Risk Assessment for Lead Exposure in Northwest Portion of Bernhart Park Reading, PA

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1 Introduction

This report presents an assessment of human health risks from adolescent exposure to surface soil lead in the northwest portion of Bernhart Park, Reading, PA. The analysis was performed using soil data collected in the park as part of an environmental assessment of properties in the vicinity of the Exide Technologies (Exide) battery manufacturing and recycling facility in Reading, PA (AGC, 2001). Risks to recreational users are characterized by estimating the effect of exposures in Bernhart Park on blood lead levels in adolescents, using US EPA's Adult Lead Model (US EPA, 2003).

Bernhart Park (the "Park") lies east of the Exide facility, separated from it by a hill with a summit that is approximately 100 feet above the elevation of the facility and 85 feet above the Park (Figure 1). The center of the Park area contains a lake with an inlet to the east and an outlet spilling down a steep grade to the west. On the northwestern side of the lake, the terrain slopes up steeply from the lake's edge. This risk assessment was performed for the strip of land along the northwestern side of the lake, three island/peninsula areas on the north side of the lake, and a small piece of land on the south side of the spillway at the west end of the lake. There is a bridge across the western spillway, which is met by a pathway on the northern end of the bridge. While the pathway is well-defined at the bridge, it becomes less defined and eventually ends as it progresses to the northeast along the lake's edge. Use of these areas by park visitors would likely be transitory and occasional, suggesting little opportunity for exposure to soils.

2 Data Used in Risk Assessment

Surface soil sampling was conducted by AGC in June, 2001. The sampling locations are approximately uniformly distributed on a grid and therefore represent an unbiased data set (*e.g.*, they were not placed in known or suspected hot-spots) (Figure 2). Lead concentration in the surface soil samples was determined using X-ray Fluorescence (XRF).

We used data from only the June 2001 XRF surface soil samples in this risk assessment, because it is this soil that is available for contact and incidental ingestion. Earlier sampling of deeper (3–10" depth) soils showed uniformly lower lead concentrations in deeper soils when compared to the surface soils. Note that, to the extent that future development of the park entails disturbance of the soil, the

resulting mixing will lower the lead concentrations in surface soil. That is, there is no concern that soil disturbance will create hazards where none now exist.

Risks were evaluated separately for a total of 11 sampling grids. The average surface soil lead concentration in each sampling grid is presented in Table 1 and on Figure 2.

Table 1
Average Soil Lead Concentrations
Bernhart Park

Area	Sample Grid ID	Average Lead Concentration (mg/kg)
South of Spillway	MM	2,028
Northwest Hillside	NN	4,845
	OO	3,655
	PP	1,155
	QQ	1,006
	RR	743
	SS	1,016
	DDD	963
Islands/Peninsula	TT	1,973
	UU	2,713
	ZZ	1,022

3 Exposure Evaluation

3.1 Exposure Pathways and Receptors

The receptor used in this evaluation is an adolescent recreator, and the target blood lead level used to evaluate the threshold for unacceptable risk is 10 µg/dL (see further discussion in Section 4 below). Typically, the Adult Lead Model is run for women of child-bearing age, with the target blood lead level of 10 µg/dL established for the fetus, rather than the mother. This allows the mother to have a blood lead level higher than 10 µg/dL, based on the fetal/maternal ratio (0.9) used in the model. As a result, setting the target blood lead as 10 µg/dL in an adolescent is more conservative than the typical approach taken with the Adult Lead Model of protecting the fetus at this level. For this reason, the adolescent is this most sensitive receptor likely to be exposed in this area of the Park, and it is not necessary to include women of child-bearing age as additional receptors. The only pathway of potential exposure to recreational users of these portions of Bernhart Park is incidental soil ingestion.

3.2 Exposure Frequency

The exposure frequency varies by area (sampling grid) because certain grids are assumed to be more accessible than others. The exposure frequencies used for this assessment represent US EPA's estimate of the worst-case scenarios for each area.[1] On the northwest hillside, grids PP, QQ, RR, SS, and DDD have an exposure frequency of 80 days/year (approximately 6-7 visits/month), while grids NN and OO have an exposure frequency of 20 days/year, because they are on a steep hillside where people would tend to spend less time. The island/peninsula area (grids TT, UU and ZZ) and the grid next to the spillway (grid MM) have an exposure frequency of 40 days/year (approximately 3-4 visits/month) because these areas are less accessible and are thus visited less often. People are assumed to visit the park occasionally throughout the year, therefore, the averaging time is based on a 365-day year.

