Ohio Environmental Protection Agency

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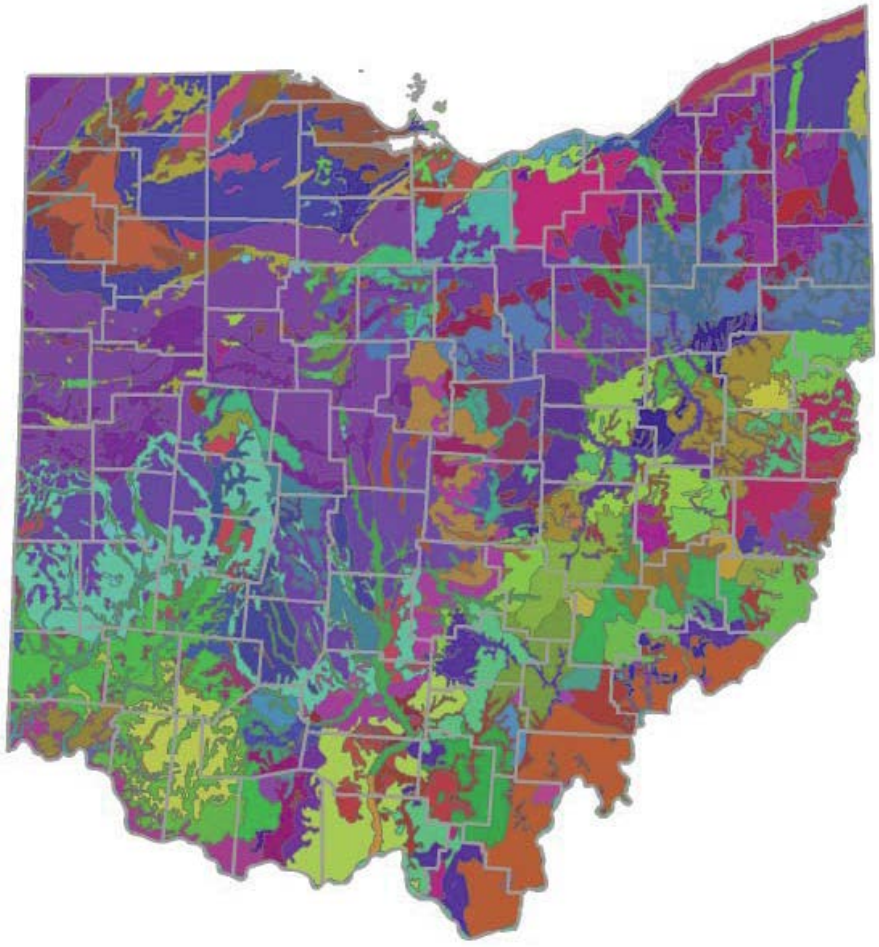
Evaluation of Background Metal Soil Concentrations in Erie County

DEVELOPED IN SUPPORT OF THE OHIO VOLUNTARY ACTION PROGRAM
DIVISION OF ENVIRONMENTAL RESPONSE AND REVITALIZATION

Summary Report



*Generalized soil map for the State of Ohio
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Acknowledgements

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Disclaimer

This summary report document was developed for sites participating in the Ohio Voluntary Action Program (VAP), DERR, Ohio EPA and to develop our understanding of the presence of background concentrations of metals in soils. Please consult with Ohio EPA to determine if use of this information is appropriate for your purposes.

The summary report serves as an aid in the investigation and evaluation of sites/properties in Ohio. It is not meant as a regulatory document and any statements herein are not legally binding.

The VAP rules identified in this report are referenced from the 2016 version. Subsequent revisions to the VAP rules may result in the rules cited in this report differing from the most current version of the VAP rules.

ACRONYMS

amsl	Above mean sea level
bgs	Below ground surface
C_v	Coefficient of variation
CQM	Castalia Quarry Reserve MetroPark
DERR	Division of Environmental Response and Revitalization
DMM	Dupont Marsh State Nature Preserve
ESP	Erie Sand Barrens State Nature Preserve
EWM-7	Edison Woods Reserve MetroPark, G.S.M. Soil Type #7
EWM-11	Edison Woods Reserve MetroPark, G.S.M. Soil Type #11
ft	Feet
FP-XRF	Field Portable X-ray Fluorescence
GOF	Goodness-of-fit
G.S.M.	General Soils Map from 2006 Soil Survey of Erie County
JMA	James McBride Arboretum MetroPark
KM	Kaplan-Meier
LCP	Lions City Park, Sandusky City
mg/kg	Milligram per kilogram
MWR	Milan State Wildlife Area
n_b	Number of background observations
OAC	Ohio Administrative Code
ODNR	Ohio Department of Natural Resources
OEPA	Ohio Environmental Protection Agency
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
RCRA	Resource Conservation Recovery Act
SAP	Sampling and Analysis Plan
S_b	Standard deviation
SGM	Schoepfle Gardens Metro Park
SIFU	Site Investigation Field Unit
SMP	Sheldons Marsh State Nature Preserve
TAL	Target Analyte List
TBA	Targeted Brownfields Assessment
TOC	Total Organic Carbon
UCL	Upper confidence level
USCS	Unified Soil Classification System
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
UPL	Upper prediction limit
UTL	Upper tolerance limit
VAP	Voluntary Action Program
VAP UL	Voluntary Action Program Upper Limit

EXECUTIVE SUMMARY

Ohio EPA Division of Environmental Response and Revitalization (DERR) staff**,** with support from Division of Surface Water (DSW) and Division of Materials and Waste Management (DMWM) staff**,** sampled and analyzed surface soils at 10 Erie County properties for background concentrations of Target Analyte List (TAL) metals (aluminum (Al), antimony (Sb), arsenic (As), barium (Ba), beryllium (Be), cadmium (Cd), calcium (Ca), chromium (Cr), cobalt (Co), iron (Fe), lead (Pb), magnesium (Mg), manganese (Mn), mercury (Hg), nickel (Ni), potassium (K), selenium (Se), sodium (Na), thallium (Tl), vanadium (V), zinc (Zn)) and molybdenum (Mo) which was substituted for silver. Silver was removed from the suite due to repeated non-detections found in other Ohio counties. Soil sample locations met the location restriction requirements of OAC 3745-300-07(H)(1)(b).

A reconnaissance was performed whereby one preliminary soil boring was installed at each property. The reconnaissance evaluated the shallow soil horizon (less than four feet [ft] deep) to ensure that areas of the property where samples were collected met location restrictions. Screening results were used to further evaluate the suitability of the sampling locations and depth intervals.

Ten soil samples per targeted soil horizon at each property were collected to provide a statistically representative data set as described by OAC 3745-300-07(H)(1)(d)(i). Ohio EPA collected all surficial soil samples between the ground surface and depth of two feet using a hand auger. Sample locations were within a 15 ft. radius of the preliminary soil boring location. All samples collected were sent to a fixed-base, VAP-certified laboratory for analyses of each soil sample.

Statistical evaluations were performed to determine the representative background concentration for each metal. Background soil concentrations were calculated in accordance with the VAP rules effective May 26, 2016, found in OAC 3745-300-07(H)(1)(d)(ii). All statistical analyses, including outlier tests, were run using ProUCL version 5.0. A summary of the background determination results for Erie County are provided in a tabular format as part of this report. Final representative background metal concentrations in Erie County are as follows:

Aluminum	**11,300 mg/kg**
Arsenic	**16.7 mg/kg**
Barium	**111 mg/kg**
Beryllium	**0.85 mg/kg**
Calcium	**6770 mg/kg**
Chromium	**17.6 mg/kg**
Cobalt	**13.23 mg/kg**
Copper	**42 mg/kg**
Iron	**27,567 mg/kg**
Lead	**29.6 mg/kg**

Magnesium	**4,090 mg/kg**
Manganese	**1,164 mg/kg**
Mercury	**0.071 mg/kg**
Molybdenum	**33.2 mg/kg**
Nickel	**22.5 mg/kg**
Potassium	**1,248 mg/kg**
Selenium	**1.1 mg/kg**
Sodium	**110 mg/kg**
Thallium	**0.6 mg/kg**
Vanadium	**22.7 mg/kg**
Zinc	**71.1 mg/kg**

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1.0 INTRODUCTION

Evaluation of metals in soils for the assessment and remediation of brownfield sites often requires that "background" concentrations be determined. Background metal concentrations are typically attributed to the natural composition of soil and not from the impact of hazardous substances or petroleum, hazardous or solid wastes, or wastewater. Background concentrations are assumed to be largely dependent on soil texture and composition (*i.e.*, the percentages of sand, silt and clay; the specific mineral components present; and the naturally occurring organic matter present) and also the types of geologic material from which the soil has been derived (*e.g.*, sand and gravel outwash, shale bedrock, till, etc.).

Background metal concentrations in urban soils are particularly challenging to characterize as opposed to background concentrations in suburban or rural areas. Urban soils often have been subjected to decades of various unregulated anthropogenic activities that can elevate background metal concentrations. For example, aerial deposition of particulate matter from fuel combustion or industrial activities in urban areas may increase the concentrations of lead, arsenic, zinc and certain other metals in soils. Construction activities, demolition activities, and surface water runoff from roofs and paved areas may also increase soil metal concentrations.

This investigation evaluates background metal concentrations in urban, suburban and rural surface soils to provide a dataset that may be used as a reference to help satisfy the requirements of, in part, VAP rules (Ohio Administrative Code [OAC] Chapter 3745-300). Specifically, this summary report applies to Erie County brownfield properties being assessed and remediated under the Ohio VAP. For the purposes of this investigation, "Erie County" means surficial soils within the county including the City of Sandusky and adjacent municipalities, suburban areas and metro parks within suburban or rural areas.

2.0 SCOPE

Under the direction of Ohio EPA – VAP Central Office, the Ohio EPA Site Investigation Field Unit (SIFU) sampled and analyzed surface soils at 10 Erie County area properties for background concentrations of Target Analyte List (TAL) metals (Al, Sb, As, Ba, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Hg, Ni, K, Se, Na, Tl, V, Zn) in addition to Mo. Analysis of TAL metals provided results for an expanded list of metals compared to the RCRA metals analyzed for in previous county-specific background reports at a similar cost. Silver was removed from the analytical suite due to repeated non-detections found in soil samples collected from other counties. The property locations are shown on Figure 1, and Tables 1A and 1B provide additional location information and property characteristics including setting (land use), topography and general soil data. The properties were selected based on the following criteria:

- The ability to obtain access from local governments or private property owners.

- Compliance with the VAP location restrictions for background soil sampling investigations [OAC 3745-300-07(H)(1)(b)].

- Design of an investigation that provided representative data for the major soil mapping units within Erie County as described on the "General Soil Map, Erie County, Ohio" of the *Soil Survey of Erie County, Ohio* (United States Department of Agriculture [USDA] Soil Conservation Service) to the extent possible given limitations imposed by the first two criteria.

In addition, at each property one representative sample of the targeted soil horizon was submitted to a contract soil laboratory for USCS and USDA soil texture classification based on sieve, hydrometer and Atterberg limits analyses.

Prior to performing sampling activities, Ohio EPA generally performs a reconnaissance and collects one preliminary soil boring at each property. The objectives of the reconnaissance were to evaluate the shallow (less than four ft deep) soil horizons present to ensure that areas of the property where samples were collected met location restrictions, and to select a general sampling area. Each preliminary soil boring (one per sampling area) was field logged, as best as possible, in accordance with the Unified Soil Classification System (USCS) and the USDA soil classification system to evaluate the soil types present and to screen the sampling location for fill or waste materials.

Alternatively, the sampling for the preliminary soil boring and the soil collected for laboratory analysis may be collected at the same time. In this situation, XRF analysis is completed on the preliminary soil boring, then, if acceptable, the samples are submitted to the lab.

