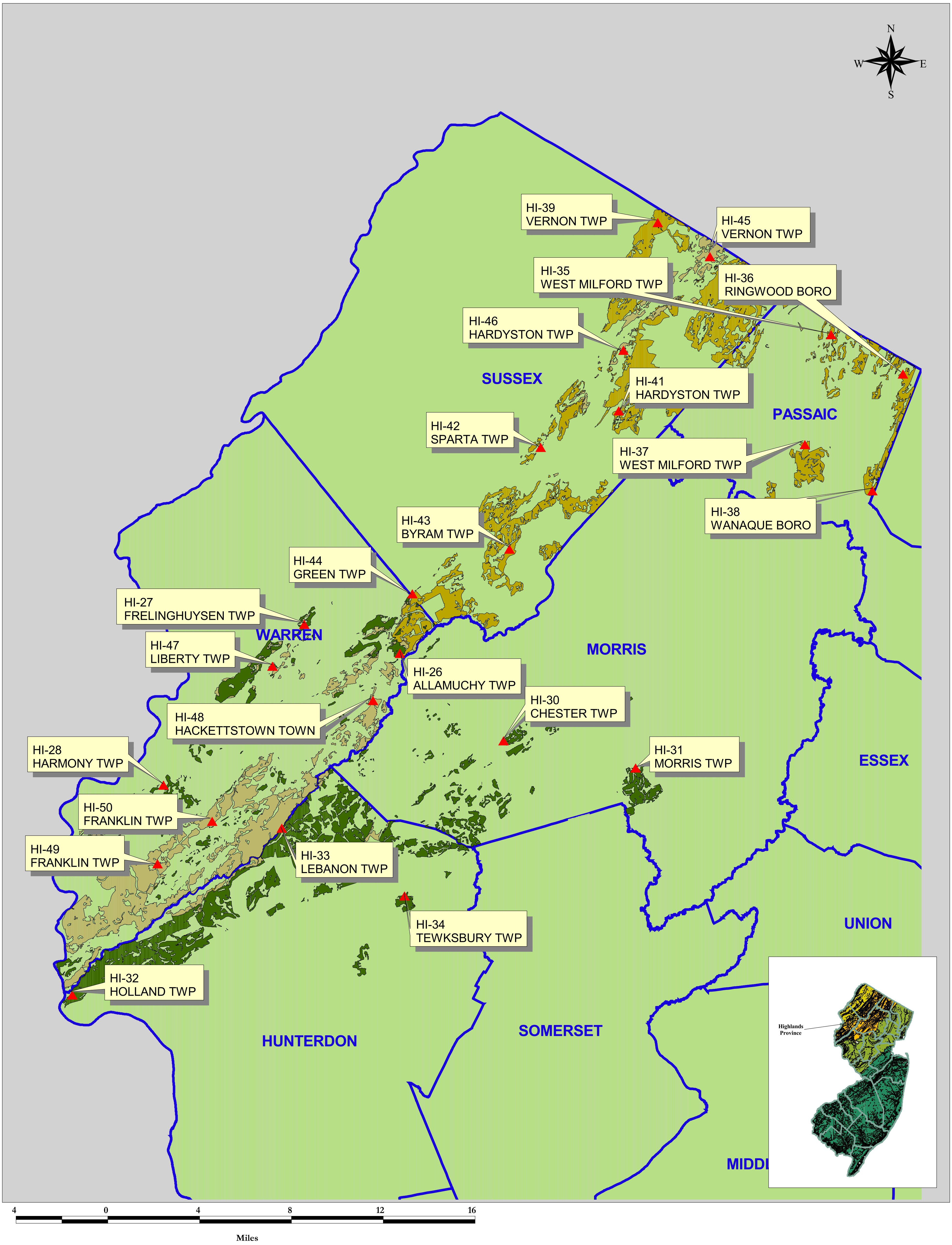
Figure 4- Soil Sample Locations in the Valley and Ridge Physiographic Province

October 5, 2001

Data Sources:
Soils, County Boundary: NJDEP GIS Resource Data, 1996.

This map was created using BEM's Geographic Information System (GIS).



