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RESEARCH AND DEVELOPMENT DEPARTMENT

REPORT NO. 03-21-A

TRACE ELEMENT CONCENTRATIONS IN STREET DUST AND SURFACE SOILS IN THE DRAINAGE BASINS OF THE STICKNEY AND CALUMET WATER RECLAMATION PLANTS

VOLUME 1

October 2003

Metropolitan Water Reclamation District of Greater Chicago
100 East Erie Street Chicago, IL 60611-2803 (312) 751-5600

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VOLUME 1

By

Thomas C. Granato
Soil Scientist III

Zainul Abedin
Biostatistician

Odona Dennison
Sanitary Chemist I

Sarah Zumpano
Sanitary Chemist I

Richard I. Pietz
Coordinator of Technical Services

Prakasam Tata
Assistant Director of Research and Development
Environmental Monitoring and Research Division
(Retired)

Cecil Lue-Hing
Lue-Hing and Associates

Research and Development Department
Richard Lanyon, Director

October 2003

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ACKNOWLEDGEMENTS

The authors wish to acknowledge Mr. Bernard Sawyer, Assistant Director of R&D - EM&R Division, who proposed the initial portion of this study in 1995 as part of a large study he was conducting on sources of lead in Imhoff sludge at the Stickney Water Reclamation Plant (WRP).

The authors are indebted to Mr. Thomas McGuiggan, Vacation Relief Laboratory Technician, for his assistance in developing the sample collection protocol utilized in this study, his development of a sector sampling system for the Stickney WRP basin and the many samples he collected. The authors are also appreciative of the efforts of Mr. Ronald Saric, Laboratory Assistant; Mr. Paul Clark, Vacation Relief Laboratory Technician; Mr. Robert Hermann, Laboratory Technician II; Ms. Alberta Johnson, Laboratory Technician II (retired); Ms. Tricia Stefanich, Laboratory Technician II; Mr. Thota Reddy, Laboratory Technician I; and Ms. Deborah Porozynski, Laboratory Assistant, in collecting samples from throughout the Stickney and Calumet WRP basins.

The authors wish to thank Mr. Audit Chaudory, Contract Technician; Ms. Corina Fitzpatrick, Vacation Relief Technician; Ms. Rebecca Rose, Laboratory Technician I; and Ms.

Tricia Stefanich, Laboratory Technician II; for their careful extraction of the samples for elemental analysis.

The authors also wish to acknowledge the staff of the Analytical Laboratories Division at the Calumet and Egan WRPs for their careful elemental analysis of the samples. Particular thanks are owed to Mr. John Gschwind, Sanitary Chemist IV; Mr. John Chavich, Sanitary Chemist IV; Mr. Thomas Liston, Sanitary Chemist III; Mr. Joseph Calvano, Sanitary Chemist III; Mr. Ronald Rivers, Sanitary Chemist I; and Mr. Herbert Lopatka, Sanitary Chemist I, for their dedicated oversight of the samples and their analysis.

The authors appreciate the contribution of Ms. Zoe Mather, Sanitary Chemist I (retired), in evaluating and tabulating the data from the 1995 sampling. The authors also appreciate the work of Ms. Corina Fitzpatrick, Vacation Relief Laboratory Technician, and Ms. Janelle Fitzpatrick, Vacation Relief Laboratory Technician, in assisting with the establishment of a sample archiving system.

The authors are indebted to Mr. Gary Pump for providing biosolids quality data for the Stickney and Calumet WRPs and to Ms. Joan Scrima, Ms. Nancy Urlacher, and Ms. Sabina Yarn for their assistance in producing this report.

DISCLAIMER

Mention of proprietary equipment and chemicals in this report does not constitute endorsement by the Metropolitan Water Reclamation District of Greater Chicago.

SUMMARY AND CONCLUSIONS

In order to assess the possible contribution of non-point sources of trace elements to the trace element concentrations in biosolids produced at the Calumet and Stickney WRPs, a study of trace element concentrations in street dust and surface soils in the Calumet and Stickney WRP drainage basins was conducted.

A total of 519 and 249 street dust and surface soil samples were collected from the Stickney and Calumet WRP basins, respectively, from 1995 to 1998 and were analyzed for 20 elements including 16 trace elements that can originate from anthropogenic contamination.

