1.0 INTRODUCTION

On January 24, 2017, the United States Environmental Protection Agency (EPA) Region 3, Office of Air Protection Division Office of Air Enforcement and Compliance (APD OAECA) requested that the Agency for Toxic Substances and Disease Registry (ATSDR) conduct a public health evaluation of the community's current exposures to lead in air near the operating American Zinc Recycling LLC (AZR), formerly Horsehead, facility in Palmerton, Carbon County, Pennsylvania, and summarize available childhood blood lead information for this community.

According to ATSDR, the July 31, 2018 Letter Health Consultation (LHC) "represents ATSDR's conclusions and recommendations regarding the National Ambient Air Quality Standard (NAAQS) monitoring results for lead and collaborative efforts with EPA Region 3 to evaluate air dispersion modeling for the American Zinc Recycling Palmerton facility in Palmerton, PA." In the LHC, ATSDR concluded that "based on preliminary spatial analysis of EPA's air modeling results and available state monitoring data, that a public health hazard is likely for young children and/or pregnant women living within 3 miles of the American Zinc Recycling facility in Palmerton from exposures to lead in outdoor air." ATSDR made several recommendations in the LHC.

The Pennsylvania Department of Environmental Protection (PADEP) developed a Sampling and Analysis Plan (SAP) dated September 21, 2018. The SAP is focused on ATSDR's recommendation to "sample surface soil and/or conduct an X-Ray Fluorescence (XRF) survey of area(s) identified from the AERMOD and particle deposition modeling with highest modeled ground level air concentrations."

The XRF soil screening and surface soil sampling were conducted on October 16-17, 2018.

1.1 Site Location

The site is located within the Borough of Palmerton, in Carbon County, Pennsylvania, as shown on **Figure 1**. The geographic coordinates of the approximate center of the site are 40.8031^{o} north latitude and -75.6119^{o} west longitude. Palmerton is located at the junction of the Lehigh River and Aquashicola Creek and occupies a narrow valley bounded on the south by Blue Mountain and on the north by Stoney Ridge. Approximately 850 people live within one mile of the site, while the population of the entire Borough of Palmerton is approximately 5,000.

1.2 Site Description

AZR is an electric arc furnace (EAF) dust recycling facility located in Palmerton, PA. The facility is owned by AZR and operates four horizontal kilns. Two (2) are designated Waelz kilns, one is a dedicated calcine kiln, and the fourth can be utilized for Waelzing or calcining. EAF dust is heated in the Waelz kiln to high temperatures, volatilizing metals for recovery as Zn-rich Waelz Oxide and iron-rich material (IRM) slag. Waelz-Oxide is further refined in the calcine kiln(s) to produce zinc calcine and lead chloride concentrate material. Due to the

chemical composition of EAF dust and combustion reactions, each kiln emits criteria pollutants and heavy metals, including lead, zinc, nickel, cadmium and chromium.

The XRF screening and sampling assessment was limited to properties currently zoned for residential or other public use (i.e. schools, child day care, parks, etc.). Commercial, industrial, and undeveloped land were not included as part of this sampling assessment. The sampling locations were developed in conjunction with Pennsylvania Department of Health (PADOH), ATSDR, EPA and PADEP. XRF screening and surface soil sampling were conducted at the following locations:

TABLE 1
SAMPLING LOCATIONS

Name	Address
Salem United Methodist Church	4145 Forest Inn Road
West End Day Care	880 Mauch Chunk Road
Palmerton Junior/Senior High School	3525-3529 Fireline Road
Palmerton Borough Park	301 Delaware Avenue
7th Street Athletic Field	701-719 Delaware Avenue
Elmer Valo Field	415-425 3rd Street
Palmerton Memorial Park	1255 & 1265 North 3rd Street
Stoney Ridge P.A.R.C.	1540-1770 Fireline Road
Bowmanstown/Palmerton BB/SB Association (BPBSA) Field	Fireline Road & Golf Road
SS Palmer Elementary Playground	298 Lafayette Avenue

1.3 Geologic Setting

The Geologic Map of Pennsylvania, 1980, indicates the geologic settings for the following locations within the XRF screening and sampling assessment:

Name	Geologic Formation
Salem United Methodist Church	Ridgeley Formation through Coeymans Formation, undivided
West End Day Care	Bloomsburg Formation
Palmerton Junior/Senior High School	Marcellus Formation
Palmerton Borough Park	Bloomsburg Formation (south portion of park) Decker Formation through Poxono Island Formation, undivided (north portion of park)
7th Street Athletic Field	Bloomsburg Formation (south portion of field) Decker Formation through Poxono Island Formation, undivided (north portion of field)
Elmer Valo Field	Bloomsburg Formation
Palmerton Memorial Park	Marcellus Formation
Stoney Ridge P.A.R.C.	Mahantango Formation
BPBSA Field	Marcellus Formation
SS Palmer Elementary Playground	Bloomsburg Formation

Bloomsburg Formation - grayish-red and greenish-gray shale, siltstone, and very fine to coarse-grained sandstone, some calcareous mudstone in central Pennsylvania; thins to west and is replaced by Mifflintown beds; thickens eastward, replacing overlying Wills Creek and Tonoloway Formations and underlying Mifflintown Formation.

Decker Formation through Poxono Island Formation, undivided - in descending order; Decker Formation - gray calcareous sandstone having lenses of calcareous conglomerate siltstone, and shale, and lenses of limestone and dolomite (in Stroudsburg area, includes calcareous shale, limestone, and dolomite of Rondout Formation at top); Bossardville Limestone - gray argillaceous limestone and dolomitic limestone; Poxono Island Formation - thin-bedded dolomite, limestone, and shale; red shale in lower part. This undivided succession is equivalent to Keyser, Tonoloway, and Wills Creek (part) Formations of central Pennsylvania.

Mahantango Formation - gray, brown, and olive shale and siltstone; marine fossils. Includes the following members, in descending order: Tully-argillaceous limestone; Sherman Ridge, Montebello (sandstone); Fisher Ridge, Dalmatia, and Turkey Ridge. In south-central Pennsylvania, includes Clearville, Frame, Chaneysville, and Gander Run Members. Characterized by coarsening-upward cycles.

Marcellus Formation - black shale, sparse marine fauna and siderite concretions. Contains local limestone (Purcell) member. Tioga bentonite included at base in eastern Pennsylvania.

Ridgeley Formation through Coeymans Formation, undivided - in descending order; Ridgeley Formation - white siliceous sandstone; Shriver Chert - gray siltstone and shale and dark-gray chert; Port Ewen Shale - dark-gray calcareous siltstone and shale; Minisink Limestone - dark-gray clayey limestone; New Scotland Formation - dark-gray fossiliferous shale and clayey limestone; Coeymans Formation - gray, clayey to sandy limestone.

