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**Mercury Concentrations in Air
during the Phase I Remediation
of the Lower East Fork
Poplar Creek Floodplain
at the Oak Ridge Y-12 Plant,
Oak Ridge, Tennessee**

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UCN-17560 (6 8-95)

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Energy Systems Environmental Restoration Program

**Mercury Concentrations in Air
during the Phase I Remediation
of the Lower East Fork
Poplar Creek Floodplain
at the Oak Ridge Y-12 Plant,
Oak Ridge, Tennessee**

M. O. Barnett, J. G. Owens, S. E. Lindberg, and R. R. Turner

Date Issued—January 1997

Prepared by
Environmental Sciences Division
Oak Ridge National Laboratory
Oak Ridge, Tennessee

Prepared for the
U.S. Department of Energy
Office of Environmental Management
under budget and reporting code EW 20

Environmental Management Activities at the
OAK RIDGE Y-12 PLANT
Oak Ridge, Tennessee 37831
managed by
LOCKHEED MARTIN ENERGY SYSTEMS, INC.
for the
U.S. DEPARTMENT OF ENERGY
under contract DE-AC05-84OR21400

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PREFACE

This report summarizes the results of off-site air monitoring for mercury during the Phase I remediation of the Lower East Fork Poplar Creek floodplain soils as part of the remedial efforts pursuant to the Comprehensive Environment Response, Compensation and Liability Act of 1980 as amended by the Superfund Amendments and Reauthorization Act of 1986 and the Federal Facility Agreement. This work was performed under Work Breakdown Structure 1.4.12.3.1.04, Activity Data Sheet 9304, "Lower East Fork Poplar Creek."

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EXECUTIVE SUMMARY

During the Phase I remediation of Lower East Fork Poplar Creek (LEFPC), the mercury concentration in air was monitored continuously at a nearby off-site location. The purpose of the monitoring was to ensure that the remediation did not adversely affect the off-site concentration of mercury in air. The concentrations of mercury in air did increase during the remediation. However, based on the results of a previous study, this increase was caused by the increase in sunlight intensity and temperature during remediation, which occurred in the summer months. In any case, all concentrations measured before, during, and after remediation were well below the standard of 300 ng/m³ recommended for continuous exposure to mercury in air.

1. INTRODUCTION

During Phase I of the remediation of the LEFPC floodplain, continuous mercury air monitoring was performed at the National Oceanic and Atmospheric Administration site, approximately 200 m northeast of the Phase I excavation area [see Fig. 1 in DOE 1996 (Ref. 1)]. The purpose of the air monitoring was to ascertain whether the excavation adversely impacted the airborne mercury in the surrounding area. The purpose of this report is to describe the results of this monitoring.

2. ANALYTICAL METHODS

A Tekran Model 2537A Mercury Vapor Analyzer was used to monitor airborne mercury in the floodplain. The Tekran analyzer can provide continuous monitoring of total gaseous mercury in the sub-ng/m³ level. The Tekran is thus many times more sensitive than typical hand-held mercury vapor analyzers used in occupational settings and is capable of measuring mercury concentrations at ambient (i.e., uncontaminated) levels. The Tekran uses cartridges containing a gold-coated absorbent. As air is passed through the cartridge, gaseous mercury amalgamates with the gold and is trapped in the cartridge. After a given interval, the cartridge is heated, releasing the amalgamated mercury which is detected and quantified using cold vapor atomic fluorescence spectroscopy. By measuring the amount of mercury (mass) retained in and then released from the cartridge and knowing the total amount of air (volume) passed through the cartridge, the average mercury concentration (mass mercury/volume air) over the sampling period can be calculated. The Tekran uses a dual-cartridge system. As one cartridge is being used, the other is being analyzed. Alternating the cartridges in this manner allows continuous air monitoring. The Tekran was used to monitor ambient levels of mercury in the floodplain in 30-min intervals continuously from March 10 to October 14, 1996. This time frame allowed the establishment of a baseline and encompassed the Phase I excavation period from July 27 to September 6, 1996.

3. RESULTS AND DISCUSSION

The monitoring results are shown in Figs. 1–6. These data are 30-min-average gaseous mercury concentrations in air over the time frame indicated. Table 1 is a statistical summary of the data by month and period (before, during, and after excavation). It should be noted that the data, over any given time period, are not normally distributed, and transforming the data (i.e., log transformation) did not result in a normal distribution. The distribution of the data is illustrated in Fig. 7 for the area during excavation (other distributions are similarly shaped). The distribution is right-skewed (i.e., has a long-tail to the right). As shown in Table 1, this results in the mean value being larger than the median and the highest value being much larger than the 95th-percentile value.