Trace Element Concentrations in Street Dust and Surface Soils From the Stickney and Calumet WRP Basins Compared with Expected Concentrations for Metropolitan Chicago

We reviewed the published literature and utilized the findings of previous studies conducted by the Research and Development (R&D) Department to determine the expected concentration ranges for 16 trace elements that were analyzed in soils of the Metropolitan Chicago area for this study.

ANTIMONY (Sb)

The expected mean Sb concentration in relatively uncontaminated soils of Metropolitan Chicago is 4.0 mg Kg^{-1}, and its concentration is expected to range from 0.2 to 10 mg Kg^{-1}.

In the Stickney WRP basin, the mean Sb concentration in all street dust and surface soil samples analyzed was 1.26 mg Kg^{-1}, and its concentration ranged from <0.08 to 13.59 mg Kg^{-1}.

In the Calumet WRP basin the mean Sb concentration in all street dust and surface soil samples analyzed was 0.86 mg Kg^{-1}, and its concentration ranged from <0.08 to 17.40 mg Kg^{-1}.

There was no significant or widespread contamination of street dust or surface soils with Sb in the basins of the Calumet or Stickney WRPs.

ARSENIC (As)

The expected mean As concentration in uncontaminated soils of Metropolitan Chicago is 13.0 mg Kg^{-1}, and its concentration is expected to range from <1 to 97 mg Kg^{-1}.

In the Stickney WRP basin the mean As concentration in all street dust and surface soil samples analyzed was 4.97 mg Kg^{-1}, and its concentration ranged from <0.10 to 33.47 mg Kg^{-1}.

In the Calumet WRP basin the mean As concentration in all street dust and surface soil samples analyzed was 5.05 mg Kg^{-1}, and its concentration ranged from <0.10 to 26.30 mg Kg^{-1}.

There was no significant or widespread contamination of street dust or surface soils with As in the basins of the Calumet or Stickney WRPs.

BARIUM (Ba)

The expected mean Ba concentration in uncontaminated soils of Metropolitan Chicago is 110 mg Kg^{-1}, and its concentration is expected to range from 10 to 5,000 mg Kg^{-1}.

In the Stickney WRP basin the mean Ba concentration in all street dust and surface soil samples analyzed was 100.5 mg Kg^{-1}, and its concentration ranged from 3.2 to 754.5 mg Kg^{-1}.

In the Calumet WRP basin the mean Ba concentration in all street dust and surface soil samples analyzed was 73.4 mg Kg^{-1}, and its concentration ranged from 8.8 to 392.0 mg Kg^{-1}.

There was no significant or widespread contamination of street dust or surface soils with Ba in the basins of the Calumet or Stickney WRPs.

BERYLLIUM (Be)

The expected mean Be concentration in uncontaminated soils of Metropolitan Chicago is 0.60 mg Kg^{-1}, and its concentration is expected to range from <0.1 to 15 mg Kg^{-1}.

In the Stickney WRP basin the mean Be concentration in all street dust and surface soil samples analyzed was 0.07 mg Kg^{-1}, and its concentration ranged from <0.01 to 2.95 mg Kg^{-1}.

In the Calumet WRP basin the mean Be concentration in all street dust and surface soil samples analyzed was 0.13 mg Kg^{-1}, and its concentration ranged from <0.01 to 2.12 mg Kg^{-1}.

There was no significant or widespread contamination of street dust or surface soils with Be in the basins of the Calumet or Stickney WRPs.

CADMIUM (Cd)

The expected mean Cd concentration in uncontaminated soils of Metropolitan Chicago is 0.20 mg Kg^{-1}, and its concentration is expected to range from <0.1 to 2.00 mg Kg^{-1}.

In the Stickney WRP basin the mean Cd concentration in all street dust and surface soil samples analyzed was 4.15 mg Kg^{-1}, and its concentration ranged from <0.01 to 26.40 mg Kg^{-1}.

In the Calumet WRP basin the mean Cd concentration in all street dust and surface soil samples analyzed was 2.62 mg Kg^{-1}, and its concentration ranged from <0.01 to 21.00 mg Kg^{-1}.

There was relatively large and widespread contamination of street dust and surface soils with Cd in the basins of the Calumet and Stickney WRPs.

CHROMIUM (Cr)

The expected mean Cr concentration in uncontaminated soils of Metropolitan Chicago is 15.0 mg Kg^{-1}, and its concentration is expected to range from 7.0 to 150.0 mg Kg^{-1}.

In the Stickney WRP basin the mean Cr concentration in all street dust and surface soil samples analyzed was 44.1 mg Kg^{-1}, and its concentration ranged from 0.8 to 734.9 mg Kg^{-1}.