The Soil Survey provided by the National Resource Conservation Service, indicates the soil type for the following locations within the XRF soil screening and surface soil sampling assessment:

Name	**Geologic Formation**
Salem United Methodist Church	Hy—Holly silt loam
West End Day Care	Ma—Made land
Palmerton Junior/Senior High School	BwA—Berks-Weikert channery silt loam, 0 to 3 percent slopes (northwest) HaB2—Hartleton channery silt loam, 3 to 8 percent slopes, moderately eroded (southwest and northeast) HaA—Hartleton channery silt loam, 0 to 3 percent slopes (remainder of site)
Palmerton Borough Park	MdA—Middlebury silt loam, 0 to 3 percent slopes
7th Street Athletic Field	MdA—Middlebury silt loam, 0 to 3 percent slopes

Elmer Valo Field (aka. 3rd Street Recreational Field)	MdA—Middlebury silt loam, 0 to 3 percent slopes (north) LeC3—Leck Kill channery silt loam, 8 to 15 percent slopes, severely eroded (south)
Palmerton Memorial Park	ShA—Shelmadine silt loam, 0 to 3 percent slopes (northwest and east) SmB—Shelmadine very stony silt loam, 0 to 8 percent slopes (pool area) CoD—Comly very stony silt loam, 8 to 25 percent slopes (south)
Stoney Ridge P.A.R.C.	CoB—Comly very stony silt loam, 0 to 8 percent slopes (south) SmB—Shelmadine very stony silt loam, 0 to 8 percent slopes (north)
BPBSA Field	CmA—Comly silt loam, 0 to 3 percent slopes (north) CmB2—Comly silt loam, 3 to 8 percent slopes, moderately eroded (south)
SS Palmer Elementary Playground	WaB2—Watson gravelly silt loam, 0 to 8 percent slopes, moderately eroded

BwA—Berks-Weikert channery silt loam, 0 to 3 percent slopes

Description of Berks

Typical profile

- *Ap - 0 to 7 inches:* channery silt loam
- *Bw1 - 7 to 14 inches:* very channery silt loam
- *Bw2 - 14 to 21 inches:* extremely channery silt loam
- *C - 21 to 36 inches:* extremely channery silt loam
- *R - 36 to 46 inches:* bedrock

Properties and qualities

- *Slope:* 0 to 3 percent
- *Depth to restrictive feature:* 20 to 40 inches to lithic bedrock
- *Natural drainage class:* Well drained
- *Runoff class:* Medium
- *Capacity of the most limiting layer to transmit water (Ksat):* Moderately low to high (0.06 to 5.95 in/hr)
- *Depth to water table:* More than 80 inches
- *Frequency of flooding:* None
- *Frequency of ponding:* None
- *Calcium carbonate, maximum in profile:* 1 percent
- *Gypsum, maximum in profile:* 1 percent
- *Salinity, maximum in profile:* Nonsaline (0.0 to 1.0 mmhos/cm)
- *Sodium adsorption ratio, maximum in profile:* 1.0
- *Available water storage in profile:* Very low (about 2.9 inches)

Description of Weikert

Typical profile

- *Ap - 0 to 7 inches:* channery silt loam
- *Bw - 7 to 10 inches:* extremely channery silt loam
- *C - 10 to 15 inches:* extremely channery silt loam
- *R - 15 to 25 inches:* bedrock

Properties and qualities

- *Slope:* 0 to 3 percent
- *Depth to restrictive feature:* 10 to 20 inches to lithic bedrock
- *Natural drainage class:* Somewhat excessively drained
- *Runoff class:* Medium
- *Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to very high (0.28 to 19.98 in/hr)
- *Depth to water table:* More than 80 inches
- *Frequency of flooding:* None
- *Frequency of ponding:* None
- *Salinity, maximum in profile:* Nonsaline (0.0 to 1.0 mmhos/cm)
- *Available water storage in profile:* Very low (about 1.4 inches)

CmA—Comly silt loam, 0 to 3 percent slopes

Typical profile

- *H1 - 0 to 11 inches:* silt loam
- *H2 - 11 to 20 inches:* silty clay loam
- *H3 - 20 to 62 inches:* channery loam
- *H4 - 62 to 66 inches:* weathered bedrock

Properties and qualities

- *Slope:* 0 to 3 percent
- *Depth to restrictive feature:* 15 to 24 inches to fragipan
- *Natural drainage class:* Moderately well drained
- *Runoff class:* Low
- *Capacity of the most limiting layer to transmit water (Ksat):* Moderately high (0.20 to 0.60 in/hr)
- *Depth to water table:* About 12 to 30 inches
- *Frequency of flooding:* None
- *Frequency of ponding:* None
- *Available water storage in profile:* Low (about 3.3 inches)

CmB2—Comly silt loam, 3 to 8 percent slopes, moderately eroded

Typical profile

- *H1 - 0 to 11 inches:* silt loam
- *H2 - 11 to 20 inches:* silty clay loam
- *H3 - 20 to 62 inches:* channery loam
- *H4 - 62 to 66 inches:* weathered bedrock

Properties and qualities

- *Slope:* 3 to 8 percent
- *Depth to restrictive feature:* 15 to 24 inches to fragipan
- *Natural drainage class:* Moderately well drained
- *Runoff class:* Medium
- *Capacity of the most limiting layer to transmit water (Ksat):* Moderately high (0.20 to 0.60 in/hr)
- *Depth to water table:* About 12 to 30 inches
- *Frequency of flooding:* None
- *Frequency of ponding:* None
- *Available water storage in profile:* Low (about 3.3 inches)

CoB—Comly very stony silt loam, 0 to 8 percent slopes

Typical profile

- *H1 - 0 to 11 inches:* very stony silt loam
- *H2 - 11 to 20 inches:* silty clay loam
- *H3 - 20 to 62 inches:* channery loam
- *H4 - 62 to 66 inches:* weathered bedrock

Properties and qualities

- *Slope:* 0 to 8 percent
- *Percent of area covered with surface fragments:* 1.6 percent
- *Depth to restrictive feature:* 15 to 24 inches to fragipan
- *Natural drainage class:* Moderately well drained
- *Runoff class:* Low
- *Capacity of the most limiting layer to transmit water (Ksat):* Moderately high (0.20 to 0.60 in/hr)
- *Depth to water table:* About 12 to 30 inches
- *Frequency of flooding:* None
- *Frequency of ponding:* None
- *Available water storage in profile:* Low (about 3.1 inches)

