APPENDIX E

METHOD TO ESTIMATING TOTAL SOIL-LEAD CONCENTRATION FROM ANALYTICAL RESULTS FOR FINE AND COARSE SOIL FRACTIONS

Method to Estimating Total Soil-Lead Concentration from Analytical Results for the Fine and Coarse Soil Fractions

In an effort to reflect bioavailable lead in soil, the Rochester Lead-in-Dust study partitioned their collected soil samples into fine- and coarse-sieved fractions. The soil-lead concentration of the complete sample (i.e., total soil) was not measured. The absence of such a measure limits the ability to compare the soil results from the Rochester study with those of other studies. The recent Milwaukee study, however, also fractioned their soil samples but made provisions to simultaneously measure total soil-lead. This appendix describes an effort to use the results of the Milwaukee study to estimate the soil-lead concentration of total soil for samples collected in the Rochester study.

The Milwaukee study data available for this analysis represented 66 paired samples collected at the child's play area and the residence's drip line. The same sieve-fraction used in the Rochester was employed in Milwaukee. For each collected sample, the lead concentration of fine-sieved, coarse-sieved and total soil was measured. The mass of each soil fraction was not reported.

Figures E-1 and E-2 compare the Milwaukee and Rochester study data. In particular, these figures plot the coarse versus the fine soil-lead concentrations for the play area and drip line measurements, respectively. Distinct plotting symbols delineate samples from the two studies. These plots show that the data range and scatter about the trend line are considerably greater in the Rochester study than in the Milwaukee study.

A likelihood ratio test was used to assess whether linear models for the two studies were statistically different. Results for play area samples in the two studies (Figure E-1) do evidence statistically ($p<.01$) distinct linear relationships between fine- and coarse-sieved soil-lead concentrations. Results for drip line samples in the two studies (Figure E-2) were not statistically distinct at the 0.05 level. These analyses suggest there are some differences in the fine- versus coarse-sieved soil-lead concentration relationships measured in these studies. These differences should be acknowledged when considering the merits of the Rochester total soil estimation procedure outlined below.

To estimate the soil-lead concentration of total soil, it is useful to consider how total soil-lead concentration may be calculated from fine- and coarse-sieve soil-lead concentrations and masses. Specifically, let x_f/y_f and x_c/y_c represent the micrograms of lead (x) per gram of soil (y) for fine- and coarse-sieved fractions, respectively, of a soil sample. The sample's total soil-lead concentration, then, can be written as follows:

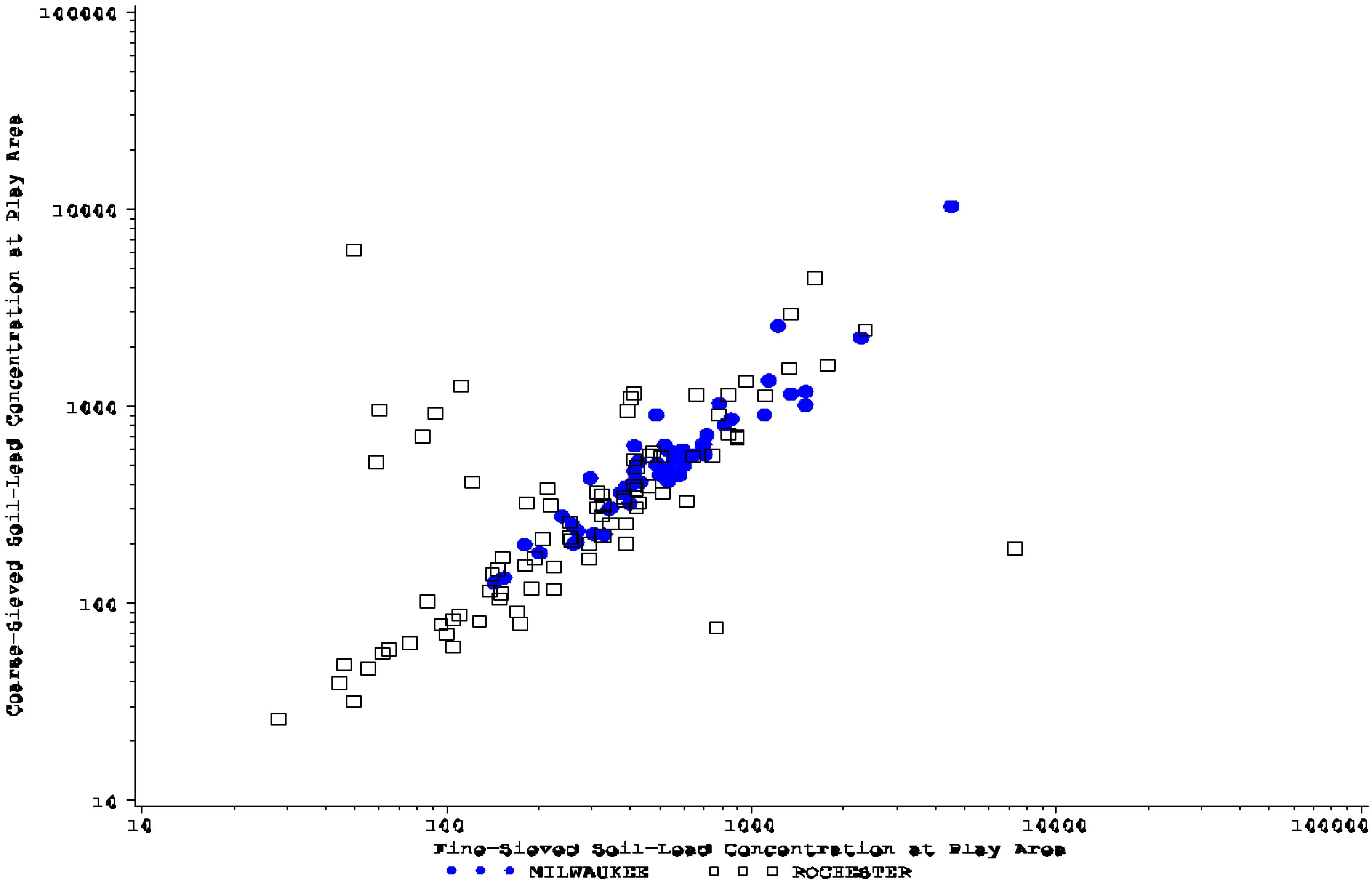

Figure E-1. **Coarse- versus Fine-Sieved Soil Lead Concentration Measured at Child's Play Area during Rochester and Milwaukee Studies**