Key to Features

▲ Sample Locations

☐ County Boundary

Highlands Soil Groups (Larger than 13,000 acres)

■ Parker - Edneyville

■ Rockaway - Whitman

■ Washington Wassaic Group

■ Soil Groups Not Sampled

Characterization of Ambient Levels of Selected Metals and PAHs in New Jersey Soils: Year 3 - Rural Areas of New Jersey Valley and Ridge, Highlands and Coastal Plain Physiographic Provinces

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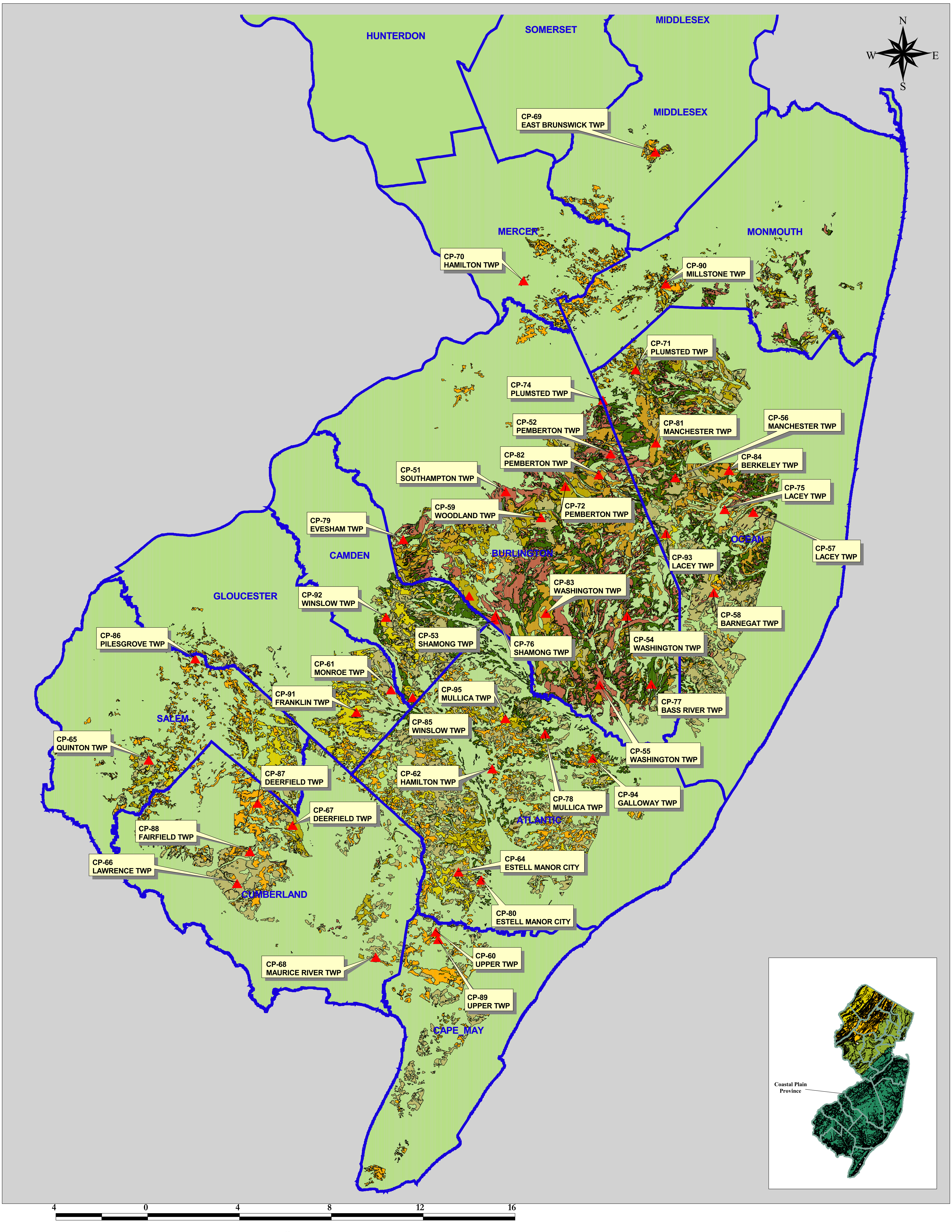
Figure 5 - Soil Sample Locations in the Highlands Physiographic Province

October 5, 2001

Data Sources:
Soils, County Boundary: NJDEP GIS Resource Data, 1996.

This map was created using BEM's Geographic Information System (GIS).



Key to Features

- ▲ Sample Location
- ☐ County Boundary

Selected Coastal soil groups greater than 66,000 acres

- 🟫 Atsion
- 🟨 Aura
- ▨ Downer
- ▨ Evesboro
- 🟩 Lakehurst
- ▨ Lakewood
- 🟧 Sassafras
- 🟩 Soil Group Not Sampled

Characterization of Ambient Levels of Selected Metals and PAHs in New Jersey Soils: Year 3 - Rural Areas of New Jersey Valley and Ridge, Highlands and Coastal Plain Physiographic Provinces

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Figure 6 - Soil Sample Locations in the Coastal Plain Physiographic Province