4 Adult Blood Lead Model

US EPA's Adult Blood Lead Model was used to evaluate risk for the Adolescent receptor (US EPA, 2003). This model is framed in terms of incremental effects attributable to particular environmental sources of lead, over and above an assumed steady state baseline blood lead level. A specified set of typical background exposure levels is presumed. Increments of blood lead over this baseline are estimated using environmental concentrations, ingestion rates, and estimates of fraction of lead intake that is absorbed. The total incremental uptake is related to an increase over the baseline blood lead level ($PbB_{baseline}$) through an empirically determined proportionality constant, the Biokinetic Slope Factor (BKSF).

[1] The exposure frequencies used for this portion of Bernhart Park are probably higher than the number of times people actually visit this portion of the site, thus yielding higher estimates of risk than site specific values would produce.

The blood lead level (PbB) is calculated from the Adult Blood Lead Model by:

$$PbB = PbB_{baseline} + [(PbS \cdot BKSF \cdot IR_S \cdot F_S \cdot AF_S \cdot EF_S)/AT]$$

where

$PbB_{baseline}$	=	Baseline blood lead level (µg/dL)
PbS	=	Soil lead concentration (µg/g)
BKSF	=	Biokinetic Slope Factor (µg/dL per µg/day)
IR_S	=	Soil ingestion rate (g/day)
Fs	=	Fraction of soil ingestion from site (unitless)
AF_S	=	Absorption fraction from soil (unitless)
EF_S	=	Exposure frequency for site soil (days)
AT	=	Averaging time (days)

The 95th percentile blood lead was calculated from the following equation:

$$PbB_{95th\ Percentile} = PbB_{GM} \cdot GSD^{1.645}$$

The probability of exceeding a target blood lead of 10 µg/dL for the adolescent was calculated by treating the model's central estimate as a geometric mean (GM) and applying a specified geometric standard deviation (GSD) to calculate the fraction of individuals predicted to have a blood lead concentration above 10 µg/dL. The probability of exceeding a target blood lead (PbB_t) of 10 µg/dL was calculated from the following equation:

$$P(Pb_{adult} > 10\ \mu g/dL) = 1 - \text{NORMSDIST}(z)$$

where

NORMSDIST is an Excel® function that returns the standard normal cumulative distribution function, *i.e.*, it gives the percentile corresponding to a certain z-score; and the z-score is given by:

$$z = \frac{\ln(10) - \ln(GM)}{\ln(GSD)}$$

We used US EPA's defaults for the baseline and exposure parameters.[2] Baseline GM and GSD blood lead were obtained from US EPA's analysis of the NHANES III database, using the values for the Northeast region of the US, for all ethnicities combined (US EPA, 2002). Baseline GM blood lead was 1.98 µg/dL, with a GSD of 2.0. The soil ingestion rate was 0.05 g/day. The fraction of incidental ingested soil that comes from the site was assumed to be 0.5. The absorption fraction for lead from soil/dust was 12%. The Biokinetic Slope Factor value was 0.4 µg/dL per µg/day.

The modeling results are summarized below in Table 2, and model calculations are shown on Table 3 (at the end of this report). The results in Table 2 indicate that the recreational use of these sections of Bernhart Park will result in only modest increases in blood lead level over the baseline. All predicted geomean and 95th percentile blood lead levels are below 10 µg/dL. In addition, for all grids, there is less than a 5% probability of exceeding a blood lead of 10 µg/dL.

Table 2
Blood Lead Modeling Results

Area	Sample Grid	GM PbB	Probability PbB >10 µg/dL
South of Spillway	MM	2.2	1.6%
Northwest Hillside	NN	2.3	1.7%
	OO	2.2	1.5%
	PP	2.3	1.7%
	QQ	2.2	1.6%
	RR	2.2	1.4%
	SS	2.2	1.6%
	DDD	2.2	1.5%
Islands/Peninsula	TT	2.2	1.5%
	UU	2.3	1.8%
	ZZ	2.1	1.2%

[2] We believe that some of these default values, including soil ingestion rate, absorption fraction, and perhaps others, are higher than may be experienced by visitors to the site. However, the result of using high estimates for exposure factors is to be overly protective, and does not change the conclusion of our analysis.

5 Conclusions

This report assesses the potential exposure of adolescent recreational users of the Northwest portion of Bernhart Park to lead in soil. Blood lead levels were modeled for 11 sampling grids at the Park, that are located along the northwest hillside, and in the island/peninsula area.

Blood lead levels were estimated with US EPA's Adult Lead Model for adolescents. Model results show that no significant elevations in blood lead levels are expected due to Park usage, and all estimated blood lead levels remain below US EPA's level of concern, which is a 5% probability of a blood lead level above 10 µg/dL.

We therefore conclude that the northwest hillside and the island/peninsula area of Bernhart Park can currently be used for recreational activities with no concern for excessive exposure to lead.