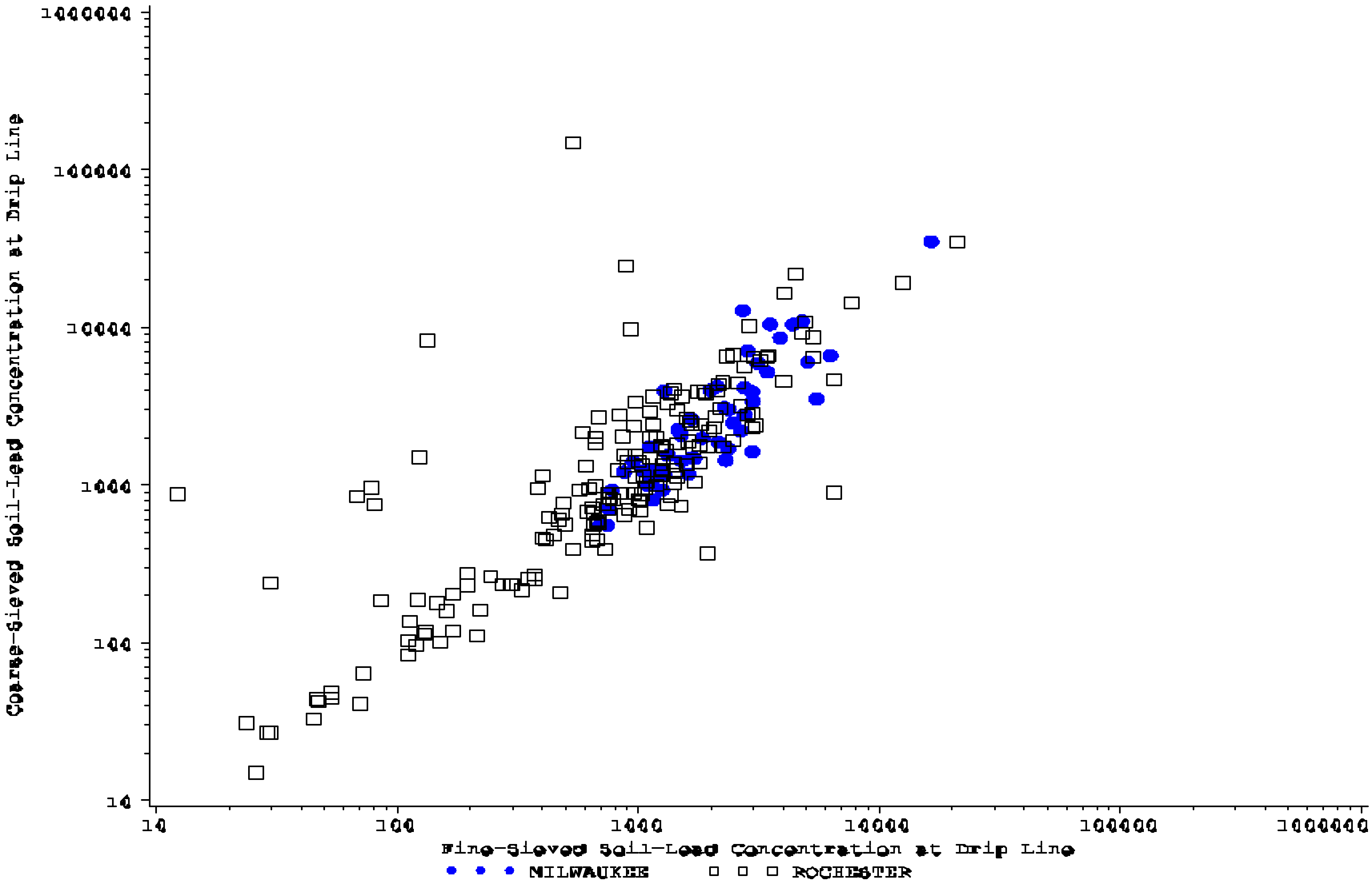

Figure E-2. **Coarse- versus Fine-Sieved Soil Lead Concentration Measured at the Drip Line during Rochester and Milwaukee Studies**

$$\frac{x_f + x_c}{y_f + y_c} = \frac{y_f}{y_f + y_c} \cdot \frac{x_f}{y_f} + \frac{y_c}{y_f + y_c} \cdot \frac{x_c}{y_c}$$

$$= \frac{y_f}{y_f + y_c} \cdot \frac{x_f}{y_f} + \left(1 - \frac{y_f}{y_f + y_c}\right) \cdot \frac{x_c}{y_c}$$

$$= b\left(y_f, y_c\right) \cdot \frac{x_f}{y_f} + \left(1 - b\left(y_f, y_c\right)\right) \cdot \frac{x_c}{y_c} \quad \text{where } \beta\left(y_f, y_c\right) = \frac{y_f}{y_f + y_c} .$$

Thus, a sample's total soil-lead concentration can be written as a function of the sample's fine-sieved soil mass fraction and the sample's fine- and coarse-sieved soil-lead concentrations. Since the sieved soil mass fractions were not reported in the Milwaukee study, some assumptions regarding these fractions were required. For the sake of simplicity, the fine-sieved soil mass fraction was assumed constant. The total soil-lead concentration, then, is a weighted combination of the fine- and coarse-sieved soil-lead concentrations,

$$\frac{x_f + x_c}{y_f + y_c} \cong b \cdot \frac{x_f}{y_f} + \left(1 - b\right) \cdot \frac{x_c}{y_c} \qquad .$$

Such a simple model is critical since the fine- and coarse-sieved soil-lead concentrations were the only soil results reported in the Milwaukee study (i.e., no mass fraction data are available).

The model equation specified above was fit to both the play area and drip line data in the Milwaukee study using the NLIN procedure in the SAS® System. This module was used because it permitted the necessary link between the coefficients on fine- and coarse-sieved soil-lead concentration. The estimated value for β was approximately 0.25 when fitting the aforementioned relationship to the play area samples alone, the drip line samples alone, and to both sets of samples together. That is, the Milwaukee data suggested the following:

Total soil-lead concentration = 0.25·(Fine) + 0.75·(Coarse).