CoD—Comly very stony silt loam, 8 to 25 percent slopes

Typical profile

- *H1 - 0 to 11 inches:* very stony silt loam
- *H2 - 11 to 20 inches:* silty clay loam
- *H3 - 20 to 62 inches:* channery loam
- *H4 - 62 to 66 inches:* weathered bedrock

Properties and qualities

- *Slope:* 8 to 25 percent
- *Percent of area covered with surface fragments:* 1.6 percent
- *Depth to restrictive feature:* 15 to 24 inches to fragipan
- *Natural drainage class:* Moderately well drained
- *Runoff class:* Medium
- *Capacity of the most limiting layer to transmit water (Ksat):* Moderately high (0.20 to 0.60 in/hr)
- *Depth to water table:* About 12 to 30 inches
- *Frequency of flooding:* None
- *Frequency of ponding:* None
- *Available water storage in profile:* Low (about 3.1 inches)

HaA—Hartleton channery silt loam, 0 to 3 percent slopes

Typical profile

- *H1 - 0 to 8 inches:* channery silt loam
- *H2 - 8 to 32 inches:* very channery loam
- *H3 - 32 to 58 inches:* very channery loam
- *R - 58 to 76 inches:* weathered bedrock

Properties and qualities

- *Slope:* 0 to 3 percent
- *Depth to restrictive feature:* 48 to 96 inches to lithic bedrock
- *Natural drainage class:* Well drained
- *Runoff class:* Very low
- *Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.60 to 6.00 in/hr)
- *Depth to water table:* More than 80 inches
- *Frequency of flooding:* None
- *Frequency of ponding:* None
- *Available water storage in profile:* Low (about 4.4 inches)

HaB2—Hartleton channery silt loam, 3 to 8 percent slopes, moderately eroded

Typical profile

- *H1 - 0 to 8 inches:* channery silt loam
- *H2 - 8 to 32 inches:* very channery loam
- *H3 - 32 to 58 inches:* very channery loam
- *R - 58 to 76 inches:* weathered bedrock

Properties and qualities

- *Slope:* 3 to 8 percent
- *Depth to restrictive feature:* 48 to 96 inches to lithic bedrock
- *Natural drainage class:* Well drained
- *Runoff class:* Low
- *Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.60 to 6.00 in/hr)
- *Depth to water table:* More than 80 inches
- *Frequency of flooding:* None
- *Frequency of ponding:* None
- *Available water storage in profile:* Low (about 4.4 inches

Hy—Holly silt loam

Typical profile

- *H1 - 0 to 8 inches:* silt loam
- *H2 - 8 to 24 inches:* silt loam
- *H3 - 24 to 40 inches:* sandy loam
- *H4 - 40 to 60 inches:* stratified gravelly sand to silt loam

Properties and qualities

- *Slope:* 0 to 3 percent
- *Depth to restrictive feature:* More than 80 inches
- *Natural drainage class:* Poorly drained
- *Runoff class:* Very high
- *Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.20 to 2.00 in/hr)
- *Depth to water table:* About 0 to 12 inches
- *Frequency of flooding:* Frequent
- *Frequency of ponding:* None
- *Available water storage in profile:* High (about 9.8 inches)

LeC3—Leck Kill channery silt loam, 8 to 15 percent slopes, severely eroded

Typical profile

- *H1 - 0 to 8 inches:* channery silt loam
- *H2 - 8 to 25 inches:* channery silt loam
- *H3 - 25 to 32 inches:* very channery silt loam
- *R - 32 to 36 inches:* unweathered bedrock

Properties and qualities

- *Slope:* 8 to 15 percent
- *Depth to restrictive feature:* 20 to 40 inches to lithic bedrock
- *Natural drainage class:* Well drained
- *Runoff class:* Medium
- *Capacity of the most limiting layer to transmit water (Ksat):* High (2.00 to 6.00 in/hr)
- *Depth to water table:* More than 80 inches
- *Frequency of flooding:* None
- *Frequency of ponding:* None
- *Available water storage in profile:* Low (about 3.6 inches)

Ma—Made land

Typical profile

- *C - 0 to 65 inches:* extremely channery silt loam

Properties and qualities

- *Slope:* 0 to 8 percent
- *Depth to restrictive feature:* More than 80 inches
- *Natural drainage class:* Well drained
- *Runoff class:* Medium
- *Capacity of the most limiting layer to transmit water (Ksat):* Moderately high (0.20 to 0.60 in/hr)
- *Depth to water table:* More than 80 inches
- *Frequency of flooding:* None
- *Frequency of ponding:* None
- *Available water storage in profile:* Low (about 4.2 inches)

MdA—Middlebury silt loam, 0 to 3 percent slopes

Typical profile

- *H1 - 0 to 11 inches:* silt loam
- *H2 - 11 to 32 inches:* silt loam
- *H3 - 32 to 60 inches:* stratified gravelly sandy loam to sand

Properties and qualities

- *Slope:* 0 to 3 percent
- *Depth to restrictive feature:* More than 80 inches
- *Natural drainage class:* Moderately well drained
- *Runoff class:* Low
- *Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.60 to 2.00 in/hr)
- *Depth to water table:* About 12 to 36 inches
- *Frequency of flooding:* Occasional
- *Frequency of ponding:* None
- *Available water storage in profile:* Moderate (about 6.8 inches)

ShA—Shelmadine silt loam, 0 to 3 percent slopes

Typical profile

- *H1 - 0 to 7 inches:* silt loam
- *H2 - 7 to 24 inches:* silt loam
- *H3 - 24 to 50 inches:* silt loam
- *H4 - 50 to 70 inches:* channery silt loam

Properties and qualities

- *Slope:* 0 to 3 percent
- *Depth to restrictive feature:* 18 to 30 inches to fragipan
- *Natural drainage class:* Poorly drained
- *Runoff class:* Very high
- *Capacity of the most limiting layer to transmit water (Ksat):* Moderately low to moderately high (0.06 to 0.20 in/hr)
- *Depth to water table:* About 0 to 6 inches
- *Frequency of flooding:* None
- *Frequency of ponding:* None
- *Available water storage in profile:* Low (about 3.2 inches)

SmB—Shelmadine very stony silt loam, 0 to 8 percent slopes

Typical profile

- *H1 - 0 to 7 inches:* very stony silt loam
- *H2 - 7 to 24 inches:* silt loam
- *H3 - 24 to 50 inches:* silt loam
- *H4 - 50 to 70 inches:* channery silt loam