References

Advanced Geoservices Corporation (AGC). 2001. "Sampling Results for Bernhart Park, Exide Technologies, Reading, PA." August 10.

US EPA. 2002. "Blood Lead Concentrations of U.S. Adult Females: Summary Statistics from Phases 1 and 2 of the National Health and Nutrition Evaluation Survey (NHANES III)." Office of Solid Waste and Emergency Response. EPA OSWER #9285.7-52. March.

US EPA. 2003. "Recommendations of the Technical Review Workgroup for Lead for an Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil." EPA-540-R-03-001. January.

Tables

Table 3
Predicted Blood Lead for Adolescent at Bernhart Park
Baseline PbB for Northeast Region, Ethnicity = All

Exposure Variable	Description of Exposure Variable	Units	Hillside Exposure Area							Islands/Peninsula Exposure Area			
			PP	QQ	RR	SS	DDD	NN	OO	MM	TT	UU	ZZ
PbS	Soil lead concentration - Site	µg/g	1155	1006	743	1016	963	4845	3655	2028	1973	2713	1022
Fs	Fraction of soil ingestion from site	--	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
BKSF	Biokinetic Slope Factor	µg/dL per µg/day	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
GSD_i	Geometric standard deviation PbB	--	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
PbB_0	Baseline PbB	µg/dL	1.98	1.98	1.98	1.98	1.98	1.98	1.98	1.98	1.98	1.98	1.98
IR_S	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050
IR_{S+D}	Total ingestion rate of outdoor soil and indoor dust	g/day	--	--	--	--	--	--	--	--	--	--	--
W_S	Weighting factor; fraction of IR_{S+D} ingested as outdoor soil	--	--	--	--	--	--	--	--	--	--	--	--
K_{SD}	Mass fraction of soil in dust	--	--	--	--	--	--	--	--	--	--	--	--
$AF_{S, D}$	Absorption fraction (same for soil and dust)	--	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
$EF_{S, D}$	Exposure frequency (same for soil and dust)	days/yr	80	80	80	80	80	20	20	40	40	40	40
$AT_{S, D}$	Averaging time (same for soil and dust)	days/yr	365	365	365	365	365	365	365	365	365	365	365
PbB_{adult}	PbB of adult, geometric mean	µg/dL	2.3	2.2	2.2	2.2	2.2	2.3	2.2	2.2	2.2	2.3	2.1
$PbB_{Adult, 0.95}$	95th percentile PbB for Adults	µg/dL	7.1	7.0	6.8	7.0	7.0	7.2	6.9	7.0	7.0	7.3	6.6
PbB_t	Target PbB level of concern (e.g., 10 ug/dL)	µg/dL	10	10	10	10	10	10	10	10	10	10	10
$P(Pb_{adult} > PbB_t)$	Probability that Adult PbB > PbB_t, assuming lognormal distribution	%	1.7%	1.6%	1.4%	1.6%	1.5%	1.7%	1.5%	1.6%	1.5%	1.8%	1.2%

Notes:
PbB and GSD Data from (US EPA, 2002), for Northeast Region of US, Ethnicity = All.
Calculation assumes 50% of daily soil ingestion is from the site, on site visit days.

US EPA. 2002. "Blood Lead Concentrations of U.S. Adult Females: Summary Statistics from Phases 1 and 2 of the National Health and Nutrition Evaluation Survey (NHANES III)." Office of Solid Waste and Emergency Response. EPA OSWER #9285.7-52. March.

Source: US EPA. 2003. "Recommendations of the Technical Review Workgroup for Lead for an Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil." EPA-540-R-03-001. January.

Figures

BERNHART PARK

W.E. 396.7

PARKING AREA

PARKING AREA

CRYSTAL

ROAD

ROAD

ROAD

SPRING VALLEY ROAD

ROCK

LITTLE

AVENUE

416.2

431.8

427.1

442.7

438.3

443.6

416.1

397.3

398.7

397.2

401.1

401.1

398.5

405.7

408.6

409.3

408.5

402.9

401.9

403.0

401.8

407.8

400.4

398.4

403.2

407.7

407.0

407.3

408.8

407.0

479.1

400.8

367.5

405.1

405.2

405.4

LEGEND

— SITE BOUNDARY

— SURFACE WATER

N

APPROXIMATE SCALE IN FEET

180 0 180 360

MAP SOURCE: ADVANCED GEOSERVICES CORP.