October 5, 2001

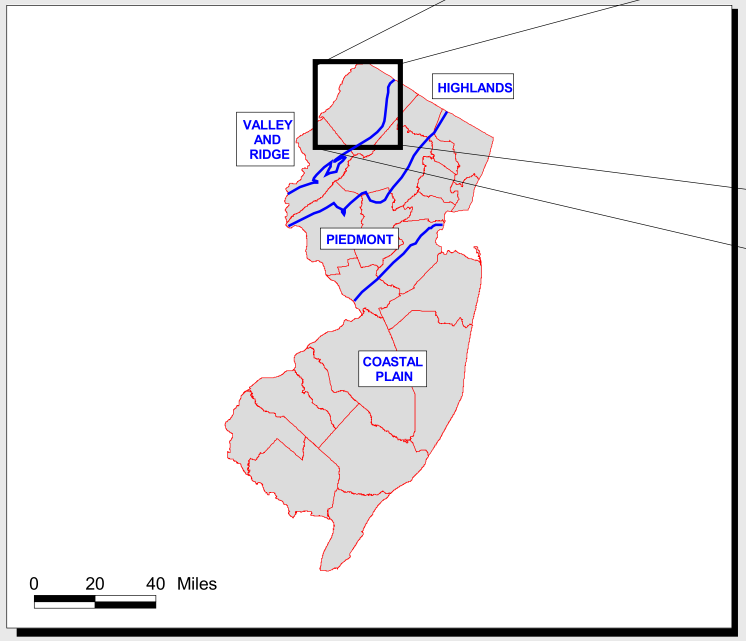
Data Sources:
Soils, County Boundary: NJDEP GIS Resource Data, 1996.

This map was created using BEM's Geographic Information System (GIS).

NJDEP Division of Science, Research and Technology (DSRT)

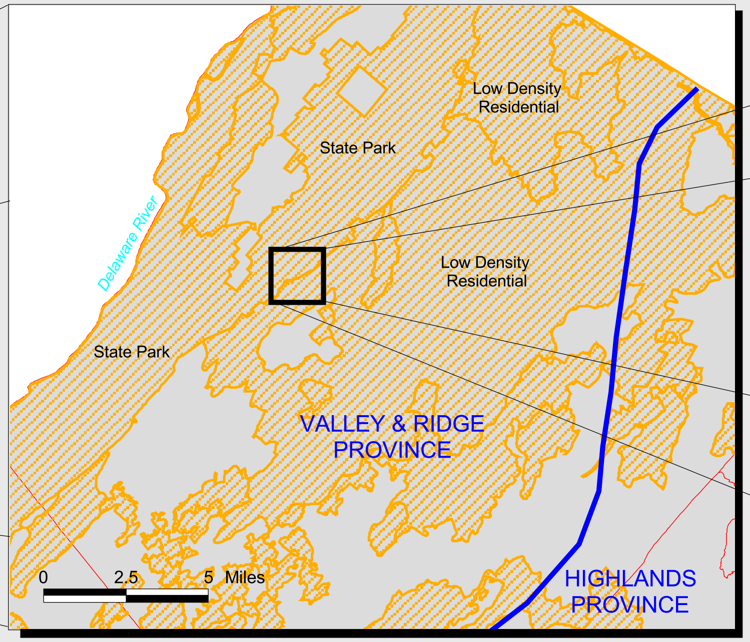
Figure 7: Sample Site Selection Flowchart

NJ State Physiographic Provinces



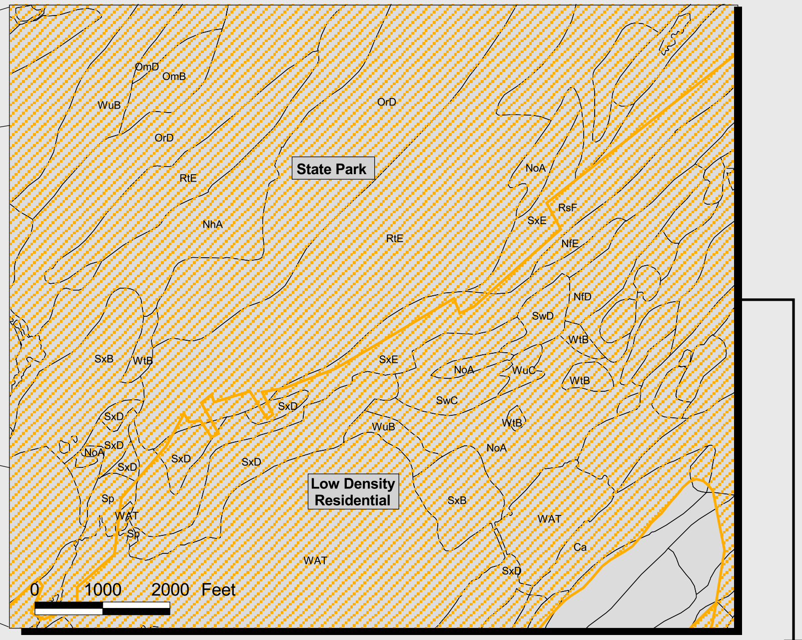
Physiographic Province Boundary
County Boundary