Data quality objectives (DQOs) for this project included the following:

1. Collect soil samples from Erie County area properties that meet the location restriction requirements of OAC 3745-300-07(H)(1)(b)

2. USCS field classification of each preliminary soil boring is completed per ASTM D2488, Standard Practice for Description and Identification of Soils (Visual–Manual Procedure)

3. USDA field classification of each preliminary soil boring is completed using "texture-by-feel" analysis (Presley and Thien, 2008)

4. Analysis of 10 soil samples per targeted soil horizon at each property to provide a statistically representative data set as described by OAC 3745-300-07(H)(1)(d)(i)

5. Fixed-base, VAP-certified laboratory analyses of each soil sample for the TAL metals (Al, Sb, As, Ba, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Hg, Ni, K, Se, Na, Tl, V, Zn) and Mo

6. USCS and USDA classification and textural composition of one selected soil sample per property based on soil laboratory testing in accordance with ASTM D422, Standard Test Method for Particle Size Analysis of Soils (modified to provide USDA soil particle size classes); ASTM D4318, Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils; and ASTM D2487, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)

3.0 ERIE COUNTY AREA SOIL TYPES

Figure 2 ("General Soil Map, Erie County, Ohio" from the Soil Survey of Erie County, Ohio) shows the general soil mapping units present in the Erie County area (Natural Resources Conservation Service, 2006). These include the following:

1. Toledo-Fulton association: Very deep, level and nearly level, very poorly drained and somewhat poorly drained soils that formed in lacustrine deposits

2. Del Rey-Milford association: Very deep, level and nearly level, somewhat poorly drained to very poorly drained soils that formed in lacustrine deposits

3. Weyers-Endoaquents-Sandusky association

4. Bennington-Haskins-Cardington association: Very deep, nearly level to sloping, somewhat poorly drained and moderately well drained soils that formed in till or loamy deposits overlying till or lacustrine deposits

5. Pewamo-Bennington association

6. Mahoning-Ellsworth-Orrville association

7. Allis-Bennington association: Moderately deep and very deep, nearly level and gently sloping, poorly drained and somewhat poorly drained soils that formed entirely in till or in till or lacustrine deposits overlying shale

8. Hornell-Fries-Colwood, bedrock substratum, (a.k.a. Allis-Mitiwanga-Miner) association: Moderately deep and deep, level to gently sloping, somewhat poorly drained to very poorly drained soils that formed in till or lacustrine deposits overlying shale

9. Milton-Millsdale-Castalia association: Moderately deep, level to moderately steep, very poorly drained and well drained soils that formed in till, lacustrine deposits, and residuum derived from limestone or dolostone or in beach or eolian deposits intermixed with limestone fragments overlying limestone or dolostone

10. Kibbie-Colwood-Elnora association: Very deep, level to gently sloping, moderately well drained to very poorly drained soils that formed in lacustrine deposits or glaciofluvial deposits

11. Jimtown-Oshtemo-Millgrove association: Very deep, level to gently sloping, somewhat poorly drained, well drained, and very poorly drained soils that formed in loamy deposits, sandy deposits, or beach deposits

The majority of the land surface of Erie County is unconsolidated glacial deposits (lake plain and till plain) atop sedimentary bedrock (limestone, dolostone, shale and sandstone). The topography is mostly flat to gently rolling, except in the stream valleys (ODNR, 1996).

In summary, properties were selected to incorporate as many of these general soil mapping units as possible to provide a background metal data set that is representative with respect to the soils present in the Erie County area.

4.0 PROPERTY USE AND REGULATORY HISTORY

Properties evaluated for soil sampling included public parks that were not underlain by engineered or structural fill [OAC 3745-300-01(A)(40)] or industrial fill [OAC 3745-300-01(A)(69)], and where industrial or waste disposal activities have not occurred (Tables 1A and 1B and Figure 1). Soil types where disposal has occurred must be excluded from background determinations by rule. The reconnaissance effort conducted prior to the actual sampling event prevented sampling of these prohibited soil types.

Properties underlain by native fill may be sampled [OAC 3745-300-01(A)(80)]. "Native fill" is soil material derived from the property and transferred from one area of the property to another area in such a manner that the original soil structure and physical properties may be altered from the initial pre-excavation conditions, but the chemical and physical properties remain consistent with other undisturbed native soils at the property.

5.0 SUMMARY OF SAMPLING STRATEGY AND FIELD ACTIVITIES

5.1 Property Reconnaissance and Preliminary Soil Boring Evaluation

Ohio EPA performed a property reconnaissance to evaluate potential sampling areas and inspect the property soils. The results of the reconnaissance were used to select the general area where samples were ultimately collected, as well as determine the soil horizon sampled for chemical (metals) and soil texture analysis (classification).

Prior to each property reconnaissance, a review of property soil descriptions provided by the Soil Survey of Erie County, Ohio was conducted. During site reconnaissance, field staff evaluated sampling location restrictions based on OAC 3745-300-07(H)(1)(b), which include:

(i) Areas underlain by engineered fill, structural fill or industrial fill
(ii) Areas where the management, treatment, handling, storage or disposal of hazardous substances or petroleum, solid or hazardous wastes, waste

waters or material handling areas are known or are suspected to have occurred

(iii) Areas within three ft. of a roadway
(iv) Parking lots or areas surrounding parking lots or other paved areas
(v) Railroad tracks or railway areas or other areas affected by their runoff
(vi) Areas of concentrated air pollution depositions or areas affected by their runoff
(vii) Storm drains or ditches presently or historically receiving industrial or urban runoff
(viii) Spill areas

The sampling locations were evaluated based on visual inspection of the property, interviews with the property owners or representatives, review of Sanborn Maps and other historical records, and sampling and inspection of property soils.

A hand auger was used to collect a preliminary soil boring at each proposed sampling area to evaluate the upper four ft. of surficial soils, which were field-classified in accordance with the USCS (ASTM D2488) and the USDA soil classification system (Presley and Thien, 2008).

At a few locations auger refusal was encountered due to very stiff to hard or heaving clays, hardpan, and / or gravel before reaching the target depth of 4 ft., and the sampling interval was slightly smaller (*i.e.*, ground surface to 3.0 ft.), but was never less than three ft. Locations where auger refusal occurred included Castalia Quarry MetroPark (0.8 to 1.4 ft.), Edison Woods Reserve MetroPark [EWM-7], (1.1 to 2.5 ft.), and James McBride MetroPark (2.65 ft.). Soil boring logs are included in Appendix A.

5.2 Soil Sampling and Analysis

Based on the results of the preliminary field investigation, the team selected 10 soil sampling localities (properties) to collect soil samples for TAL metals laboratory analysis (excluding silver), including molybdenum. Maps of each of the sampling locations are included in Appendix C.

At each locality, Ohio EPA collected 10 surficial soil samples between the ground surface and a depth of two ft. using a hand auger. At each of the 10 locations Ohio EPA was able to auger to the minimum required depth interval (*i.e.*, twofeet below ground surface) except for Castalia Quarry MetroPark where refusal was encountered between 0.8 to 1.4 ft. bgs. at every sampling point, and Edison Woods MetroPark, EWM-7 (refusal at 1.1 to 2.0 ft.).

The sample locations were within a 15 ft. radius of the preliminary soil boring location (a circular sampling area with an approximate diameter of 30 ft with the preliminary soil boring location in the center). Ohio EPA collected the geotechnical and 10 analytical soil

samples within an area approximately 30 feet in diameter to ensure that the soil samples were similar in texture and composition (*i.e.*, from the same population). The Ohio EPA sampling team used this approach at all sampling localities for a consistent investigative approach across all properties sampled.

At each locality, the first analytical sample (*e.g.*, CQM-1, DMM-1, ESP-1, etc.) and the geotechnical sample were collected adjacent to the preliminary soil boring location. The other nine analytical samples were collected at random locations within a 15 ft. radius of the preliminary soil boring. Upon completion, each sampling location was backfilled with native soil.

Each soil sample (approximately three to four pounds) was homogenized in a stainless steel mixing pan. A two-ounce subsample was collected and preserved on ice at 4^{o} C and submitted to Ohio EPA's contract laboratory for TAL metals (minus silver and cyanide), but including molybdenum analysis. Approximately two (2) pounds of soil were collected for laboratory USCS and USDA classification and soil texture composition based on sieve, hydrometer, and Atterberg limits testing (one per sampling area).

5.3 Field Sampling Equipment Decontamination

Hand augers, sampling spoons, mixing bowls, and other field equipment used to sample soils were decontaminated between properties by washing with a solution of non-phosphate detergent and potable water and rinsing with deionized water.

5.4 Laboratory Analyses

Ohio EPA's contract laboratory (Microbac Laboratories, Inc.) analyzed 100 soil samples (10 per site) for the TAL metals (Al, Sb, As, Ba, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Hg, Ni, K, Se, Na, Tl, V, Zn) and Mo using Inductively Coupled Plasma (ICP) and/or Graphite Furnace Atomic Absorption Spectrophotometry (GFAAS) via U.S. EPA Method 6020 and Method 7471. Geotechnics, subcontracted by Microbac**,** Inc. performed the USCS and USDA classification (see Table 2 and Appendix B) and soil texture composition in accordance with ASTM D422, Standard Test Method for Particle Size Analysis of Soils (modified to provide USDA soil particle size classes); ASTM D4318, Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils; and ASTM D2487, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System). Data received from Microbac are considered certified under the Ohio EPA VAP certified laboratory program.

6.0 SAMPLING LOCATIONS

6.1 Property Descriptions and Locations

Details for the 10 locations sampled for this investigation are included in Tables 1A and 1B. Information contained in Table 1A provides property information such as site location (latitude/longitude), generalized setting (*e.g.*, urban, suburban or rural), and the topography (*e.g.*, level, gently sloping, etc.). Surveying the location of each sampling point was determined not to be practical; therefore, the longitude and latitude coordinates presented are only for the center sampling location, the preliminary soil boring. The coordinates were collected in the center of the 15-foot radius using a Global Positioning System (GPS) device. As noted in Section 5.0, samples were collected within a 15-foot radius of the original preliminary sample boring.

Table 1B provides information relative to the soil survey for Erie County. Specific details in the table include the mapping (soil type) unit at each property, the underlying parent material (*e.g.*, bedrock, lake deposits, etc.) underlying each property, and the longitude and latitude coordinates for the preliminary soil boring. For Erie County the preliminary soil boring location was also used as the first analytical sampling location.

7.0 METHOD OF BACKGROUND VALUE DETERMINATION

Upon receipt of all laboratory data, statistical evaluations were performed to determine the representative background concentrations. It was determined that data collected from all 10 locations would be incorporated into a single data set. Preliminary evaluations were performed whereby a comparison of properties was performed. Using this method statistically similar sites were combined into a single data set. Though statistically correct, this method was found to be cumbersome such that multiple background values were generated per metal. Therefore, the more direct approach was selected whereby all data points were combined into a single data set and outliers were removed as the entire data set was analyzed. The result was that a single, representative background number was generated for each metal. Background values were determined for the 0-2 ft bgs interval from all 10 property locations.

7.1 Outlier Test

The data set was evaluated for the presence of outliers in accordance with the VAP Rule OAC 3745-300-07(H)(1)(d)(ii)(d). The presence of outliers in the background data sets could yield higher or lower estimates of the upper limits. Statistical outlier tests give evidence that a value does not fit with the distribution of the remainder of the data and is, therefore, a statistical outlier. The outlier identification was performed by the Rosner outlier test using ProUCL. All outliers were removed prior to completing background calculations.

7.2 Nondetect Test

According to the ProUCL user's guide, when the percentage of non-detects in a data set is high (greater than 50 percent (%)) or when multiple detection limits are present, it is hard to reliably perform goodness-of-fit (GOF) tests to determine data distribution. In those cases, the uncertainty associated with the GOF tests is high, especially with smaller data sets (less than 10 to 20 samples). In those situations, the use of nonparametric methods such as the Kaplan-Meier (KM) method to compute statistics such as upper confidence limits, upper prediction limits (UPLs), and upper tolerance limits (UTLs) is preferred because nonparametric methods do not require any distributional assumptions about the data sets.

By example, Table 3 shows that cadmium results had approximately 85% non-detect results. In some cases, the fraction of non-detects is so great as to preclude any reliable statistical analysis. The cadmium data for Erie County contained only 15 detectable values out of the 100 samples. In this case, the maximum concentration will be used as the background rather than attempting a statistical analysis.

7.3 Soil Background Mean

The background mean (X_b) for data sets without non-detects was calculated by ProUCL by dividing the sum of the total background values (X_n) by the total number of background readings (n_b):

$$X_b = \frac{X_1 + X_2 + X_3 \text{ (etc.)}}{n_b}$$

The background mean for data sets with non-detects was calculated by ProUCL using the appropriate method based on the distribution (*e.g.,* the KM method for nonparametric data sets with multiple detection limits).