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FIGURE 1

BERNHART PARK
SITE PLAN

Reading, PA

DRAWN BY:	RJAM	REVISED BY:	RLM	PROJ. NO.:	199045
DATE:	01/15/08	DATE:	01/15/08	FILE:	...02Contours

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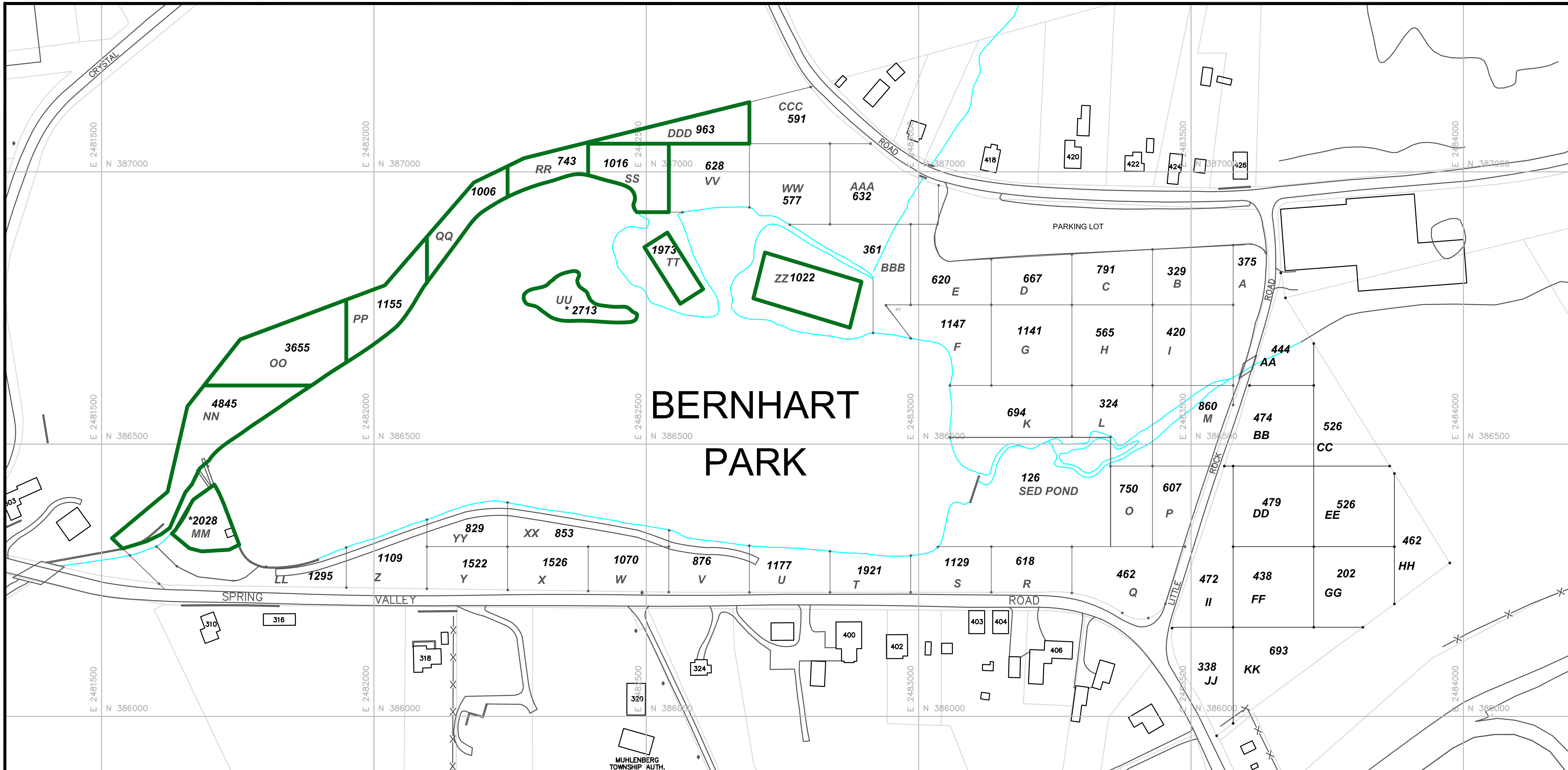

LEGEND

- SAMPLING GRIDS EVALUATED
- #### – MEAN TOTAL LEAD mg/kg UNLESS OTHERWISE NOTED
- * – 1 COMPOSITE SAMPLE OF 5 DISCRETE SAMPLES (PER K. DAO USEPA).
- SURFACE WATER

N

APPROXIMATE SCALE IN FEET

180 0 180 360

MAP SOURCE: ADVANCED GEOSERVICES CORP.

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FIGURE 2

BERNHART PARK SAMPLING GRID AND SOIL LEAD CONC.

Reading, PA

DRAWN BY: RJAM	REVISED BY: RLM	PROJ. NO.: 199045
DATE: 03/25/08	DATE: 03/25/08	FILE: ...01SoilConc

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