Figure E-3 presents the results of fitting the above model to the Milwaukee data. The plot is of the predicted total soil-lead concentration versus the observed total soil-lead concentrations. Distinct plotting symbols represent the different sampling locations (drip line or play area). As expected, the fit is more than reasonable for both locations.

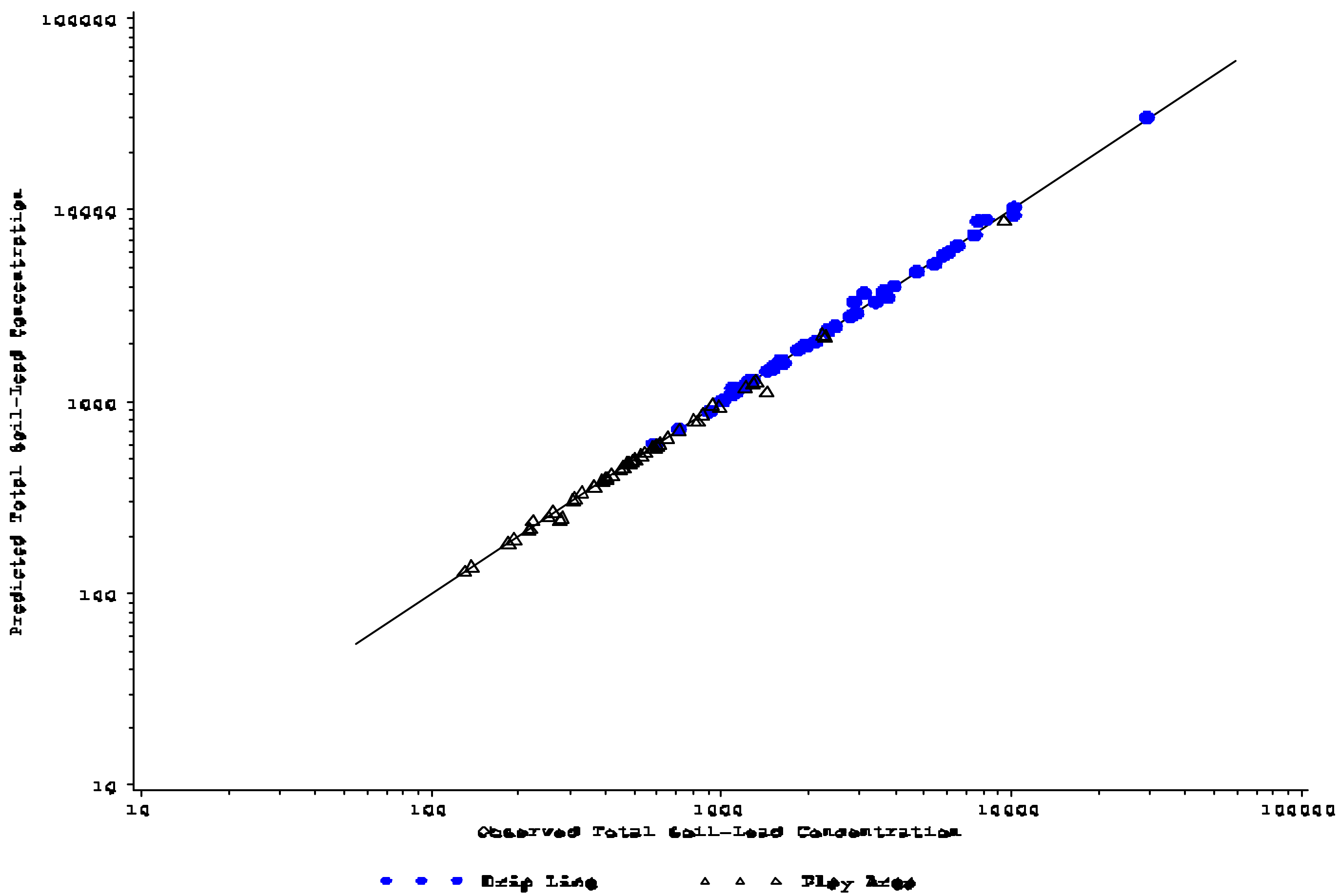

Figure E-3. Predicted versus Observed Total Soil-Lead Concentration by Sampling Location (Milwaukee Study)