7.4 Standard Deviation

The standard deviation (S_b) for data sets without non-detects was calculated by ProUCL by taking the square root of the sum of the squares of each value (X_n) minus the mean (X_b), divided by the degrees of freedom (number of background soil samples minus one):

$$S_b = \left[\frac{(X_1 - X_b)^2 + (X_2 - X_b)^2 + (X_3 - X_b)^2 \text{ (etc.)}}{n_b - 1} \right]^{1/2}$$

For data sets with non-detects, the standard deviation was calculated by ProUCL using the appropriate method based on the distribution (*e.g.*, the KM method for nonparametric data sets with multiple detection limits).

7.5 Coefficient of Variation

The C_v is the ratio of the standard deviation (S_b) to the mean (X_b) and describes the magnitude of sample values and the variation within them:

$$C_v = \frac{S_b}{X_b}$$

The C_v is used to evaluate the distribution of the data, where generally a C_v of less than 0.5 indicates a normal distribution. A C_v was calculated only for data sets without non-detects.

7.6 Distribution

The distribution of each data set was also evaluated using ProUCL to determine if the distributions were normal or lognormal. The upper limits for the data sets that were normal were then calculated as described below. Data sets that were not normally distributed were evaluated for the upper limits using nonparametric methods. Nonparametric methods do not assume a population probability distribution, and are, therefore, valid for data from any population with any probability distribution, which can remain unknown.

7.7 VAP Upper Limit (UL)

In accordance with the VAP background soil determination requirements in OAC 3745-300-07(H)(1), the background mean plus two standard deviations is the maximum allowable limit or upper limit for normally distributed data. The background upper limit for normally distributed data sets was calculated by multiplying the standard deviation by two and adding the background mean such that:

$$\text{VAP UL} = X_b + (2 \times S_b)$$

If the data follows a lognormal or nonparametric distribution, the upper limit was calculated using ProUCL to determine the 95% upper prediction limit (UPL) based on the best fit distribution. This is noted in Table 3.

8.0 ERIE COUNTY SOIL BACKGROUND VALUES

Background soil concentrations were calculated in accordance with the VAP rules effective May 26, 2016, found in OAC 3745-300-07(H)(1)(d)(ii). As noted in Section 7.7, for normally distributed data, the background mean plus two standard deviations is the maximum allowable limit, or UL, which was calculated by multiplying the standard deviation by two and then adding the mean concentration. Normally distributed data were observed in the nickel, cobalt, iron, vanadium and zinc data sets. The 95% upper tolerance limit was used as the representative background concentrations for aluminum, arsenic, barium, beryllium, calcium, chromium, copper, lead, magnesium, manganese, mercury, molybdenum, potassium, selenium, sodium and thallium data sets. There was insufficient data to calculate a background value for antimony and cadmium. Due to the high number of non-detects for antimony and cadmium, there was insufficient data to conduct statistical analyses and calculate background values. A summary of the background determination results for Erie County are provided in Table 3.

The ProUCL output data sheets are provided in Appendix D. Analytical results for each metal are provided in Tables 5 through 27. Metal concentrations for each sample at each location are provided. Summary statistics including maximum, minimum, average, and standard deviation are also provided. The following sections are a narrative of the summary results.

8.1 Aluminum

Concentrations of aluminum ranged from 405 to 12,800 mg/kg with no non-detects. There were 100 valid data points, with no outliers. The data set mean was calculated to be 5,047 mg/kg, with a standard deviation of 2,599 mg/kg. The 95% UTL was determined to be 11,300 mg/kg using nonparametric analysis. This value is the representative soil background concentration for aluminum.

8.2 Antimony

Antimony was not detected in any of the 100 samples collected and analyzed. Therefore, a background concentration could not be determined.

8.3 Arsenic

Concentrations of arsenic ranged from 1.31 to 19.8 mg/kg with no non-detects. There were 99 valid data points, with one outlier removed. The data set mean was calculated to be 6.22 mg/kg, with a standard deviation of 4.39 mg/kg. The 95% UTL was determined to be 16.7 mg/kg using nonparametric analysis. This value is the representative soil background concentration for arsenic.

8.4 Barium

Concentrations of barium ranged from 3.17 to 123 mg/kg with no non-detects. There was one outlier removed. The data set mean was calculated to be 44.3 mg/kg, with a standard deviation of 28.23 mg/kg. The 95% UTL was calculated to be 111 mg/kg using nonparametric analysis. This value is the representative soil background concentration for barium.

8.5 Beryllium

Concentrations of beryllium ranged from 0.22 to 0.87 mg/kg with 13 non-detects. There were 84 valid data points with 3 outliers removed. The data set mean was calculated to be 0.423 mg/kg, with a standard deviation of 0.152 mg/kg. The 95% UTL with 95% coverage was determined to be 0.85 mg/kg using nonparametric analysis. This value is the representative soil background concentration for beryllium.

8.6 Cadmium

Cadmium was only detected in 15 out of 100 samples. This is too small of a data set to calculate a background concentration.

8.7 Calcium

Concentrations of calcium ranged from 155 to 7,800 mg/kg with no non-detects. There were 90 valid data points, with 10 outliers removed. The data set mean was calculated to be 1,472 mg/kg, with a standard deviation of 1,760 mg/kg. The 95% UTL was determined to be 6,770 mg/kg using nonparametric analysis. This value is the representative soil background concentration for calcium.

8.8 Chromium

Concentrations of chromium ranged from 2.03 to 18.4 mg/kg with no non-detects. There were 100 valid data points with no outliers removed. The data set mean was calculated to be 7.97 mg/kg, with a standard deviation of 3.86 mg/kg. The 95% UTL with 95% coverage was determined to be 17.6 mg/kg using a lognormal distribution. This value is the representative soil background concentration for chromium.

8.9 Cobalt

Detected concentrations of cobalt ranged from 0.495 to 16.6 mg/kg. There were 92 valid data points with eight outliers removed. There were no non-detects in the data set. The data set mean was calculated to be 6.61 mg/kg, with a standard deviation of 3.31 mg/kg. The VAP UL was determined to be 13.23 mg/kg. The 95% UTL with 95% coverage was determined to be 13.03 mg/kg. Either the VAP UL or the 95% UTL can be considered the

representative soil background concentration for cobalt.

8.10 Copper

Copper concentrations ranged from 1.63 to 42 mg/kg with no non-detects. There were 100 valid data points with no outliers removed. The data set mean was calculated to be 15.45 mg/kg, with a standard deviation of 8.08 mg/kg. The 95% UTL with 95% coverage was determined to be 42.3 mg/kg using a lognormal distribution. However, this value exceeds the maximum concentration detected. Therefore, the representative background concentration is 42 mg/kg.

8.11 Iron

Detected concentrations of iron ranged from 999 to 35,300 mg/kg. There were 100 valid data points. There were no non-detects in the data set. The data set mean was calculated to be 14,369 mg/kg, with a standard deviation of 6599 mg/kg. The VAP UL was determined to be 27,567 mg/kg. The 95% UTL with 95% coverage was determined to be 27,062 mg/kg. Either the VAP UL or the 95% UTL can be considered the representative soil background concentration for iron.

8.12 Lead

Detected concentrations of lead ranged from 5.92 to 33.5 mg/kg. There were 98 valid data points after the removal of two outliers. There were no non-detects in the data set. The data set mean was calculated to be 15.34 mg/kg, with a standard deviation of 6.17 mg/kg. The 95% UTL with 95% coverage was determined to be 29.6 mg/kg using a lognormal distribution. This value is the representative soil background concentration for lead.

8.13 Magnesium

Concentrations of magnesium ranged from 216 to 5,930 mg/kg with no non-detects. There were 90 valid data points, with 10 outliers removed. The data set mean was calculated to be 1,275 mg/kg, with a standard deviation of 1,084 mg/kg. The 95% UTL was determined to be 4,090 mg/kg using nonparametric analysis. This value is the representative soil background concentration for magnesium.

8.14 Manganese

Concentrations of manganese ranged from 63.2 to 1,250 mg/kg with no non-detects. There were 100 valid data points with no outliers removed. The data set mean was calculated to be 390.5 mg/kg, with a standard deviation of 266.2 mg/kg. The 95% UTL with 95% coverage was determined to be 1,164 mg/kg using a lognormal distribution. This value is the representative soil background concentration for manganese.

8.15 Mercury

Concentrations of mercury ranged from 0.0137 to 0.0744 mg/kg. There were 97 valid data points with one outlier removed and two non-detects. The data set mean was calculated to be 0.0347 mg/kg, with a standard deviation of 0.0139 mg/kg. The 95% UTL with 95% coverage was determined to be 0.071 mg/kg using a lognormal distribution. This value is the representative soil background concentration for lead.

8.16 Molybdenum

Concentrations of molybdenum ranged from 2.18 to 40.4 mg/kg with 48 non-detects. There were 52 valid data points, with no outliers. The data set mean was calculated to be 13.9 mg/kg, with a standard deviation of 10.7 mg/kg. The 95% UTL was determined to be 33.2 mg/kg using nonparametric analysis. This value can be used as the representative soil background concentration, however, given the large number of non-detects, this value should be used with caution.

8.17 Nickel

Detected concentrations of nickel ranged from 3.32 to 26.9 mg/kg. There were 99 valid data points with one outlier removed. There were no non-detects in the data set. The data set mean was calculated to be 12.38 mg/kg, with a standard deviation of 5.1 mg/kg. The VAP UL was determined to be 22.5 mg/kg. The 95% UTL with 95% coverage was determined to be 22.2 mg/kg. Either the VAP UL or the 95% UTL can be considered the representative soil background concentration for nickel.

8.18 Potassium

Potassium concentrations ranged from 109 to 1,420 mg/kg with no non-detects. There were 100 valid data points with no outliers removed. The data set mean was calculated to be 451.3 mg/kg, with a standard deviation of 296.2 mg/kg. The 95% UTL with 95% coverage was determined to be 1,248 mg/kg using a lognormal distribution. This value is the representative soil background concentration for potassium.

8.19 Selenium

Detected concentrations of selenium ranged from 0.11 to 1.24 mg/kg. There were 97 valid data points with one non-detect and two outliers removed. The mean was 0.454 mg/kg. The standard deviation was 0.239 mg/kg. The 95% UTL with 95% coverage was determined to be 1.1 mg/kg. This value is the representative soil background concentration for selenium.

8.20 Sodium

Concentrations of sodium ranged from 10.2 to 170 mg/kg with 12 non-detects. There were 88 valid data points. The data set mean was calculated to be 35.71 mg/kg, with a standard deviation of 33.51 mg/kg. The 95% UTL with 95% coverage was determined to be 110 mg/kg using nonparametric analysis. This value is the representative soil background concentration for sodium.

8.21 Thallium

Concentrations of thallium ranged from 0.045 to 0.63 mg/kg with no non-detects. There were 98 valid data points with two outliers. The data set mean was calculated to be 0.20 mg/kg, with a standard deviation of 0.132 mg/kg. The 95% UTL with 95% coverage was determined to be 0.6 mg/kg based on a lognormal distribution. This value is the representative soil background concentration.

8.22 Vanadium

Vanadium concentrations detected ranged from 2.51 to 28.1 mg/kg. There were 100 valid data points with no outliers. There were no non-detects in the data set. The data set mean was calculated to be 12.9 mg/kg, with a standard deviation of 4.9 mg/kg. The VAP UL was determined to be 22.7 mg/kg. The 95% UTL with 95% coverage was determined to be 22.3 mg/kg. Either the VAP UL or the 95% UTL can be considered the representative soil background concentration for vanadium.

8.23 Zinc

Detected concentrations of zinc ranged from 13.4 to 84.1 mg/kg. There were 99 valid data points with one outlier removed. There were no non-detects in the data set. The data set mean was calculated to be 39.36 mg/kg, with a standard deviation of 15.85 mg/kg. The VAP UL was determined to be 71.1 mg/kg. The 95% UTL with 95% coverage was determined to be 69.9 mg/kg. Either the VAP UL or the 95% UTL can be considered the representative soil background concentration for zinc.

9.0 APPLICATION OF THIS REPORT AND SUMMARY OF BACKGROUND DETERMINATION

Background results generated in this report are specific to Erie County. Users of this report may elect to utilize the results presented in Section 8.0 and Table 3 for direct comparison purposes to other properties in Erie County in accordance with VAP soil background rule requirements (OAC 3745-300-07(H)(2)). It is generally inappropriate to apply these background values to properties located in non-adjacent or surrounding counties. Exceptions to this provision may be allowable if the user can demonstrate that the subject property has a similar soil provenance and type to one or more soil types listed for properties within this study. Geotechnical analysis of the subject property soil type is advisable to make the soil type comparison. Additionally, samples collected at the subject property must be representative of the zone (*e.g.*, 0-2 ft. bgs.) assessed in this study.