Properties and qualities

- *Slope:* 0 to 8 percent
- *Percent of area covered with surface fragments:* 1.6 percent

- *Depth to restrictive feature:* 18 to 30 inches to fragipan
- *Natural drainage class:* Poorly drained
- *Runoff class:* Very high
- *Capacity of the most limiting layer to transmit water (Ksat):* Moderately low to moderately high (0.06 to 0.20 in/hr)
- *Depth to water table:* About 0 to 6 inches
- *Frequency of flooding:* None
- *Frequency of ponding:* None
- *Available water storage in profile:* Low (about 3.1 inches)

WaB2—Watson gravelly silt loam, 0 to 8 percent slopes, moderately eroded

Typical profile

- *H1 - 0 to 8 inches:* gravelly silt loam
- *H2 - 8 to 22 inches:* silty clay loam
- *H3 - 22 to 60 inches:* gravelly silty clay loam

Properties and qualities

- *Slope:* 0 to 8 percent
- *Depth to restrictive feature:* More than 80 inches
- *Natural drainage class:* Moderately well drained
- *Runoff class:* Medium
- *Capacity of the most limiting layer to transmit water (Ksat):* Moderately low to moderately high (0.06 to 0.20 in/hr)
- *Depth to water table:* About 18 to 33 inches
- *Frequency of flooding:* None
- *Frequency of ponding:* None
- *Available water storage in profile:* Moderate (about 6.9 inches)

2.0 OBJECTIVE AND DATA USE

The objective of the XRF soil screening and surface soil sampling was to determine the existence of elevated lead, zinc, nickel, cadmium, chromium, and copper concentrations in soils. Several communal areas (schools, daycares, parks, etc.) were screened to determine concentrations for the above-mentioned metals to determine if additional soil investigation will be required.

ATSDR and EPA assisted in the XRF soil screening and the collection of surface soil samples to determine whether elevated lead, zinc, nickel, cadmium, chromium, and copper concentrations in soils pose a threat to public health and/or the environment or are below levels of concern at the Site.

3.0 XRF SOIL SCREENING AND SURFACE SOIL SAMPLING

Table 1 lists sampling locations, which PADEP selected based on the LHC and locations determined in conjunction with PADOH, ATSDR and EPA. As indicated on the table, there are one (1) Daycare Center, two (2) schools, six (6) parks/athletic fields, and one (1) church. The AZR facility and potential sampling locations with placemarks depicting their locations are shown in **Figure 2A** and **Figure 2B** which are two (2) aerial photographs of the Borough of Palmerton.

3.1 XRF Soil Screening

Initially, an XRF survey was completed by Dr. Karl Markiewicz, CDC/ATSDR Senior Toxicologist and Dominic Ventura, EPA On Scene Coordinator (OSC). EPA Method 6200 is applicable to the in situ and intrusive analysis for the six (6) RCRA metals applicable to this site (total lead, total zinc, total nickel, total cadmium, total chromium, and total copper). This method is a screening method to be used with confirmatory analysis using other techniques (e.g., flame atomic absorption spectrometry (FLAA), graphite furnace atomic absorption spectrometry (GFAA), inductively coupled plasma-atomic emission spectrometry, (ICP-AES), EPA Method 6010D or 6020B: Inductively Coupled Plasma-Optical Emission Spectrometry (ICP-OES), or inductively coupled plasma-mass spectrometry, (ICP-MS). The main strength of XRF is that it is a rapid field screening procedure.

XRF analysis is an ideal tool to undertake many measurements of elemental concentrations in soil in a very short time. However, the technique is subject to many sampling and analytical errors, and therefore is regarded as a screening level assessment tool only. The main sources of error affecting accuracy of this technique are sampling error due to heterogeneity in the contaminant distribution in the soil, and moisture content variation in the sample.

The use of XRF can be an excellent method of delineating metals concentrations in soils and soil-like materials, including sediments, mine wastes and tailings, and other granular materials and powders. Most XRF instruments can also analyze thin materials, such as painted surfaces. The use of XRF can be an invaluable aide during all project phases: investigation, design, and cleanup. However, understanding the method's strengths and limitations is critical to obtaining usable results. XRF analyzers have a distinct operating range that is subject to interferences caused by site-specific physical and chemical characteristics which must be understood to optimize the use of the instrument. These interferences are:

- Physical matrix effects, such as variations in particle size and sample homogeneity
- Sample moisture content greater than about 20 percent
- Inconsistent positioning of samples in front of the probe window
- Chemical matrix effects resulting from differences in the concentrations of interfering elements

- Changes in ambient air temperature producing instrument drift

EPA Method 6200 (EPA 2007) is a standard analytical method developed by EPA guiding the use of XRF instruments. The method discusses the two modes in which XRF instruments can be operated when analyzing soil-like materials: In-situ and intrusive. The in-situ mode involves analysis of an undisturbed material. Intrusive analysis involves collection and preparation of a sample before analysis. In-situ analysis is an attractive method in that no sample is collected and prepared, only limited preparation of the surface to be sampled is needed, and rapid results can be obtained.

In-situ XRF analysis (by placing the XRF directly in contact onto the ground) requires minimal sample preparation but is only a screening level technique. Screening level analysis can be used for:

- Identifying potential hotspots on a site;
- Preliminary identification of contaminants present;
- Assisting with remediation decision making;
- Screening of hazardous waste.

Intrusive XRF analysis can be achieved by implementing more intensive sample preparation, correct QA/QC techniques and correct use of the XRF. Sieving, drying and homogenization of soil samples removes many of the sampling errors caused by grain size effects, moisture content and other matrix effects, and increases the accuracy and reliability of the results. Intrusive investigations can:

- Assist with determining the appropriate soil sampling density and sampling locations for site investigation works (exploratory level site investigations);
- Provide an indication of degree of heterogeneity of contaminants present on the site;
- Be used in a Preliminary Site Investigation, assisting (with traditional information sources) to determine if it is more likely than not that the site is contaminated.

The PADEP/ATSDR utilized the in-situ XRF method for screening soils. An example of an SOP for Field X-Ray Fluorescence Measurement is included as **Appendix A**. Randomly selected sampling points were selected at each location. XRF was primarily used to identify potential hotspots and provide an indication of the extent of contamination within the sampling grids.

All XRF screening soil locations were analyzed for total lead, total copper, total nickel, total cadmium, total chromium, and total zinc by in-situ XRF analysis, EPA Method 6200 (EPA

2007). Method procedures for EPA Method 6200: Field Portable X-Ray Fluorescence Spectrometry for the Determination of Elemental Concentrations in Soil and Sediment is included as **Appendix B**. Maps depicting the location for each XRF soil screening location is included within **Appendix C**. The geographic location of each XRF soil screening analysis was recorded with a GPS device.