In the Calumet WRP basin the mean Cr concentration in all street dust and surface soil samples analyzed was 52.9 mg Kg^{-1}, and its concentration ranged from 2.0 to 1,817 mg Kg^{-1}.

There was a relatively low level but widespread contamination of street dust and surface soils with Cr in the basins of the Calumet and Stickney WRPs.

COPPER (Cu)

The expected mean Cu concentration in uncontaminated soils of Metropolitan Chicago is 20.0 mg Kg^{-1}, and its concentration is expected to range from <1 to 700 mg Kg^{-1}.

In the Stickney WRP basin the mean Cu concentration in all street dust and surface soil samples analyzed was 152.3 mg Kg^{-1}, and its concentration ranged from <0.08 to 2,523 mg Kg^{-1}.

In the Calumet WRP basin the mean Cu concentration in all street dust and surface soil samples analyzed was 52.6 mg Kg^{-1}, and its concentration ranged from <0.08 to 784.0 mg Kg^{-1}.

There was a relatively low level but widespread contamination of street dust and surface soils with Cu in the basins of the Calumet and Stickney WRPs.

LEAD (Pb)

The expected mean Pb concentration in uncontaminated soils of Metropolitan Chicago is 36 mg Kg^{-1}, and its concentration is expected to range from <0.1 to 150 mg Kg^{-1}.

In the Stickney WRP basin the mean Pb concentration in all street dust and surface soil samples analyzed was 182 mg Kg^{-1}, and its concentration ranged from <0.08 to 3,359 mg Kg^{-1}.

In the Calumet WRP basin the mean Pb concentration in all street dust and surface soil samples analyzed was 127 mg Kg^{-1}, and its concentration ranged from <0.08 to 1,513 mg Kg^{-1}.

There was a relatively large and widespread contamination of street dust and surface soils with Pb in the basins of the Calumet and Stickney WRPs.

MANGANESE (Mn)

The expected mean Mn concentration in uncontaminated soils of Metropolitan Chicago is 636 mg Kg^{-1}, and its concentration is expected to range from <1 to 7,000 mg Kg^{-1}.

In the Stickney WRP basin the mean Mn concentration in all street dust and surface soil samples analyzed was 420 mg Kg^{-1}, and its concentration ranged from 5 to 12,420 mg Kg^{-1}.

In the Calumet WRP basin the mean Mn concentration in all street dust and surface soil samples analyzed was 835 mg Kg^{-1}, and its concentration ranged from 81 to 17,778 mg Kg^{-1}.

There was no significant contamination of street dust or surface soils with Mn in the basins of the Calumet and Stickney WRPs.

MERCURY (Hg)

The expected mean Hg concentration in uncontaminated soils of Metropolitan Chicago is 0.06 mg Kg^{-1}, and its concentration is expected to range from 0.02 to 0.15 mg Kg^{-1}.

In the Stickney WRP basin the mean Hg concentration in all street dust and surface soil samples analyzed was 0.157 mg Kg^{-1}, and its concentration ranged from 0.030 to 0.930 mg Kg^{-1}.

In the Calumet WRP basin the mean Hg concentration in all street dust and surface soil samples analyzed was 0.148 mg Kg^{-1}, and its concentration ranged from 0.010 to 0.980 mg Kg^{-1}.

There was significant and widespread contamination of street dust and surface soils with Hg in the basins of the Calumet and Stickney WRPs.

MOLYBDENUM (Mo)

The expected mean Mo concentration in uncontaminated soils of Metropolitan Chicago is 1.0 mg Kg^{-1}, and its concentration is expected to range from <0.1 to 30 mg Kg^{-1}.

In the Stickney WRP basin the mean Mo concentration in all street dust and surface soil samples analyzed was 2.54 mg Kg^{-1}, and its concentration ranged from <0.08 to 74.72 mg Kg^{-1}.

In the Calumet WRP basin the mean Mo concentration in all street dust and surface soil samples analyzed was 4.06 mg Kg^{-1}, and its concentration ranged from <0.08 to 422.0 mg Kg^{-1}.

With the exception of one street dust sample in the Calumet WRP basin, there was no significant contamination of street dust or surface soils with Mo in the basins of the Calumet and Stickney WRPs.

NICKEL (Ni)

The expected mean Ni concentration in uncontaminated soils of Metropolitan Chicago is 18.0 mg Kg^{-1}, and its concentration is expected to range from 1.0 to 250.0 mg Kg^{-1}.