The following results are the background upper limits for metal soil concentrations in Erie County:

Aluminum	**11,300 mg/kg**
Arsenic	**16.7 mg/kg**
Barium	**111 mg/kg**
Beryllium	**0.85 mg/kg**
Calcium	**6,770 mg/kg**
Chromium	**17.6 mg/kg**
Cobalt	**13.23 mg/kg**
Copper	**42 mg/kg**
Iron	**27,567 mg/kg**
Lead	**29.6 mg/kg**
Magnesium	**4,090 mg/kg**
Manganese	**1,164 mg/kg**
Mercury	**0.071 mg/kg**
Molybdenum	**33.2 mg/kg**
Nickel	**22.5 mg/kg**
Potassium	**1,248 mg/kg**
Selenium	**1.1 mg/kg**
Sodium	**110 mg/kg**
Thallium	**0.6 mg/kg**
Vanadium	**22.7 mg/kg**
Zinc	**71.1 mg/kg**

10.0 REFERENCES

ASTM D2487, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)

ASTM D2488, Standard Practice for Description and Identification of Soils (Visual – Manual Procedure)

ASTM D422, Standard Test Method for Particle Size Analysis of Soils

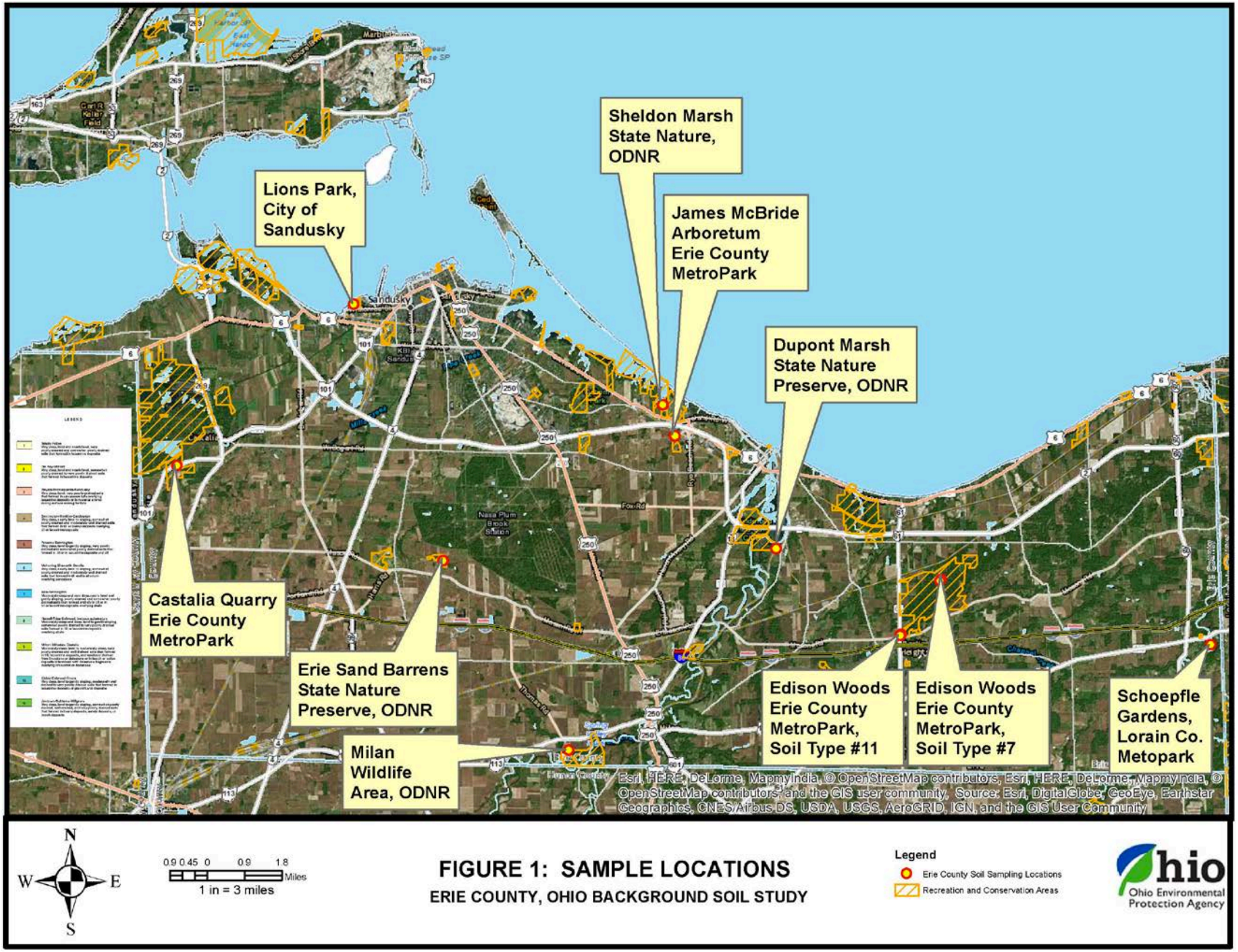
ASTM D4318, Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

ODNR Division of Water, June, 1994, Ground Water Pollution Potential of Erie County, Ohio (Report No. 16)

Presley, D., and S. Thien, September 2008, Estimating Soil Texture by Feel, Kansas State University Department of Agronomy, MF-2852

USDA Natural Resources Conservation Service, January 2006, Soil Survey of Erie County, Ohio

U.S. EPA, U.S. EPA Statistical Software ProUCL 5.0 for Environmental Applications for Data Sets with and Without Non-detect Observations



N
W E
S

0 0.45 0 0.9 1.8 Miles
1 in = 3 miles

FIGURE 1: SAMPLE LOCATIONS

ERIE COUNTY, OHIO BACKGROUND SOIL STUDY

Legend
- Erie County Soil Sampling Locations
- Recreation and Conservation Areas

Ohio Environmental Protection Agency

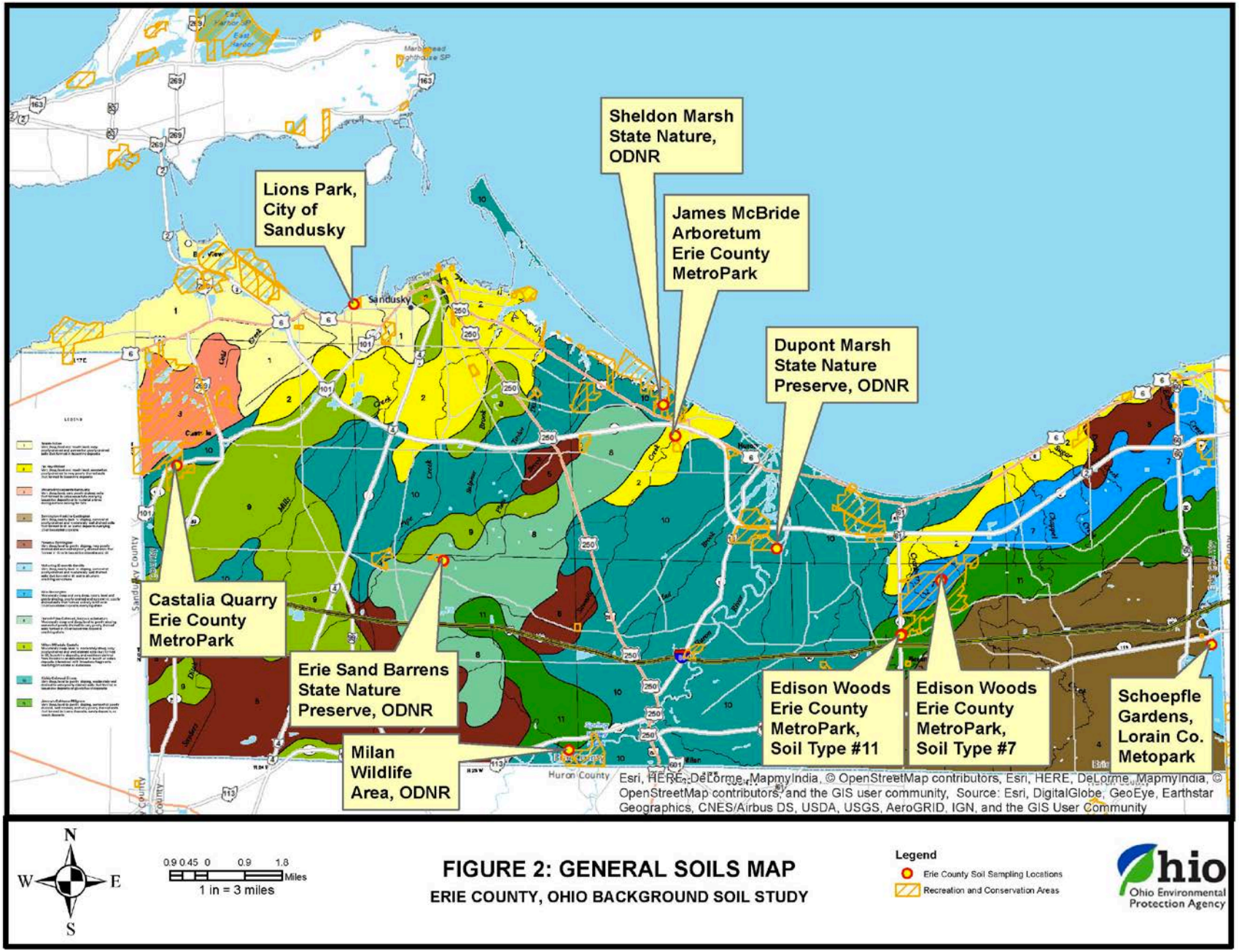


FIGURE 2: GENERAL SOILS MAP

ERIE COUNTY, OHIO BACKGROUND SOIL STUDY

TABLE 1A

Soil Sampling Property Information Summary: Locations, Settings & Topography

Sampled Property, GSM Soil Type # (Sample Abbreviation)	Location			Setting	Topography	EASTING[1]	NORTHING[1]	ELEVATION[1] a.m.s.l.
	Address	North Latitude[1]	West Longitude[1]					
Castalia Quarry Reserve, 9 & 10 (CQM--PSB & CQM--1) Erie County MetroParks	8404 State Route 101 (a.k.a. Sandusky-Clyde Rd.), Castalia, OH 44824	41.390954542	82.828687311	rural park	Lake plains, deltas, reefs on lake plains	1235497.024	1878259.823	653.493
Dupont Marsh State Nature Preserve, 10 (DMM--PSB & DMM-1) Mnged by Erie Co. MetroParks & Owned by ODNR Nature Preserve, St. of Ohio	1805 River Road, (at Huron River Path MetroPark) Huron, OH 44839	41.362583888	82.550942826	rural park	Lake plains, deltas	1224993.597	1954507.925	608.023
Erie Sand Barrens St. Nature Preserve, 8 (ESP--PSB & ESP--1) ODNR Nature Preserve, State of Ohio	West Scheid Rd. (T.R. 12), ~300' east of Taylor Rd., Sandusky, OH 44870	41.357982812	82.705003554	rural park	Lake plains	1223376.171	1912189.484	695.906
Edison Woods Reserve, 7 (EWM-7--PSB & EWM-7--1) Erie County MetroParks	8132 Smokey Road, (T.R. 80), ~2000' southeast of Driver Rd. (T.R. 81) Berlin Heights, OH 44814	41.351567492	82.474143263	rural park	Lake plains	1220974.464	1975603.022	645 (USGS Topo)
Edison Woods Reserve, 11 (EWM-11--PSB & EWM-11--1) Erie County MetroParks	At intersection of 10498 Ceylon Rd. (S.R. 61) and 7301 E. Mason Rd. (C.R. 13), Berlin Heights, OH 44814	41.332376133	82.493018807	rural park	Lake plains	1213977.087	1970418.322	708.065
James McBride Arboretum, 2 (JMA--PSB & JMA-1) Erie County MetroParks	near One University Drive (~1600 Boos Road, T.R. 9), Huron, OH 44839	41.401852099	82.597960275	suburban park	Lake plains	1239320.373	1941609.538	590.406
Lions City Park, 1 (LCP--PSB & LCP-1) City of Sandusky	631 La Salle St., (at Winnebago Avenue) Sandusky, OH 44870	41.447659796	82.746858516	urban neighborhood park	Lake plains	1256099.176	1900782.142	577.467
Milan Wildlife Area, 10 & 11 (MWR--PSB & MWR--1) ODNR Wildlife Area, State of Ohio	Lovers Lane (T.R. 48) ~1500' south of S.R. 113, Norwalk, OH 44857	41.292012940	82.646760825	rural park	Lake plains, deltas	1199295.268	1928148.532	675.259
Schoepfle Gardens, 6 (SGM--PSB & SGM-1) Managed by Lorain Co. Metro Parks [located in Erie County]	11106 Market St, (near South Street) Birmingham, OH 44816	41.328693782	82.349272310	rural park in small town	Ground moraines	1212669.150	2009919.824	733.599
Sheldons Marsh State Nature Preserve, 10 (SMP--PSB & SMP--1) ODNR Nature Preserve, State of Ohio	2715 Cleveland Road West, (a.k.a. State Route 6), Huron, Ohio 44839	41.412576241	82.603276501	suburban park	Lake plains, deltas	1243231.809	1940154.687	589.442