Rural Areas Within Example County (Sussex)



Physiographic Province Boundary
Major Rivers
County Boundary
▨ Rural Planning Area (Includes State Parks, Forests, Low Density Residential, and Rural Environmental Sensitive Planning Areas)

USCS Soil Classification Areas in Rural Study Area

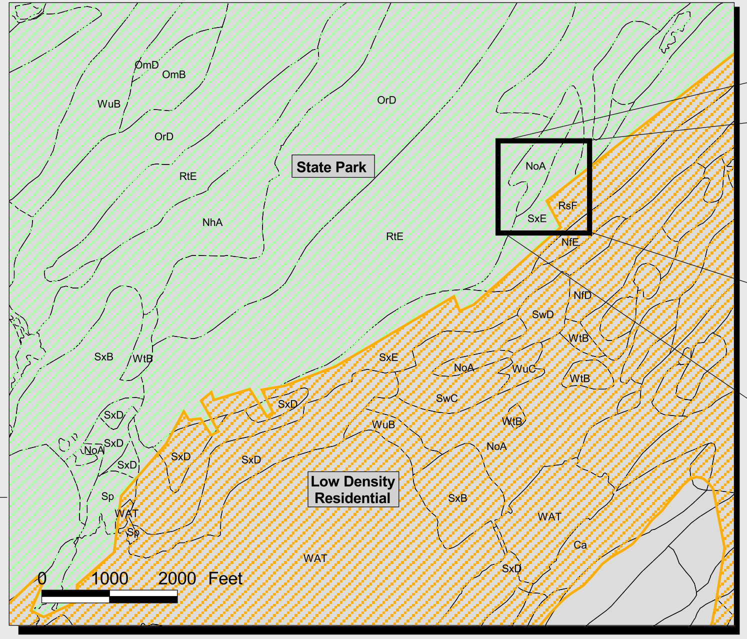


☐ Soil Type Boundary
▨ Rural Planning Area (Includes State Parks, Forests, Low Density Residential, and Rural Environmental Sensitive Planning Areas)

USCS Soil Classification Table: GIS Aerial Weighting Analysis and Sample Quantity Correlation

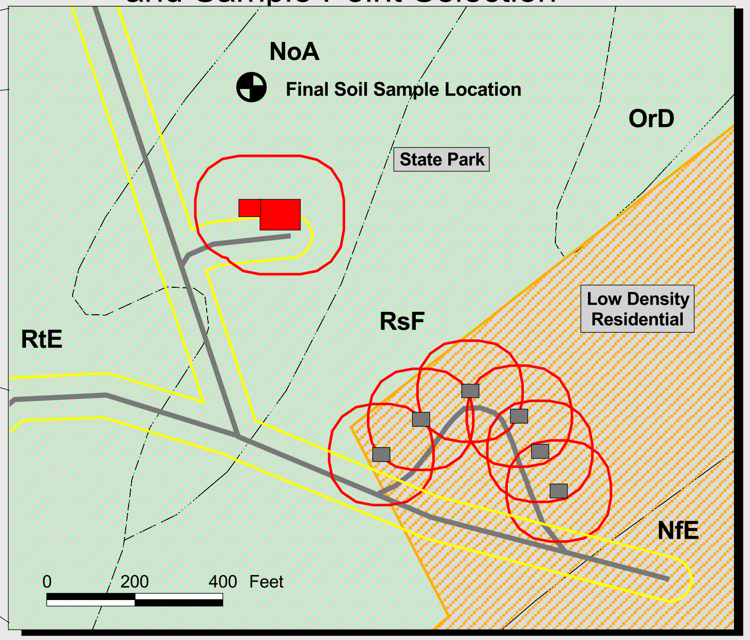
USCS Soil Classification	Relative Proportion within Rural Areas	Number of Soil Samples
SxD	10%	3
Sp	20%	6
WtB	30%	9
NoA	10%	3
SxB	30%	9
Total	**100%**	**30**

Selection of Representative Sample Sites In Accessible Areas



☐ Soil Type Boundary
▨ Low Densitiy Residential Area
🟩 State Park Area

Final Sample Location Screening and Sample Point Selection



Road	▨ Low Densitiy Residential Area
🟥 100 Ft Building Buffer	🟩 State Park Area
🟨 50 Ft Road Buffer	■ Residential Home
☐ Soil Type Boundary	🟥 Park Administration Building

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Sources:
Hydrology, County Boundaries, and Soils:
NJDEP GIS Resource Data, 1996.
Rural Areas and Parks: NJ OSP GIS Data, 1997.