3.2 Surface Soil Sampling

Soil samples were collected from approximately 10 percent of the XRF screening locations. The soil sample collected for laboratory analysis was selected from the XRF screening results with the highest lead, zinc, and cadmium results. The samples were sent to the PADEP Bureau of Laboratories (BOL) for analyses to confirm the concentrations of total lead, total copper, total nickel, total cadmium, total chromium, chromium (VI), and total zinc via EPA Method 6010D or 6020B: Inductively Coupled Plasma-Optical Emission Spectrometry (ICP-OES). Locations for surface soil samples were prepared for sampling using a steel trowel to loosen the topsoil. Surface soil samples were collected from the prepared sampling location from 0 to 3 inches below ground surface (bgs) using a dedicated plastic scoop. A map depicting the location for each surface soil location is included within **Appendix C**. The geographic location of each soil sample was recorded with a GPS device. The SOP for Soil Sampling is included as **Appendix D**. The following PADEP Statewide Health Standards (SHS) were utilized for determining the extent of contamination at the site and are included on the following page:

- Total Lead - 450 mg/kg
- Total Copper - 8,100 mg/kg
- Total Nickel - 650 mg/kg
- Total Cadmium - 38 mg/kg
- Total Chromium (Chromium (III) plus Chromium (VI)) - 190,000 mg/kg
- Chromium (VI) - 4 mg/kg
- Total Zinc - 12,000 mg/kg

4.0 EQUIPMENT DECONTAMINATION

Dedicated disposable sampling equipment and personal protective equipment were double-bagged and disposed of as municipal waste. Non-dedicated sampling equipment were decontaminated with Alconox, followed by a rinse with distilled water, followed by a rinse will 10% nitric acid, and completed with an additional rinse with distilled water. A trowel was used during sample collection and analysis. The trowel was decontaminated before each use. All investigation-derived waste (IDW) was disposed of as municipal waste. The small quantity

of water generated from equipment decontamination activities was not collected and was released at the site.

5.0 ANALYTICAL PARAMETERS AND METHODS

Soil samples were analyzed by XRF for total lead, total copper, total nickel, total cadmium, total chromium, and total zinc by ATSDR. Soil samples were analyzed in accordance with EPA Method 6200 (EPA 2007). As prescribed in EPA Method 6200 (EPA 2007), a minimum of 10 percent of the soil samples analyzed by XRF were sent to BOL for analysis of total lead, total copper, total nickel, total cadmium, total chromium, and total zinc via EPA Method 6010D or 6020B. Chromium (VI) was analyzed via EPA Method 218.6.

TABLE 2
ANALYTICAL PARAMETERS

Matrix	Analysis	Analytical Method	Containers and Preservatives	Detection Limit	Holding Time
Soil	Lead and Instrument specific metals	EPA 6200 (EPA 2007)		XRF Instrument specific	
Soil	Lead, zinc, nickel, cadmium, total chromium, and copper Chromium (VI)	EPA 6010D or EPA 6020B EPA 218.6	500-ml Nalgene or Amber glass; ice	Lead (50 mg/kg) Zinc (2.5 mg/kg) Nickel (5.0 mg/kg) Cadmium (0.5 mg/kg) Total Chromium (2.5 mg/kg) Chromium (VI) (0.001 mg/kg) Copper (2.0 mg/kg)	180 days

Notes:
EPA = U.S. Environmental Protection Agency

6.0 QUALITY ASSURANCE AND QUALITY CONTROL PROCEDURES

This section describes the QA/QC procedures for personnel during the site sampling event, including responsibilities, field QC, XRF QC, laboratory QC, and data evaluation and management.

6.1 Responsibility

The PADEP was responsible for ensuring that sample quality and integrity are maintained in accordance with the EPA "Quality Assurance/Quality Control Guidance for Removal Actions" (EPA 1990).

6.2 Field Quality Control

Each sampling location was noted in the Site logbook. Field QA/QC measures consisted of collecting field duplicates, confirmation, and rinsate/equipment blank samples; and maintaining photographic, logbook, and chain-of-custody documentation. Field duplicate samples, at a rate of at least one for every 20 samples collected, were used to test the reproducibility of the sampling procedures. Rinsate/equipment blank samples, at a rate of at least one for every 20 samples collected, were used to assess the adequacy of the decontamination process. Confirmation samples, at a rate of one for every 10 samples analyzed by XRF, were analyzed by a BOL in accordance with EPA Method 6010D or EPA Method 6020B, and were used to test the accuracy of the XRF analysis.

6.3 X-Ray Fluorescence Quality Control

XRF QC measures consisted of instrument blanks, continuing calibration measurements, and precision measurements, in accordance with EPA Method 6200 (EPA 2007). An instrument blank was run at the beginning and end of every working day, and once every 20 samples, to test for any contamination that may have been introduced to the instrument. Continuing calibration measurements, using a known standard, was run at the beginning and end of each working day. Precision measurement samples were run at least once per day by analyzing a known standard seven times to check the precision of the instrument.

6.4 Chain of Custody

PADEP uses standard chain-of-custody forms to maintain a record of sample collection, transfer between personnel, and receipt by the laboratory. These forms were initiated in the field by designated field personnel and accompanied samples to the BOL. Prior to transfer of samples to the BOL, the chain-of-custody forms were signed and dated prior to release to the BOL.

7.0 XRF SOIL SCREENING AND SURFACE SOIL SAMPLE RESULTS

The following sections present the results of XRF soil screening and surface soil sampling results. XRF soil screening and surface soil sampling activities are detailed above in Section 3.0 and results are detailed in the following sections.

7.1 XRF Soil Screening Results

A total of 141 sampling points were analyzed via XRF soil screening from the ten (10) sampling locations. All sampling points were analyzed for total lead, total copper, total nickel,

total chromium, total cadmium, and total zinc. The results are documented in **Table 3** and are as follows:

7.1.1 SS Palmer Elementary Playground

Eight (8) sampling points were analyzed via XRF soil screening. Total lead concentrations ranged from ND to 56.2 mg/kg. Total copper concentrations ranged from ND to 25 mg/kg. Total nickel concentrations were ND for all points. Total chromium concentrations were ND for all points. Total cadmium concentrations ranged from ND to 30 mg/kg. Total zinc concentrations ranged from 85.1 mg/kg to 2,232 mg/kg.