Note:

1 Latitude, longitude, easting, northing & elevation values were collected using sub-meter Trimble G.P.S from the center of area from which soil samples were collected

TABLE 1B

Soil Sampling Property Information Summary: Soil Mapping Units, Parent Materials and Soil Types

Sampled Property, GSM Soil Type # (Sample Abbreviation) Property Owner	Preliminary Soil Boring[1] (PSB) & Location			Soil Mapping Units, Classification and Parent Materials			
	PSB	Latitude[2]	Longitude	Mapping Unit[3]	USCS Soil Type[4]	USDA Soil Type[4]	Parent Material[5]
Castalia Quarry Reserve, 9 & 10 (CQM--1) Erie County MetroParks	CQM--PSB	41.390954542	82.828687311	GSM #9, Udorthents, loam (UdB); [Tuscola fine sandy loam, TuA]	Silty Clay (CL-ML)	Silt Loam	Areas altered during mining; Stratified lacustrine deposits
Dupont Marsh State Nature Preserve, 10 (DMM-1) Mnged by Erie Co. MetroParks & Owned by ODNR Nature Preserve, St. of Ohio	DMM--PSB	41.362583888	82.550942826	GSM #10; Ogontz silt loam (OhB), Udorthents, loam (UdB), Zurich silt loam (ZuF)	Lean Clay with Sand (CL)	Loam	Stratified lacustrine deposits; Areas altered during mining; and/or Lacustrine deposits
Erie Sand Barrens St. Nature Preserve, 8 (ESP--1) ODNR Nature Preserve, St. of Ohio	ESP--PSB	41.357982812	82.705003554	GSM #8, Hornell loam (HpB)	Slit with Sand (ML)	Loam	Till or lacustrine deposits overlying shale
Edison Woods Reserve, 7 (EWM-7--1) Erie County MetroParks	EWM-7--PSB	41.351567492	82.474143263	GSM #7, Allis clay loam (AkA)	Sandy Lean Clay (CL)	Clay Loam	Till or lacustrine deposits overlying shale
Edison Woods Reserve, 11 (EWM-11--1) Erie County MetroParks	EWM-11--PSB	41.332376133	82.493018807	GSM #11, Allis clay loam (AkA)	Fat Clay (CH)	Silty Clay Loam	Till or lacustrine deposits overlying shale
James McBride Arboretum, 2 (JMA-1) Erie County MetroParks	JMA--PSB	41.401852099	82.597960275	GSM #2, Elnora loamy fine sand, bedrock substratum (EoA)	Lean Clay with Sand (CL)	Loam	Sandy lacustrine deposits overlying shale
Lions City Park, 1 (LCP-1) City of Sandusky	LCP--PSB	41.447659796	82.746858516	GSM #1, Fulton silty clay loam (FuA), Toledo silty clay (ToA)	Fat Clay (CH)	Silty Clay	Lacustrine deposits
Milan Wildlife Area, 10 & 11 (MWR--1) ODNR Wildlife Area, State of Ohio	MWR--PSB	41.292012940	82.646760825	GSM #10; Oshtemo loamy sand (OsB)	Silty, Clayey Sand (SC-SM)	Sandy Loam	Loamy and sandy deposits
Schoepfle Gardens, 6 (SGM-1) Managed by Lorain Co. Metro Parks [but located in Erie County]	SGM--PSB	41.328693782	82.349272310	GSM #4, Amanda-Dekalb-Rock outcrop (AnG)	Sandy Lean Clay (CL)	Loam	Till or Sandstone residuum
Sheldons Marsh State Nature Preserve, 10 (SMP--1) ODNR Nature Preserve, St. of Ohio	SMP---PSB	41.412576241	82.603276501	GSM #10, Milford silty clay loam (MfA)	Silt (ML)	Silt Loam	Lacustrine deposits

Notes:

1 One preliminary soil boring (PSB) was collected at each sampling location to evaluate soil conditions prior to sample analyses, however, mechanical problems with XRF prevented screening analyses. PSB logs (with field soil descriptions) are included in Appendix A. GSM = General Soils Map. GSM Soil Types #3, 4 & 5 were not sampled.

2 Latitude and longitude values were collected using sub-meter Trimble G.P.S for the center of area from which soil samples were collected

3 Mapping Number is based on Erie County Soil Survey data; and, Mapping Unit is derived from Ohio EPA--GIS soils data base.

4 Soil Types are based on Geotechnical Analysis by Microbac's sub-contractor, Geotechnics of East Pittsburgh, PA.

5 Parent Material is based on Erie County Soil Survey data.

TABLE 2
Summary of Soil Geotechnical Testing Results

Soil Sample	Soil Parent Material[1]	Unified Soil Classification System (USCS)								USDA Soil Classification System				
		USCS Soil Type	Particle Size Distribution				Atterberg Limits			USDA Soil Type	Particle Size Distribution			
			% Gravel (>4.76 mm)	% Sand (<=4.76 mm, >0.074 mm)	% Silt (<=0.074 mm, >0.002 mm)	% Clay (<=0.002 mm)	LL (%)	PL (%)	PI (%)		% Gravel (>2 mm)	% Sand (<=2 mm, >0.05 mm)	% Silt (<=0.05 mm, >0.002 mm)	% Clay (<=0.002 mm)
CQM-1	Areas altered during mining [Ground moraines, lake plains, stream terraces, flood plains]; Stratified lacustrine deposits	Silty Clay (CL-ML)	1.27	5.64	79.90	13.19	26	21	5	Silt Loam	1.90	11.73	73.18	13.19
DMM-1	Stratified lacustrine deposits; Areas altered during mining; and/or Lacustrine deposits	Lean Clay with Sand (CL)	0.00	28.00	55.53	16.47	24	16	8	Loam	0.06	38.74	44.74	16.47
ESP-1	Till or lacustrine deposits overlying shale	Slit with Sand (ML)	0.39	28.40	48.22	22.99	38	25	13	Loam	2.34	29.05	45.62	22.99
EWM-7 --1	Till or lacustrine deposits overlying shale	Sandy Lean Clay (CL)	4.79	25.55	37.67	31.99	37	22	15	Clay Loam	9.77	22.75	35.50	31.99
EWM-11--1	Till or lacustrine deposits overlying shale	Fat Clay (CH)	1.74	9.36	50.74	38.16	56	26	30	Silty Clay Loam	3.62	12.11	46.10	38.16
JMA-1	Sandy lacustrine deposits overlying shale	Lean Clay with Sand (CL)	0.58	26.73	50.98	21.71	30	21	9	Loam	1.42	30.95	45.92	21.71
LCP-1	Lacustrine deposits	Fat Clay (CH)	0.11	2.46	51.89	45.54	61	25	36	Silty Clay	0.33	5.41	48.73	45.54
MWR-1	Loamy and sandy deposits	Silty, Clayey Sand (SC-SM)	3.38	68.39	20.92	7.31	23	19	4	Sandy Loam	21.45	52.44	18.80	7.31
SGM-1	Till or Sandstone residuum	Sandy Lean Clay (CL)	2.19	43.51	38.09	16.21	25	17	8	Loam	2.75	48.60	32.44	16.21
SMP-1	Lacustrine deposits	Silt (ML)	2.43	4.92	79.37	13.28	30	23	7	Silt Loam	2.55	17.31	66.85	13.28

[1] Parent Material is based on Erie County Soil Survey data.

Table 3
Background Statistics for Erie County
Summary Results for 23 TAL Metals

Metal	# of Sites Included	Number of Outliers	% ND	Data points	Maximum	Mean	SD	Distribution	VAP UL	95% UTL with 95% Coverage	Units	Comments
Aluminum	10	0	0	96	12800	5047	2599	Nonparametric	-	**11,300**	mg/kg	
Antimony	10	0	100%	0	-	-	-	-	-	-	mg/kg	All non-detects, Detection limits ≈ 4.5 mg/kg
Arsenic	10	1	0%	99	19.8	6.225	4.397	Nonparametric	-	**16.7**	mg/kg	1 outlier removed, no discernable distribution
Barium	10	1	0%	99	123	44.39	28.23	Nonparametric	-	**111**	mg/kg	1 outlier removed; no discernable distribution
Beryllium	10	3	13%	97	0.87	0.423	0.152	Nonparametric	-	**0.85**	mg/kg	3 outliers removed and 13 ND
Cadmium(1)	10	0	85%	15	-	-	-	-	-	-	mg/kg	Only 15 detections; 85% non-detect, no statistical analysis
Calcium	10	10	0	90	7800	1472	1760	Nonparametric	-	**6,770**	mg/kg	10 outliers removed – all CQM site
Chromium	10	0	0%	100	18.4	7.972	3.861	Lognormal	-	**17.61**	mg/kg	Data are lognormal at a 5% significance level
Cobalt	10	8	0	92	16.6	6.608	3.319	Normal	**13.23**	13.03	mg/kg	8 outliers removed – all ESP site
Copper	10	0	0	100	42	15.45	8.08	Lognormal	-	**42.29**	mg/kg	Calculated UTL exceeds maximum value of 42.0. Use 42.0 for UTL value
Iron	10	0	0	100	35300	14369	6599	Normal	**27,567**	27,062	mg/kg	
Lead	10	2	0%	98	33.5	15.34	6.179	Lognormal	-	**29.62**	mg/kg	2 outliers removed
Magnesium	10	10	0	90	5930	1275	1084	Nonparametric	-	**4,090**	mg/kg	10 outliers removed – all CQM site
Manganese	10	10	0	90	1250	390.5	266.2	Lognormal	-	**1164**	mg/kg	
Mercury	10	1	2%	97	0.0744	0.0347	0.0139	Lognormal	-	**0.071**	mg/kg	1 outlier removed, 2 ND, data are lognormal at a 5% sig. level
Molybdenum	10	0	48	52	40.4	13.92	10.65	Nonparametric	-	**33.2**	mg/kg	48 ND; this value should be used with caution
Nickel	10	1	0%	99	26.9	12.38	5.103	Normal	**22.5**	22.2	mg/kg	1 outlier removed, Normal distribution
Potassium	10	0	0	100	1420	451.3	296.2	Lognormal	-	**1,248**	mg/kg	
Selenium	10	2	1%	97	1.24	0.454	0.239	Lognormal	-	**1.097**	mg/kg	2 outliers removed & 1 ND, data are lognormal at a 5% sig. level
Sodium	10	0	12	88	170	35.71	33.51	Nonparametric	-	**110**	mg/kg	12 non-detects
Thallium	10	2	0%`	98	0.631	0.207	0.132	Lognormal	-	**0.597**	mg/kg	2 outliers removed, data are lognormal at a 5% sig. level
Vanadium	10	0	0	100	28.1	12.91	4.895	Normal	**22.7**	22.32	mg/kg	
Zinc	10	1	0	99	84.1	39.36	15.85	Normal	**71.1**	69.88	mg/kg	1 outlier removed

(1) Maximum observed value was used for cadmium due to high number of non-detects. No statistical evaluations were made (*e.g.,* mean, SD, distribution).

Note: ND – Non-detect SD – Standard deviation VAP UL – Voluntary Action Program upper limit
UTL – Upper tolerance limit

Bold Number = Representative background value for associated metal

VAP UL = bkgrd mean + 2 SD; if dataset is not normally distributed, value is not appropriate for use as background value.