One phenomenon of note in Table 1 is the mercury concentrations relative to excavation. The mean, median, and 95th-percentile values are larger during excavation than either before or after excavation. However, rather than reflecting an increase in mercury concentration because of

Table 1 Statistical Summary of the Air-Monitoring Data. All concentrations are given in ng/m³.

Time	Mean	Median	Standard Deviation	Minimum Value	Maximum Value	95th Percentile
<u>Month</u>						
March	5.03	2.92	4.33	1.73	27.2	14.9
April	5.07	3.29	4.27	1.71	30.1	14.3
May	6.25	4.28	5.76	1.70	46.3	18.3
June	7.74	5.92	6.36	1.69	60.8	19.7
July	7.13	5.77	5.44	1.61	50.4	17.3
August	8.51	6.41	7.22	1.65	58.2	22.3
September	4.67	3.67	3.47	1.44	38.9	11.4
October	3.21	2.44	1.98	1.50	11.8	7.6
<u>Time Period Relative to Excavation</u>						
Before	6.31	4.35	5.51	1.61	60.8	17.3
During	7.77	5.89	6.60	1.56	58.2	20.7
After	4.13	3.14	3.12	1.44	38.9	10.2
Before + After	5.84	4.01	5.17	1.44	60.8	16.0

excavation, these higher values are thought to reflect temperature and sunlight differences, which coincidentally occurred during remediation. Both sunlight and temperature are known to increase mercury fluxes from soils. The diurnal cycles caused by the increase in temperature and sunlight during the day are readily apparent in Figs. 1 - 6. The excavation intentionally coincided with some of the warmest and sunniest time periods during the summer months so groundwater levels would be low. Lindberg, et al. (Ref. 2) have shown that mercury fluxes from LEFPC soils increase during the summer and peak during August, the month where most of the excavation occurred. Figure 8 is a plot of the median monthly mercury concentrations and the modeled monthly emission data taken from Lindberg, et al. (Ref. 2). The concentration and predicted flux relationships reflect one another very closely. Therefore, the increase in mercury concentration in air seen during the excavation relative to the baseline is attributed to increased emissions resulting from increased temperatures and sunlight, not to the excavation.

In absolute terms, the data reflect our general beliefs about the concentration of mercury in air in the floodplain—the mercury concentrations may be slightly above background but are much too low to be a human health threat. The mean concentrations ranged from 3.2–8.5 ng/m³, and the median concentrations ranged from 2.4 - 6.4 ng/m³. Background levels vary from 1–2 ng/m³ over the open ocean, approximately 1–2 ng/m³ at Walker Branch Watershed and to 4–6 ng/m³ at a background site in Indiana. The values in the floodplain are at or slightly above these background values. The recommended continuous (24 h/day, 365 days/year) exposure level is 300 ng/m³, well above the levels measured. For perspective, the concentration requiring respiratory protection in the workplace is 50,000 ng/m³. The concentrations measured at LEFPC in this study would not even have been detectable with instruments typically used for occupational safety.

4. SUMMARY AND CONCLUSIONS

Mercury concentrations in air were measured continuously from March 10 to October 14, 1996 in support of the Phase I remediation effort at LEFPC. The mercury concentrations increased during the excavation. However, this increase was attributed to the coincidental increase in temperature and sunlight during most of the excavation. The monthly median concentrations varied in good agreement with modeled emissions data from an earlier investigation. In absolute terms, the mercury concentrations in the floodplain, although slightly above background, are well below the recommended human health thresholds.

5. REFERENCES

1. U. S. Department of Energy, 1996. *Post Construction Report for Lower East Fork Poplar Creek, Phase I, Oak Ridge, Tennessee*. Prepared by Foster Wheeler Environmental Corporation. (STD no. 96-1535-49342).
2. Lindberg, S. E., K. Kim, T. P. Myers and J. G. Owens, 1995. "Micrometeorological gradient approach for quantifying air/surface exchange of mercury vapor: Tests over contaminated soils." *Environmental Science and Technology*. 28(1): 126-135.

Figure 1 Data for March and April

Figure 2 Data for May

June

Figure 3 Data for June

Figure 4 Data for July

Figure 5 Data for August

Figure 6 Data for September and October

Figure 7 Distribution of Air Concentrations during Excavation

Figure 8 Mercury Concentration and Flux versus Month.
Flux data taken from Lindberg et al. (2).

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1. L. V. Asplund
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