7.1.2 Palmerton Borough Park

Twenty-one (21) sampling points were analyzed via XRF soil screening. Total lead concentrations ranged from 4.1 mg/kg to 285 mg/kg. Total copper concentrations ranged from ND to 60 mg/kg. Total nickel concentrations ranged from ND to 53 mg/kg. Total chromium concentrations were ND for all points. Total cadmium concentrations ranged from ND to 70 mg/kg. Total zinc concentrations ranged from 136.3 mg/kg to 4,589 mg/kg.

The results for XRF soil screening indicated that total cadmium was detected at a concentration above the SHSs; specifically:

- Total cadmium was detected above the SHS of 38 mg/kg in the samples collected from PBP S-6 (52 mg/kg), PBP K-16 (39 mg/kg), PBP K-17 (41 mg/kg), PBP K-18 (64 mg/kg), PBP K-19 (39 mg/kg), PBP K-21 (40 mg/kg), PBP K-22 (45 mg/kg), PBP K-25 (48 mg/kg), and PBP K-27 (70 mg/kg).

7.1.3 Elmer Valo Field

Ten (10) sampling points were analyzed via XRF soil screening. Total lead concentrations ranged from 13.3 mg/kg to 118 mg/kg. Total copper concentrations ranged from ND to 53 mg/kg. Total nickel concentrations ranged from ND to 17 mg/kg. Total chromium concentrations were ND for all points. Total cadmium concentrations ranged from ND to 40 mg/kg. Total zinc concentrations ranged from 599 mg/kg to 4,353 mg/kg.

The results for XRF soil screening indicated that total cadmium was detected at a concentration above the SHSs; specifically:

- Total cadmium was detected above the SHS of 38 mg/kg in the sample collected from EVF S-2 (40 mg/kg).

7.1.4 7th Street Athletic Fields

Eleven (11) sampling points were analyzed via XRF soil screening. Total lead concentrations ranged from 21.5 mg/kg to 89 mg/kg. Total copper concentrations ranged from 9.3 mg/kg to 28 mg/kg. Total nickel concentrations ranged from ND to 21 mg/kg. Total chromium concentrations were ND for all points. Total cadmium concentrations ranged from ND to 42 mg/kg. Total zinc concentrations ranged from 705 mg/kg to 3,191 mg/kg.

The results for XRF soil screening indicated that total cadmium was detected at a concentration above the SHSs; specifically:

- Total cadmium was detected above the SHS of 38 mg/kg in the sample collected from SSA S-4 (42 mg/kg).

7.1.5 Salem United Methodist Church

Three (3) sampling points were analyzed via XRF soil screening. Total lead concentrations ranged from 59.4 mg/kg to 175 mg/kg. Total copper concentrations ranged from 21 mg/kg to 56 mg/kg. Total nickel concentrations ND for all points. Total chromium concentrations were ND for all points. Total cadmium concentrations ranged from 29 mg/kg to 49 mg/kg. Total zinc concentrations ranged from 2,627 mg/kg to 4,335 mg/kg.

The results for XRF soil screening indicated that total cadmium was detected at a concentration above the SHSs; specifically:

- Total cadmium was detected above the SHS of 38 mg/kg in the samples collected from SMC K-48 (49 mg/kg) and SMC K-49 (48 mg/kg).

7.1.6 West End Day Care

Five (5) sampling points were analyzed via XRF soil screening. Total lead concentrations ranged from 2.8 mg/kg to 381 mg/kg. Total copper concentrations ranged from ND to 168 mg/kg. Total nickel concentrations ranged from ND to 33 mg/kg. Total chromium concentrations were ND for all points. Total cadmium concentrations ranged from 20 mg/kg to 61 mg/kg. Total zinc concentrations ranged from 89.3 mg/kg to 7,364 mg/kg.

The results for XRF soil screening indicated that total cadmium was detected at a concentration above the SHSs; specifically:

- Total cadmium was detected above the SHS of 38 mg/kg in the sample collected from WED S-2 (61 mg/kg).

7.1.7 BPBSA Field

Ten (10) sampling points were analyzed via XRF soil screening. Total lead concentrations ranged from 5.6 mg/kg to 67 mg/kg. Total copper concentrations ranged from ND to 66 mg/kg. Total nickel concentrations ranged from ND to 36 mg/kg. Total chromium concentrations ranged from ND to 121 mg/kg. Total cadmium concentrations ranged from ND to 36 mg/kg. Total zinc concentrations ranged from 73 mg/kg to 615 mg/kg.

7.1.8 Stoney Ridge P.A.R.C.

Fifteen (15) sampling points were analyzed via XRF soil screening. Total lead concentrations ranged from 9.3 mg/kg to 29.5 mg/kg. Total copper concentrations ranged from 8.0 mg/kg to 46 mg/kg. Total nickel concentrations ranged from ND to 18 mg/kg. Total chromium concentrations were ND for all points. Total cadmium concentrations ranged from ND to 28 mg/kg. Total zinc concentrations ranged from 67 mg/kg to 6,599 mg/kg.

7.1.9 Palmerton Junior/Senior High School

Forty-one (41) sampling points were analyzed via XRF soil screening. Total lead concentrations ranged from ND to 155 mg/kg. Total copper concentrations ranged from ND to 73 mg/kg. Total nickel concentrations ranged from ND to 54 mg/kg. Total chromium concentrations ranged from ND to 42 mg/kg. Total cadmium concentrations ranged from ND to 42 mg/kg. Total zinc concentrations ranged from 58 mg/kg to 1,388 mg/kg.

The results for XRF soil screening indicated that total cadmium was detected at a concentration above the SHSs; specifically:

- Total cadmium was detected above the SHS of 38 mg/kg in the samples collected from PHS K-26 (40 mg/kg), PHS K-28 (40 mg/kg), and PHS S-14 (42 mg/kg).

7.1.10 Palmerton Memorial Park

Seventeen (17) sampling points were analyzed via XRF soil screening. Total lead concentrations ranged from 4.4 mg/kg to 142 mg/kg. Total copper concentrations ranged from ND to 29 mg/kg. Total nickel concentrations ranged from ND to 12 mg/kg. Total chromium concentrations were ND for all

points. Total cadmium concentrations ranged from ND to 47 mg/kg. Total zinc concentrations ranged from 16 mg/kg to 2,025 mg/kg.

The results for XRF soil screening indicated that total cadmium was detected at a concentration above the SHSs; specifically:

- Total cadmium was detected above the SHS of 38 mg/kg in the sample collected from PMP S-11 (47 mg/kg).