Table 4

Property Abbreviation Key

Abbreviation	Property & General Location
CQM	Castalia Quarry Reserve MetroPark, Castalia
DMM	Dupont Marsh State Nature Preserve, Huron
ESP	Erie Sand Barrens State Nature Preserve
EWM-7	Edison Woods Reserve MetroPark, General Soils Map, Soil Type #7, Berlin Heights
EWM-11	Edison Woods Reserve MetroPark, General Soils Map, Soil Type #11, Berlin Heights
JMA	James McBride Arboretum MetroPark, Huron
LCP	Lions City Park, Sandusky
MWR	Milan State Wildlife Area, Norwalk
SGM	Schoepfle Gardens MetroPark, Birmingham
SMP	Sheldons Marsh State Nature Preserve, Huron

Table 5
Summary of Aluminum Data
Erie County Background Soils Summary Report

Sample	Location		CQM	DMM	ESP	EWM-7	EWM-11	JMA	LCP	MWR	SGM	SMP
	Units											
1	mg/kg		1,090	4,160	3,450	2,820	8,260	4,670	2,820	4,620	5,210	3,290
2	mg/kg		7,260	6,680	3,200	5,350	5,880	4,690	5,350	4,000	3,760	3,360
3	mg/kg		829	4,890	3,430	5,150	6,820	5,220	5,150	4,030	4,960	2,810
4	mg/kg		666	7,870	3,640	4,340	7,620	5,070	4,340	4,550	4,970	4,030
5	mg/kg		4,05	5,580	3,550	5,020	6,250	5,390	5,020	3,370	6,470	3,940
6	mg/kg		1,030	8,490	3,390	4,360	12,800	5,380	4,360	3,740	3,500	3,540
7	mg/kg		1,170	4,610	3,560	4,120	9,090	6,500	4,120	4,130	4,840	3,100
8	mg/kg		431	7,380	3,430	5,780	9,240	5,670	5,780	3,390	4,800	3,080
9	mg/kg		837	6,620	3,510	5,400	8,810	4,080	5,400	4,510	4,440	4,330
10	mg/kg		1,330	5,850	3,340	4,800	5,740	3,890	4,800	3,820	4,810	3,580

Notes:
mg/kg – milligrams per kilogram
Total Aluminum

Table 6
Summary of Antimony Data
Erie County Background Soils Summary Report

Sample	Location		CQM	DMM	ESP	EWM-7	EWM-11	JMA	LCP	MWR	SGM	SMP
	Units											
1	mg/kg		<4.57 U	<4.44 U	<4.57 U	<4.54 U	<4.39 U	<5.02 U	<4.54 U	<3.86 U	<4.11 U	<4.43 U
2	mg/kg		<4.39 U	<4.41 U	<4.48 U	<4.96 U	<4.91 U	<5.56 U	<4.27 U	<4.17 U	<5.17 U	<3.98 U
3	mg/kg		<4.27 U	<4.20 U	<4.06 U	<4.44 U	<4.72 U	<4.57 U	<4.42 U	<3.87 U	<3.88 U	<3.90 U
4	mg/kg		<4.90 U	<4.82 U	<4.62 U	<4.89 U	<4.29 U	<4.97 U	<4.37 U	<4.12 U	<4.39 U	<4.46 U
5	mg/kg		<4.18 U	<4.39 U	<4.23 U	<4.78 U	<4.36 U	<4.62 U	<4.25 U	<4.18 U	<4.13 U	<4.29 U
6	mg/kg		<4.11 U	<4.62 U	<5.18 U	<4.54 U	<5.01 U	<4.59 U	<4.44 U	<4.07 U	<4.70 U	<4.35 U
7	mg/kg		<4.57 U	<4.74 U	<4.56 U	<4.73 U	<4.95 U	<5.31 U	<4.71 U	<3.94 U	<4.55 U	<4.40 U
8	mg/kg		<4.46 U	<4.10 U	<4.32 U	<4.35 U	<4.60 U	<4.54 U	<4.45 U	<4.10 U	<4.23 U	<4.06 U
9	mg/kg		<4.15 U	<4.26 U	<4.45 U	<4.60 U	<4.42 U	<5.03 U	<9.37 U	<3.85 U	<4.35 U	<4.57 U
10	mg/kg		<4.51 U	<4.32 U	<4.07 U	<4.54 U	<4.14 U	<4.60 U	<4.41 U	<4.16 U	<3.99 U	<4.34 U

Notes:
mg/kg – milligrams per kilogram
Total Antimony

Table 7
Summary of Arsenic Data
Erie County Background Soils Summary Report

Sample	Location		CQM	DMM	ESP	EWM-7	EWM-11	JMA	LCP	MWR	SGM	SMP
	Units											
1	mg/kg		2.26	4.06	8.21	19.80	6.20	2.43	9.91	1.97	8.58	2.73
2	mg/kg		2.77	2.82	16.80	14.70	5.52	1.74	8.88	2.26	7.45	2.92
3	mg/kg		2.62	3.93	15.50	12.60	6.85	2.57	12.90	1.97	11.40	2.53
4	mg/kg		3.10	5.39	7.57	9.49	7.30	2.18	8.74	1.82	8.54	2.18
5	mg/kg		2.19	5.32	8.36	8.19	4.71	3.33	11.80	1.96	12.10	1.66
6	mg/kg		2.82	6.62	9.19	11.40	6.60	2.19	7.77	1.97	12.20	2.30
7	mg/kg		2.30	2.41	5.33	16.70	6.67	2.20	7.03	1.35	11.10	2.72
8	mg/kg		1.58	5.66	6.68	16.50	6.42	2.07	7.29	2.44	9.04	1.48
9	mg/kg		2.28	4.80	9.91	15.70	8.64	1.31	145.00	1.74	9.78	3.39
10	mg/kg		2.72	4.99	6.23	12.90	4.67	2.53	9.03	2.40	10.50	1.92

Notes:
mg/kg = milligrams per kilogram
Total Arsenic

Table 8
Summary of Barium Data
Erie County Background Soils Summary Report

Sample	Location		CQM	DMM	ESP	EWM-7	EWM-11	JMA	LCP	MWR	SGM	SMP
	Units											
1	mg/kg		7.93	34.3	31.3	29.1	84.2	20.8	76.7	22.3	83.7	26.3
2	mg/kg		6.34	29.8	34.3	67.0	57.2	31.8	80.4	24.6	67.8	23.5
3	mg/kg		7.33	32.8	28.4	57.2	84.2	49.9	112.0	26.3	51.4	17.1
4	mg/kg		7.26	27.0	45.4	52.4	99.5	54.5	77.4	25.2	62.1	25.2
5	mg/kg		3.17	32.8	32.1	72.2	51.2	28.2	84.8	24.4	90.6	28.7
6	mg/kg		9.03	32.0	20.7	54.9	156.0	30.5	80.4	48.3	41.5	25.9
7	mg/kg		9.19	27.0	29.0	65.4	111.0	32.2	80.6	26.2	52.2	39.5
8	mg/kg		5.17	30.3	33.2	46.5	111.0	36.6	100.0	29.1	50.1	31.8
9	mg/kg		5.47	26.0	23.4	57.6	106.0	18.4	123.0	29.9	45.0	24.6
10	mg/kg		12.00	27.6	27.8	65.1	58.7	42.9	92.8	20.6	45.3	22.6

Notes:
mg/kg = milligrams per kilogram
Total Barium

Table 9
Summary of Beryllium Data
Erie County Background Soils Summary Report

Sample	Location		CQM	DMM	ESP	EWM-7	EWM-11	JMA	LCP	MWR	SGM	SMP
	Units											
1	mg/kg		<0.457 U	**0.287 J**	**0.556**	**0.381 J**	**0.790**	**0.277 J**	**0.592**	**0.330 J**	**0.404 J**	**0.302 J**
2	mg/kg		<0.439 U	**0.368 J**	**0.617**	**0.365 J**	**0.706**	<0.556 U	**0.523**	**0.347 J**	**0.327 J**	**0.294 J**
3	mg/kg		<0.427 U	**0.315 J**	**0.488**	**0.247 J**	**0.851**	**0.548**	**0.565**	**0.298 J**	**0.308 J**	**0.255 J**
4	mg/kg		<0.490 U	**0.386 J**	**0.739**	**0.257 J**	**0.998**	**0.591**	**0.483**	**0.438**	**0.281 J**	**0.300 J**
5	mg/kg		<0.418 U	**0.315 J**	**0.515**	**0.397 J**	**0.498**	**0.308 J**	**0.566**	**0.314 J**	**0.389 J**	**0.343 J**
6	mg/kg		<0.411 U	**0.438 J**	**0.603**	**0.259 J**	**1.210**	**0.323 J**	**0.551**	**0.439**	<0.470 U	**0.287 J**
7	mg/kg		<0.457 U	**0.303 J**	**0.536**	**0.320 J**	**0.859**	**0.301 J**	**0.477**	**0.342 J**	**0.322 J**	**0.447**
8	mg/kg		<0.446 U	**0.369 J**	**0.494**	**0.248 J**	**1.030**	**0.342 J**	**0.510**	**0.372 J**	**0.314 J**	**0.346 J**
9	mg/kg		<0.415 U	**0.338 J**	**0.539**	**0.328 J**	**0.870**	<0.503 U	**0.615 J**	**0.453**	**0.269 J**	**0.305 J**
10	mg/kg		<0.451 U	**0.340 J**	**0.537**	**0.344 J**	**0.595**	**0.399 J**	**0.592**	**0.280 J**	**0.247 J**	**0.301 J**

Notes:
mg/kg – milligrams per kilogram
Total Beryllium

Table 10
Summary of Cadmium Data
Erie County Background Soils Summary Report

Sample	Location		CQM	DMM	ESP	EWM-7	EWM-11	JMA	LCP	MWR	SGM	SMP
	Units											
1	mg/kg		<0.457 U	<0.444 U	<0.457 U	<0.454 U	<0.439 U	<0.502 U	<0.454 U	<0.386 U	**0.456**	<0.443 U
2	mg/kg		<0.439 U	<0.441 U	<0.448 U	<0.496 U	<0.491 U	<0.556 U	<0.427 U	<0.417 U	**0.300 J**	<0.398 U
3	mg/kg		**0.261 J**	<0.420 U	<0.406 U	<0.444 U	**0.309 J**	<0.457 U	**0.354 J**	<0.387 U	<0.388 U	<0.390 U
4	mg/kg		**0.271 J**	<0.482 U	<0.462 U	<0.489 U	**0.299 J**	<0.497 U	<0.437 U	<0.412 U	<0.439 U	<0.446 U
5	mg/kg		<0.418 U	<0.439 U	<0.423 U	<0.478 U	<0.436 U	<0.462 U	<0.425 U	<0.418 U	**0.397 J**	<0.429 U
6	mg/kg		**0.232 J**	<0.462 U	<0.518 U	<0.454 U	<0.501 U	<0.459 U	**0.268 J**	<0.407 U	<0.470 U	<0.435 U
7	mg/kg		**0.273 J**	<0.474 U	<0.456 U	<0.473 U	<0.495 U	<0.531 U	<0.471 U	<0.394 U	<0.455 U	<0.440 U
8	mg/kg		<0.446 U	<0.410 U	<0.432 U	<0.435 U	**0.268 J**	<0.454 U	**0.234 J**	<0.410 U	<0.423 U	<0.406 U
9	mg/kg		**0.266 J**	<0.426 U	<0.445 U	<0.460 U	<0.442 U	<0.503 U	**1.150**	<0.385 U	<0.435 U	<0.457 U
10	mg/kg		**0.346 J**	<0.432 U	<0.407 U	<0.454 U	<0.414 U	<0.460 U	**0.297 J**	<0.416 U	<0.399 U	<0.434 U

Notes:
mg/kg – milligrams per kilogram
Total Cadmium

Table 11
Summary of Calcium Data
Erie County Background Soils Summary Report

Sample	Location		CQM	DMM	ESP	EWM-7	EWM-11	JMA	LCP	MWR	SGM	SMP
	Units											
1	mg/kg		168,000	563	488	177	3,650	734	4,830	311	683	1,020
2	mg/kg		165,000	802	351	271	2,680	1,840	4,360	398	581	1,060
3	mg/kg		182,000	519	392	262	5,740	1,080	3,060	422	426	760
4	mg/kg		131,000	681	538	662	3,880	904	2,510	353	625	1,090
5	mg/kg		106,000	587	398	281	2,720	1,100	7,800	316	776	1,020
6	mg/kg		207,000	971	303	270	6,770	468	4,350	551	320	1,270
7	mg/kg		192,000	532	356	534	4,510	1,070	4,020	322	329	1,150
8	mg/kg		178,000	951	585	229	5,370	794	3,850	310	503	1,050
9	mg/kg		167,000	755	155 J	209	3,840	478	4,520	262	320	922
10	mg/kg		175,000	709	318	470	3,370	2,240	6,860	319	380	916

Notes:
mg/kg – milligrams per kilogram
Total Calcium

Table 12
Summary of Chromium Data
Erie County Background Soils Summary Report

Sample	Location		CQM	DMM	ESP	EWM-7	EWM-11	JMA	LCP	MWR	SGM	SMP
	Units											
1	mg/kg		3.81	6.91	4.86	5.92	13.0	6.72	14.3	5.37	8.32	5.54
2	mg/kg		2.99	10.7	5.01	7.95	9.18	7.90	17.0	4.76	6.13	5.79
3	mg/kg		3.37	7.12	5.56	7.10	9.17	7.30	17.2	5.41	8.33	4.80
4	mg/kg		2.82	11.6	5.77	6.75	10.4	6.75	13.6	5.11	8.97	6.90
5	mg/kg		2.29	8.55	5.99	6.07	10.8	8.28	15.7	4.10	8.93	6.72
6	mg/kg		3.85	13.2	4.42	6.17	18.4	7.85	15.6	4.91	5.96	6.67
7	mg/kg		3.97	7.33	5.55	6.47	13.6	10.8	12.6	5.01	8.15	4.48
8	mg/kg		2.03	12.0	5.59	9.29	12.3	7.53	18.2	4.05	8.21	5.25
9	mg/kg		3.37	10.2	5.30	7.91	12.8	6.98	18.1	4.90	7.55	7.60
10	mg/kg		4.20	9.48	4.24	7.76	9.04	5.96	17.9	5.80	9.07	5.97

Notes:
mg/kg – milligrams per kilogram
Total Chromium

Table 13
Summary of Cobalt Data
Erie County Background Soils Summary Report

Sample	Location		CQM	DMM	ESP	EWM-7	EWM-11	JMA	LCP	MWR	SGM	SMP
	Units											
1	mg/kg		1.150	5.65	32.7	2.92	10.40	7.02	13.40	6.24	7.79	5.57
2	mg/kg		0.902	6.67	24.8	4.79	9.40	5.57	9.67	5.44	6.32	5.73
3	mg/kg		1.100	4.91	20.1	2.85	5.68	10.50	12.90	5.45	8.85	4.44
4	mg/kg		0.990	8.71	30.5	3.49	9.39	11.50	6.18	6.51	6.55	6.88
5	mg/kg		0.504 J	6.02	20.4	5.80	5.72	7.12	10.20	4.58	7.70	8.10
6	mg/kg		1.360	8.79	65.9	2.83	14.90	8.62	9.20	5.35	5.09	5.31
7	mg/kg		1.320	5.22	16.6	4.30	12.30	6.68	8.49	5.71	6.75	5.81
8	mg/kg		0.495 J	7.17	16.6	3.74	8.21	7.81	9.49	5.39	6.90	5.32
9	mg/kg		0.914	7.30	27.3	4.31	9.84	4.60	9.00	6.39	7.49	5.62
10	mg/kg		1.240	7.27	25.9	5.23	9.45	6.77	11.20	5.85	6.38	6.05

Notes:
mg/kg – milligrams per kilogram
Total Cobalt

Table 14
Summary of Copper Data
Erie County Background Soils Summary Report

Sample	Location		CQM	DMM	ESP	EWM-7	EWM-11	JMA	LCP	MWR	SGM	SMP
	Units											
1	mg/kg		4.76	7.05	26.0	13.7	17.4	17.3	22.1	10.8	15.3	8.71
2	mg/kg		3.45	14.8	28.9	17.3	18.5	8.80	30.4	9.20	15.2	8.99
3	mg/kg		4.26	6.63	21.9	11.2	19.5	13.0	27.4	10.6	17.2	7.59
4	mg/kg		4.68	15.1	29.3	12.4	19.8	15.3	14.4	11.1	15.4	12.70
5	mg/kg		1.84	10.2	27.2	9.27	18.9	18.3	20.0	7.60	16.7	12.80
6	mg/kg		5.10	19.8	35.1	10.3	25.7	16.6	28.0	8.71	11.4	9.91
7	mg/kg		5.08	9.34	30.5	14.6	42.0	19.2	19.6	10.3	16.5	7.46
8	mg/kg		1.63	15.9	29.4	15.0	22.8	11.3	30.0	8.72	17.4	8.16
9	mg/kg		3.54	12.2	26.0	15.1	22.2	9.96	35.2	9.00	15.4	14.10
10	mg/kg		5.18	11.1	19.9	14.6	14.2	12.9	27.0	12.5	18.5	9.55

Notes:
mg/kg – milligrams per kilogram
Total Copper

Table 15
Summary of Iron Data
Erie County Background Soils Summary Report

Sample	Location		CQM	DMM	ESP	EWM-7	EWM-11	JMA	LCP	MWR	SGM	SMP
	Units											
1	mg/kg		2,960	8,990	17,300	23,800	29,800	14,100	19,000	12,200	1,6400	8,290
2	mg/kg		1,940	15,100	18,800	18,800	21,300	10,500	19,800	11,400	12,700	8,580
3	mg/kg		2,540	8,990	16,700	15,200	16,200	10,300	22,700	11,000	17,000	7,200
4	mg/kg		2,180	15,100	18,700	17,000	20,600	9,370	16,600	12,500	16,800	10,600
5	mg/kg		1,290	11,400	19,900	12,100	22,200	13,900	21,400	9,250	18,500	10,600
6	mg/kg		2,970	18,500	20,400	17,000	35,300	13,500	22,400	10,200	12,000	9,800
7	mg/kg		2,930	10,200	18,900	16,200	29,000	17,000	14,900	11,700	16,300	6,400
8	mg/kg		999	16,400	17,600	19,600	23,700	10,800	21,100	10,000	18,300	7,660
9	mg/kg		2,080	13,200	19,500	16,200	23,800	9,410	21,800	11,200	15,400	11,700
10	mg/kg		2,720	12,500	13,900	15,400	26,600	9,480	21,900	12,300	17,400	9,090

Notes:
mg/kg – milligrams per kilogram
Total Iron

Table 16
Summary of Lead Data
Erie County Background Soils Summary Report

Sample	Location		CQM	DMM	ESP	EWM-7	EWM-11	JMA	LCP	MWR	SGM	SMP
	Units											
1	mg/kg		13.5	10.1	18.8	14.3	10.6	13.5	33.5	6.32	13.9	11.2
2	mg/kg		12.7	9.22	13.9	11.7	15.3	16.3	32.6	9.43	14.9	10.3
3	mg/kg		15.6	8.46	12.0	16.0	51.3	32.5	22.1	10.5	15.0	9.45
4	mg/kg		26.2	11.0	18.8	21.8	12.2	27.0	25.7	8.36	11.5	11.3
5	mg/kg		11.9	11.9	17.7	11.6	13.4	21.9	22.9	9.71	26.4	10.7
6	mg/kg		14.8	10.6	17.2	19.3	17.3	18.4	22.8	13.5	15.2	11.2
7	mg/kg		13.4	8.17	12.4	13.4	18.9	17.2	31.0	5.92	14.1	17.4
8	mg/kg		10.9	10.4	15.6	17.7	21.3	23.5	21.0	8.70	11.9	9.85
9	mg/kg		11.1	9.05	22.1	14.0	25.8	9.85	38.3	7.89	11.4	14.0
10	mg/kg		15.6	9.07	15.3	17.4	7.78	26.1	23.4	10.9	14.5	9.33

Notes:
mg/kg – milligrams per kilogram
Total Lead

Table 17
Summary of Magnesium Data
Erie County Background Soils Summary Report

Sample	Location		CQM	DMM	ESP	EWM-7	EWM-11	JMA	LCP	MWR	SGM	SMP
	Units											
1	mg/kg		77,300	897	338	372	1,710	885	3,670	988	1,010	599
2	mg/kg		79,100	1,620	216	677	1,280	1,340	3,340	718	722	621
3	mg/kg		85,800	928	359	711	1,270	913	4,090	972	997	424
4	mg/kg		5,9000	1,790	375	573	1,400	837	3,220	795	1,060	761
5	mg/kg		5,3100	1,250	397	710	1,380	1,190	4,790	590	946	707
6	mg/kg		96,900	2,210	329	480	2,780	961	3,910	787	694	657
7	mg/kg		89,600	1,040	400	617	2,440	1,890	3,040	912	900	434
8	mg/kg		97,700	1,880	407	820	1,780	941	3,470	576	931	507
9	mg/kg		81,500	1,460	278	748	1,540	1,170	3,620	920	811	921
10	mg/kg		83,000	1,360	312	769	1,180	860	5,930	1,060	941	625

Notes:
mg/kg – milligrams per kilogram
Total Magnesium

Table 18
Summary of Manganese Data
Erie County Background Soils Summary Report

Sample	Location		CQM	DMM	ESP	EWM-7	EWM-11	JMA	LCP	MWR	SGM	SMP
	Units											
1	mg/kg		120	521	703	117	634	200	246	252	501	406
2	mg/kg		93.6	340	747	150	440	170	196	353	460	368
3	mg/kg		108	385	542	82.2	633	558	1,110	269	443	273
4	mg/kg		87.7	402	821	164	1,140	614	133	322	341	353
5	mg/kg		63.2	429	597	202	205	205	371	258	732	548
6	mg/kg		124	370	1130	104	1,250	258	306	488	358	353
7	mg/kg		121	347	481	179	1,140	153	269	251	330	731
8	mg/kg		92.6	317	528	113	832	257	266	280	260	489
9	mg/kg		102	334	594	144	1,160	119	263	448	337	285
10	mg/kg		122	406	594	191	596	378	514	225	284	366

Notes:
mg/kg – milligrams per kilogram
Total Manganese

Table 19
Summary of Mercury Data
Erie County Background Soils Summary Report

Sample	Location		CQM	DMM	ESP	EWM-7	EWM-11	JMA	LCP	MWR	SGM	SMP
	Units											
1	mg/kg		0.0174 J	0.0326 J	0.0456 J	0.0499 J	0.0593 J	0.0225 J	0.0470 J	0.0171 J	0.0297 J	0.0325 J
2	mg/kg		0.0163 J	0.0199 J	0.0611 J	0.0264 J	0.0513 J	0.371 U	0.0381 J	0.0229 J	0.0383 J	0.0343 J
3	mg/kg		0.0224 J	0.0212 J	0.0384 J	0.0232 J	0.0586 J	0.0489 J	0.0412 J	0.0239 J	0.0328 J	0.0263 J
4	mg/kg		0.0256 J	0.0288 J	0.0416 J	0.0356 J	0.0648 J	0.0441 J	0.0525 J	0.0186 J	0.0433 J	0.0399 J
5	mg/kg		0.0137 J	0.0246 J	0.0342 J	0.0309 J	0.0298 J	0.0285 J	0.0309 J	0.0157 J	0.0478 J	0.0439 J
6	mg/kg		0.0170 J	0.0220 J	0.0628 J	0.0273 J	0.0576 J	0.0244 J	0.0390 J	0.0322 J	0.0357 J	0.0385 J
7	mg/kg		0.0183 J	0.0217 J	0.0469 J	0.0508 J	0.0744 J	0.0238 J	0.0409 J	0.0162 J	0.0314 J	0.0407 J
8	mg/kg		0.0251 J	0.0185 J	0.0407 J	0.0285 J	0.0693 J	0.0486 J	0.0437 J	0.0137 J	0.0410 J	0.0401 J
9	mg/kg		0.0147 J	0.0264 J	0.0472 J	0.0299 J	0.0889 J	0.329 U	0.0493 J	0.0176 J	0.0287 J	0.0447 J
10	mg/kg		0.0212 J	0.0209 J	0.0366 J	0.0329 J	0.0222 J	0.0598 J	0.0512 J	0.0177 J	0.0281 J	0.0346 J