7.2 Surface Soil Sample Results

A total of 20 surface soil samples were collected to confirm results from the XRF soil screening from the ten (10) sampling locations. All soil samples were analyzed for total lead, total copper, total nickel, total chromium, chromium (VI), total cadmium, and total zinc. The results are documented in **Table 4. Table 4** additionally compares the XRF Soil Screening Results to the Surface Soil Sample Results. The Analytical Report including Chain of Custody documentation is included in **Appendix E**. The Surface Soil Sample Results and are as follows:

7.2.1 SS Palmer Elementary Playground

One (1) sample was collected on October 16, 2018 for confirmation of the total lead, total copper, total nickel, total cadmium, total chromium, chromium (VI), and total zinc results acquired by XRF analysis. The analytical results for the soil sampling event indicated that, while detections of several of the metals were present, none exceeded the respective SHSs for total lead, total copper, total nickel, total chromium, chromium (VI), total cadmium, and total zinc.

7.2.2 Palmerton Borough Park

Two (2) samples plus a duplicate sample were collected on October 16, 2018 for confirmation of the total lead, total copper, total nickel, total cadmium, total chromium, chromium (VI), and total zinc results acquired by XRF analysis. The analytical results for soil sampling event indicated that total lead and total cadmium were detected at concentrations above the SHSs; specifically:

- Total lead was detected above the SHS of 450 mg/kg in the samples collected from PBP S-6 (485 mg/kg) and PBP K-27 (912 mg/kg).
- Total cadmium was detected above the SHS of 38 mg/kg in the samples collected from PBP S-6 (73.90 mg/kg) and PBP K-27 (136 mg/kg).

7.2.3 Elmer Valo Field

One (1) sample was collected on October 16, 2018 for confirmation of the total lead, total copper, total nickel, total cadmium, total chromium, chromium (VI), and total zinc results acquired by XRF analysis. The analytical results for the

soil sampling event indicated that, while detections of several of the metals were present, none exceeded the respective SHSs for total lead, total copper, total nickel, total chromium, chromium (VI), total cadmium, and total zinc.

7.2.4 7th Street Athletic Fields

One (1) sample was collected on October 16, 2018 for confirmation of the total lead, total copper, total nickel, total cadmium, total chromium, chromium (VI), and total zinc results acquired by XRF analysis. The analytical results for the soil sampling event indicated that, while detections of several of the metals were present, none exceeded the respective SHSs for total lead, total copper, total nickel, total chromium, chromium (VI), total cadmium, and total zinc.

7.2.5 Salem United Methodist Church

One (1) sample was collected on October 16, 2018 for confirmation of the total lead, total copper, total nickel, total cadmium, total chromium, chromium (VI), and total zinc results acquired by XRF analysis. The analytical results for the soil sampling event indicated that, while detections of several of the metals were present, none exceeded the respective SHSs for total lead, total copper, total nickel, total chromium, chromium (VI), total cadmium, and total zinc.

7.2.6 West End Day Care

One (1) sample was collected on October 16, 2018 for confirmation of the total lead, total copper, total nickel, total cadmium, total chromium, chromium (VI), and total zinc results acquired by XRF analysis. The analytical results for soil sampling event indicated that total lead, total cadmium, and total zinc were detected at concentrations above the SHSs; specifically:

- Total lead was detected above the SHS of 450 mg/kg in the sample collected from WED S-2 at a concentration of 701 mg/kg.
- Total cadmium was detected above the SHS of 38 mg/kg in the sample collected from WED S-2 at a concentration of 86.30 mg/kg.
- Total zinc was detected above the SHS of 12,000 mg/kg in the sample collected from WED S-2 at a concentration of 16,046 mg/kg.

7.2.7 BPBSA Field

One (1) sample was collected on October 16, 2018 for confirmation of the total lead, total copper, total nickel, total cadmium, total chromium, chromium (VI), and total zinc results acquired by XRF analysis. The analytical results for the soil sampling event indicated that, while detections of several of the metals were present, none exceeded the respective SHSs for total lead, total copper, total nickel, total chromium, chromium (VI), total cadmium, and total zinc.

7.2.8 Stoney Ridge P.A.R.C.

Two (2) samples were collected on October 16, 2018 for confirmation of the total lead, total copper, total nickel, total cadmium, total chromium, chromium (VI), and total zinc results acquired by XRF analysis. The analytical results for the soil sampling event indicated that, while detections of several of the metals were present, none exceeded the respective SHSs for total lead, total copper, total nickel, total chromium, chromium (VI), total cadmium, and total zinc.

7.2.9 Palmerton Junior/Senior High School

Five (5) samples were collected on October 17, 2018 for confirmation of the total lead, total copper, total nickel, total cadmium, total chromium, chromium (VI), and total zinc results acquired by XRF analysis. The analytical results for the soil sampling event indicated that, while detections of several of the metals were present, none exceeded the respective SHSs for total lead, total copper, total nickel, total chromium, chromium (VI), total cadmium, and total zinc.

7.2.10 Palmerton Memorial Park

Three (3) samples were collected on October 17, 2018 for confirmation of the total lead, total copper, total nickel, total cadmium, total chromium, chromium (VI), and total zinc results acquired by XRF analysis. The analytical results for the soil sampling event indicated that, while detections of several of the metals were present, none exceeded the respective SHSs for total lead, total copper, total nickel, total chromium, chromium (VI), total cadmium, and total zinc.

7.3 Duplicate Samples

Duplicate samples are samples collected in tandem with one another from the same source at the same time in the field, sent to the same laboratory and analyzed by the same method. Duplicates provide information on field collection techniques, sample homogeneity and analytical precision. Precision assessment is reported as Relative Percent Difference (RPD) between the two results (sample and duplicate) and calculated using the following equation:

$$\%RPD = \frac{(\text{sample result - duplicate result})}{(\text{sample result + duplicate result})/2} \times 100$$

The soil samples were placed in separate containers and given different sample ID numbers. The duplicate samples were collected at Palmerton Borough Park on October 16, 2018 (PBP S-6 & the duplicate BD-01) and at Palmerton High School on October 17, 2018 (PHS S-17 &

the duplicate BD-02). All of the soil samples were analyzed for total lead, total copper, total nickel, total chromium, chromium (VI), total cadmium, and total zinc. The results are documented on **Table 5.** The Analytical Report including Chain of Custody documentation is included in **Appendix E**.

The results of PBP S-6 and BD-01 are comparable. The Relative Percent Difference (RPD) for each of the metal results in the soil sample and its duplicate is < 30%. The results of PHS S-17 and BD-02 are comparable, except for nickel and copper, which have RPDs > 50%. The comparison of the duplicate samples is found on **Table 5**. The difference in the results for both duplicate pairs is most likely due to the lack of homogenization.