Notes:
mg/kg – milligrams per kilogram
Total Mercury

Table 20
Summary of Molybdenum Data
Erie County Background Soils Summary Report

Sample	Location		CQM	DMM	ESP	EWM-7	EWM-11	JMA	LCP	MWR	SGM	SMP
	Units											
1	mg/kg		<4.57 U	<4.44 U	**17.1**	**25.7**	<4.39 U	**27.1**	<4.54 U	**6.00**	**4.02 J**	<4.43 U
2	mg/kg		<4.39 U	<4.41 U	**21.5**	**40.4**	<4.91 U	<5.56 U	<4.27 U	**5.88**	**3.34 J**	<3.98 U
3	mg/kg		<4.27 U	<4.20 U	**15.4**	**29.3**	<4.72 U	**8.27**	<4.42 U	**5.31**	**4.34 J**	<3.90 U
4	mg/kg		<4.90 U	<4.82 U	**19.1**	**31.2**	<4.29 U	**5.69**	<4.37 U	**6.78**	**3.83 J**	<4.46 U
5	mg/kg		<4.18 U	<4.39 U	**20.1**	**17.9**	<4.36 U	**21.2**	<4.25 U	**4.46**	**4.01 J**	<4.29 U
6	mg/kg		<4.11 U	**2.59 J**	**19.4**	**29.9**	**2.51 J**	**17.8**	<4.44 U	**4.73**	**3.06 J**	<4.35 U
7	mg/kg		<4.57 U	<4.74 U	**19.6**	**33.2**	<4.95 U	**16.0**	<4.71 U	**6.40**	**4.20 J**	<4.40 U
8	mg/kg		<4.46 U	**2.18 J**	**24.3**	**30.4**	<4.60 U	**12.7**	<4.45 U	**5.64**	**4.68 J**	<4.06 U
9	mg/kg		<4.15 U	<4.26 U	**18.3**	**29.6**	<4.42 U	**6.77**	<9.37 U	**5.33**	**4.09 J**	<4.57 U
10	mg/kg		<4.51 U	<4.32 U	**12.8**	**35.4**	<4.14 U	**13.3**	<4.41 U	**6.48**	**4.53 J**	<4.34 U

Notes:
mg/kg – milligrams per kilogram
Total Molybdenum

Table 21
Summary of Nickel Data
Erie County Background Soils Summary Report

Sample	Location		CQM	DMM	ESP	EWM-7	EWM-11	JMA	LCP	MWR	SGM	SMP
	Units											
1	mg/kg		6.51	8.18	14.0	8.42	17.4	13.2	19.3	15.8	18.20	5.58
2	mg/kg		5.26	14.60	15.0	10.20	13.3	10.8	19.0	13.1	10.20	5.68
3	mg/kg		6.37	9.48	11.3	7.20	12.6	14.3	41.3	14.2	11.70	3.93
4	mg/kg		5.26	15.90	18.3	7.42	16.6	13.6	17.6	15.9	11.80	7.45
5	mg/kg		3.32	11.00	15.0	10.50	12.3	14.2	23.5	11.0	12.90	7.73
6	mg/kg		7.35	19.90	20.6	6.36	26.2	11.1	20.5	12.8	9.02	5.85
7	mg/kg		7.10	9.48	14.1	9.61	25.2	17.1	18.4	14.4	11.10	5.19
8	mg/kg		3.35	15.70	14.8	9.01	18.0	12.0	19.6	12.3	11.40	5.11
9	mg/kg		5.58	13.00	12.6	10.90	16.1	10.3	21.9	14.3	10.40	8.34
10	mg/kg		6.94	12.20	11.2	11.20	12.4	11.0	26.9	14.8	11.20	5.92

Notes:
mg/kg – milligrams per kilogram
Total Nickel

Table 22
Summary of Potassium Data
Erie County Background Soils Summary Report

Sample	Location		CQM	DMM	ESP	EWM-7	EWM-11	JMA	LCP	MWR	SGM	SMP
	Units											
1	mg/kg		332	295	294	380	918	363	723	251	309	117
2	mg/kg		223	434	235	694	781	521	,1140	207	218	120
3	mg/kg		218	325	288	614	915	475	847	216	306	119
4	mg/kg		183	640	387	442	662	479	599	204	314	123
5	mg/kg		115	394	292	402	704	563	956	145	349	164
6	mg/kg		242	561	343	375	1,420	461	956	243	276	155
7	mg/kg		315	298	404	446	856	468	661	223	293	109
8	mg/kg		352	452	313	661	966	434	1,210	152	284	121
9	mg/kg		262	584	257	561	1,060	294	1,400	198	240	249
10	mg/kg		837	455	247	569	628	436	1,150	233	298	125

Notes:
mg/kg – milligrams per kilogram
Total Potassium

Table 23
Summary of Selenium Data
Erie County Background Soils Summary Report

Sample	Location		CQM	DMM	ESP	EWM-7	EWM-11	JMA	LCP	MWR	SGM	SMP
	Units											
1	mg/kg		0.384	0.304	0.511	0.871	0.663	0.156 J	0.788	0.160 J	0.492	0.257
2	mg/kg		0.393	0.294	0.811	0.444	0.925	0.160 J	0.816	0.217 J	0.788	0.342
3	mg/kg		0.374	0.383	0.791	0.360	1.040	0.398	0.574	0.205 J	0.463	0.229 J
4	mg/kg		0.495	0.464	0.535	0.282	1.400	0.381	0.895	0.167 J	0.613	0.240 J
5	mg/kg		0.302	0.412	0.468	0.358	0.659	0.219 J	0.671	0.219 U	0.632	0.272
6	mg/kg		0.366	0.424	0.385	0.229	1.110	0.211 J	0.625	0.202 J	0.484	0.336
7	mg/kg		0.355	0.253	0.300	0.590	1.240	0.157 J	0.619	0.110 J	0.486	0.393
8	mg/kg		0.400	0.419	0.358	0.425	1.460	0.305	0.596	0.200 J	0.432	0.236 J
9	mg/kg		0.364	0.402	0.426	0.454	1.170	0.133 J	0.856	0.125 J	0.533	0.367
10	mg/kg		0.437	0.265	0.413	0.581	0.557	0.416	0.677	0.198 J	0.499	0.274

Notes:
mg/kg – milligrams per kilogram
Total Selenium

Table 24
Summary of Sodium Data
Erie County Background Soils Summary Report

Sample	Location		CQM	DMM	ESP	EWM-7	EWM-11	JMA	LCP	MWR	SGM	SMP
	Units											
1	mg/kg		71.2	12.3 J	11.9	14.2 J	103.0	13.3 J	38.9	15.3 J	14.5 J	<22.1 U
2	mg/kg		64.4	16.7 J	<22.4 U	23.5 J	71.7	14.6 J	44.2	11.9 J	13.7	11.4
3	mg/kg		72.3	18.1 J	<20.3 U	22.9	106.0	18.0 J	50.7	14.1 J	13.5	10.2
4	mg/kg		49.4	21.2 J	17.2	17.8 J	107.0	18.9 J	35.5	12.3 J	13.4	<22.3 U
5	mg/kg		45.7	16.6 J	13.1	17.8 J	96.2	17.3 J	46.6	<20.9 U	38.8	<21.4 U
6	mg/kg		73.8	18.3 J	18.5	14.8 J	170.0	16.6 J	38.2	13.7 J	<23.5 U	<21.8 U
7	mg/kg		76.4	12.6 J	13.6	17. 7J	118.0	16.3 J	34.2	13.3 J	19.9	11.8
8	mg/kg		92.5	14.3 J	13.9	20.9 J	110.0	17.7 J	35.2	<20.5 U	24.5	10.2
9	mg/kg		75.4	21.8 J	<22.3 U	18.0 J	107.0	<25.1 U	43.6 J	13.4 J	12.6	<22.8 U
10	mg/kg		75.9	16.1 J	11.0	20.3 J	108.0	14.8 J	50.7	14.6 J	12.9 J	11.9

Notes:
mg/kg – milligrams per kilogram
Total Sodium

Table 25
Summary of Thallium Data
Erie County Background Soils Summary Report

Sample	Location		CQM	DMM	ESP	EWM-7	EWM-11	JMA	LCP	MWR	SGM	SMP
	Units											
1	mg/kg		0.185	0.1190	0.372	1.110	0.154	0.1930	0.299	0.0449	0.241	0.0973
2	mg/kg		0.204	0.0931	0.391	0.461	0.141	0.0654	0.267	0.0612	0.212	0.0971
3	mg/kg		0.202	0.0916	0.539	0.587	0.143	0.1500	0.274	0.0629	0.230	0.0875
4	mg/kg		0.229	0.1580	0.219	0.330	0.162	0.1300	0.261	0.0463	0.245	0.0885
5	mg/kg		0.171	0.1720	0.314	0.388	0.141	0.1340	0.329	0.0470	0.284	0.0638
6	mg/kg		0.201	0.2070	0.631	0.429	0.189	0.1690	0.246	0.0694	0.324	0.0788
7	mg/kg		0.166	0.0716	0.270	0.705	0.164	0.1060	0.234	0.0463	0.247	0.0901
8	mg/kg		0.139	0.1790	0.312	0.499	0.166	0.1400	0.253	0.0790	0.237	0.0562
9	mg/kg		0.168	0.1250	0.558	0.484	0.175	0.0827	0.279	0.0508	0.245	0.0980
10	mg/kg		0.200	0.1560	0.279	0.486	0.121	0.1030	0.280	0.0625	0.246	0.0699

Notes:
mg/kg – milligrams per kilogram
Total Thallium

Table 26
Summary of Vanadium Data
Erie County Background Soils Summary Report

Sample	Location		CQM	DMM	ESP	EWM-7	EWM-11	JMA	LCP	MWR	SGM	SMP
	Units											
1	mg/kg		5.17	10.7	10.7	11.4	20.2	9.32	18.1	8.91	15.9	11.30
2	mg/kg		4.12	16.9	11.5	17.0	14.6	11.40	20.2	8.07	12.1	10.90
3	mg/kg		4.57	11.4	10.5	14.9	15.0	11.00	21.8	7.86	15.9	9.55
4	mg/kg		3.63	18.1	11.9	15.5	16.9	10.00	15.0	8.94	15.3	13.10
5	mg/kg		2.51	13.3	11.7	12.8	18.1	13.60	19.8	6.98	16.8	13.20
6	mg/kg		5.33	19.7	8.17	13.6	28.1	12.20	21.2	7.09	11.9	13.60
7	mg/kg		5.47	11.8	10.5	13.4	16.9	12.90	16.4	8.46	15.8	7.79
8	mg/kg		5.04	17.9	11.2	16.3	18.7	12.40	23.4	7.11	15.2	9.59
9	mg/kg		4.78	15.8	11.5	15.3	19.7	10.50	22.1	8.69	14.3	14.10
10	mg/kg		5.74	14.6	10.0	15.3	14.9	9.85	23.1	8.21	15.9	11.20

Notes:
mg/kg – milligrams per kilogram
Total Vanadium

Table 27
Summary of Zinc Data
Erie County Background Soils Summary Report

Sample	Location		CQM	DMM	ESP	EWM-7	EWM-11	JMA	LCP	MWR	SGM	SMP
	Units											
1	mg/kg		31.1	21.1	33.6	11.4	20.2	29.2	18.1	36.5	55.8	17.5
2	mg/kg		24.2	31.9	30.4	17.0	14.6	31.4	20.2	34.3	39.9	16.3
3	mg/kg		32.1	22.7	29.4	14.9	15.0	44.6	21.8	37.7	48.0	13.4
4	mg/kg		30.8	35.6	42.0	15.5	16.9	48.8	15.0	37.0	41.1	20.9
5	mg/kg		13.6	26.8	39.8	12.8	18.1	35.0	19.8	26.9	49.6	21.0
6	mg/kg		33.5	40.4	48.6	13.6	28.1	29.5	21.2	38.2	34.9	17.9
7	mg/kg		35.7	22.8	40.7	13.4	16.9	36.9	16.4	36.1	44.5	16.8
8	mg/kg		19.6	35.0	43.7	16.3	18.7	32.7	23.4	29.6	45.7	15.2
9	mg/kg		27.9	29.0	27.9	15.3	19.7	22.7	22.1	35.5	42.4	25.8
10	mg/kg		39.2	27.2	24.1	15.3	14.9	28.1	23.1	38.7	46.6	17.7

Notes:
mg/kg – milligrams per kilogram
Total Zinc