7.4 Rinsate Blank Samples

A total of 2 rinsate blank samples were collected to determine if proper decontamination procedures were followed. One (1) rinsate blank sample was collected on October 16, 2018 and one (1) rinsate blank sample was collected on October 17, 2018. The rinsate blanks were analyzed for total lead, total copper, total nickel, total chromium, total cadmium, and total zinc. The results are documented on **Table 5.** The Analytical Report including Chain of Custody documentation is included in **Appendix E**. The analytical results for the metals are below the reporting limits or at very low concentrations. The results indicate that proper decontamination procedures were followed for both samples.

8.0 RESULTS AND RECOMMENDATIONS

8.1 Results

8.1.1 XRF Soil Screening Results

A total of 141 sampling points were analyzed via XRF soil screening from the ten (10) sampling locations. All sampling points were analyzed for total lead, total copper, total nickel, total chromium, total cadmium, and total zinc. The results are documented in **Table 3** and **Table 4.**

Exceedances of the Statewide Health Standard were documented at Palmerton Borough Park, Elmer Valo Field, 7th Street Athletic Fields, Salem United Methodist Church, West End Day Care, Palmerton Junior/Senior High School, and Palmerton Memorial Park.

The results for XRF soil screening at Palmerton Borough Park indicated that total cadmium was detected at a concentration above the SHSs; specifically:

- Total cadmium was detected above the SHS of 38 mg/kg in the samples collected from PBP S-6 (52 mg/kg), PBP K-16 (39 mg/kg), PBP K-17

(41 mg/kg), PBP K-18 (64 mg/kg), PBP K-19 (39 mg/kg), PBP K-21 (40 mg/kg), PBP K-22 (45 mg/kg), PBP K-25 (48 mg/kg), and PBP K-27 (70 mg/kg).

The results for XRF soil screening at Elmer Valo Field indicated that total cadmium was detected at a concentration above the SHSs; specifically:

- Total cadmium was detected above the SHS of 38 mg/kg in the sample collected from EVF S-2 (40 mg/kg).

The results for XRF soil screening at 7th Street Athletic Fields indicated that total cadmium was detected at a concentration above the SHSs; specifically:

- Total cadmium was detected above the SHS of 38 mg/kg in the sample collected from SSA S-4 (42 mg/kg).

The results for XRF soil screening at Salem United Methodist Church indicated that total cadmium was detected at a concentration above the SHSs; specifically:

- Total cadmium was detected above the SHS of 38 mg/kg in the samples collected from SMC K-48 (49 mg/kg) and SMC K-49 (48 mg/kg).

The results for XRF soil screening at West End Day Care indicated that total cadmium was detected at a concentration above the SHSs; specifically:

- Total cadmium was detected above the SHS of 38 mg/kg in the sample collected from WED S-2 (61 mg/kg).

The results for XRF soil screening at Palmerton Junior/Senior High School indicated that total cadmium was detected at a concentration above the SHSs; specifically:

- Total cadmium was detected above the SHS of 38 mg/kg in the samples collected from PHS K-26 (40 mg/kg), PHS K-28 (40 mg/kg), and PHS S-14 (42 mg/kg).

The results for XRF soil screening at Palmerton Memorial Park indicated that total cadmium was detected at a concentration above the SHSs; specifically:

- Total cadmium was detected above the SHS of 38 mg/kg in the samples collected from PMP S-11 (47 mg/kg).

As indicated in **Table 4**, the total lead, total cadmium, total chromium, total zinc, total nickel, and total copper lab results were typically greater than the total XRF results with some lab results three (3) times greater than the XRF

results. The lower XRF results may be due to the % moisture content in the soil. As indicated in Section 3.1, XRF analyzers have a distinct operating range that is subject to interferences such as sample moisture content greater than about 20%. Moisture contents of greater than 20% biases the results low. Therefore, the higher the soil moisture in a particular matrix, the lower the reported concentration relative to the actual concentration.

In conclusion, XRF analysis is an ideal tool to undertake many measurements of elemental concentrations in soil in a very short time. However, the technique is subject to many sampling and analytical errors and therefore is regarded as a screening level assessment tool only. The main sources of error affecting accuracy of this technique are sampling error due to heterogeneity in the contaminant distribution in the soil, and moisture content variation in the sample.

8.1.2 Surface Soil Sampling Results

A total of 20 surface soil samples were collected to confirm results from the XRF soil screening from the ten (10) sampling locations. All soil samples were analyzed for total lead, total copper, total nickel, total chromium, chromium (VI), total cadmium, and total zinc. The results are documented in **Table 4.** The Analytical Report including Chain of Custody documentation is included in **Appendix E**.

Exceedances of the Statewide Health Standard were only documented at Palmerton Borough Park and West End Day Care. The analytical results for soil sampling at Palmerton Borough Park indicated that total lead and total cadmium were detected at concentrations above the SHSs; specifically:

- Total lead was detected above the SHS of 450 mg/kg in the samples collected from PBP S-6 (485 mg/kg) and PBP K-27 (912 mg/kg).
- Total cadmium was detected above the SHS of 38 mg/kg in the samples collected from PBP S-6 (73.90 mg/kg) and PBP K-27 (136 mg/kg).

The analytical results for soil sampling event at West End Day Care indicated that total lead, total cadmium, and total zinc were detected at concentrations above the SHSs; specifically:

- Total lead was detected above the SHS of 450 mg/kg in the sample collected from WED S-2 at a concentration of 701 mg/kg.
- Total cadmium was detected above the SHS of 38 mg/kg in the sample collected from WED S-2 at a concentration of 86.30 mg/kg.
- Total zinc was detected above the SHS of 12,000 mg/kg in the sample collected from WED S-2 at a concentration of 16,046 mg/kg.

In conclusion, exceedances of the Statewide Health Standard were observed in four (4) of twenty (20) soil samples, including, one (1) of the Blind Duplicate samples which indicated that total cadmium was detected at concentrations above the SHSs; specifically:

- Total cadmium was detected above the SHS of 38 mg/kg in the samples collected from BD-01 (83.40 mg/kg). BD-01 was a blind duplicate sample for PBP S-6, and the results were similar to the results observed for PBP S-6.

8.2 Recommendations

Based on the XRF soil screening results and the surface soil sampling results, additional soil sampling and XRF soil screening (under dryer conditions) is recommended within and adjacent to Palmerton Borough Park and West End Day Care. Additionally, based on the moisture content in the soil, additional sampling and XRF soil screening (under dryer conditions) may be warranted since numerous XRF soil screening results were biased low.