In the Stickney WRP basin the mean Ni concentration in all street dust and surface soil samples analyzed was 16.81 mg Kg^{-1}, and its concentration ranged from 0.80 to 357.8 mg Kg^{-1}.

In the Calumet WRP basin the mean Ni concentration in all street dust and surface soil samples analyzed was 14.05 mg Kg^{-1}, and its concentration ranged from 2.0 to 106.0 mg Kg^{-1}.

There was no significant contamination of street dust or surface soils with Ni in the basins of the Calumet and Stickney WRPs.

SELENIUM (Se)

The expected mean Se concentration in uncontaminated soils of Metropolitan Chicago is 0.48 mg Kg^{-1}, and its concentration is expected to range from <0.1 to 4.3 mg Kg^{-1}.

In the Stickney WRP basin Se was only detected in four samples, and the mean concentration in all street dust and surface soil samples analyzed was 0.120 mg Kg^{-1}. The Se concentration ranged from <0.200 to 8.000 mg Kg^{-1}.

In the Calumet WRP basin Se was not detected in any of the samples that were analyzed.

There was no significant contamination of street dust or surface soils with Se in the basins of the Calumet and Stickney WRPs.

SILVER (Ag)

The expected mean Ag concentration in uncontaminated soils of Metropolitan Chicago is 0.55 mg Kg^{-1}, and its concentration is expected to range from <0.1 to 5.0 mg Kg^{-1}.

In the Stickney WRP basin the mean Ag concentration in all street dust and surface soil samples analyzed was 3.20 mg Kg^{-1}, and its concentration ranged from <0.01 to 34.76 mg Kg^{-1}.

In the Calumet WRP basin the mean Ag concentration in all street dust and surface soil samples analyzed was 0.91 mg Kg^{-1}, and its concentration ranged from 0.04 to 11.95 mg Kg^{-1}.

There were a small number of street dust samples with significant Ag contamination in the basins of the Calumet and Stickney WRPs. These samples were not in close proximity to each other, but randomly distributed across much of the basins. Aside from them, there was no widespread contamination of street dust or surface soils with Ag in the Calumet and Stickney WRP basins.

THALLIUM (Tl)

The expected mean Tl concentration in uncontaminated soils of Metropolitan Chicago is 0.32 mg Kg^{-1}, and its concentration is expected to range from 0.1 to 0.8 mg Kg^{-1}.

In the Stickney WRP basin the mean Tl concentration in all street dust and surface soil samples analyzed was 2.10 mg Kg^{-1}, and its concentration ranged from <0.20 to 7.51 mg Kg^{-1}.

In the Calumet WRP basin the mean Tl concentration in all street dust and surface soil samples analyzed was 1.62 mg Kg^{-1}, and its concentration ranged from <0.20 to 5.00 mg Kg^{-1}.

There was significant and widespread contamination of street dust and surface soils with Tl in the basins of the Calumet and Stickney WRPs.

ZINC (Zn)

The expected mean Zn concentration in uncontaminated soils of Metropolitan Chicago is 95.0 mg Kg^{-1}, and its concentration is expected to range from <0.1 to 300 mg Kg^{-1}.

In the Stickney WRP basin the mean Zn concentration in all street dust and surface soil samples analyzed was 361 mg Kg^{-1}, and its concentration ranged from <0.20 to 5,828 mg Kg^{-1}.

In the Calumet WRP basin the mean Zn concentration in all street dust and surface soil samples analyzed was 302 mg Kg^{-1}, and its concentration ranged from 19 to 3,343 mg Kg^{-1}.

There was significant and widespread contamination of street dust and surface soils with Zn in the basins of the Calumet and Stickney WRPs.

We have drawn the following conclusions based on these results:

1. The mean and range of concentrations for Ba, Mn, Mo, and Ni correspond well to expected values for Chicagoland soils, and there is not significant anthropogenic contamination of soils or street dust in the Calumet and Stickney WRP basins with these elements.
2. The trace elements Sb, As, Be, and Se are present at concentrations lower than expected in street dust and surface soils from the Calumet and Stickney WRP basins, and there is no significant anthropogenic contamination of soils or street dust in the Calumet and Stickney WRP basins with these elements.
3. The results of the study indicate that the trace elements Cr, Cu, and Ag are present at higher than expected concentrations in street dust and surface soils from the Calumet and Stickney WRP basins, and that there is widespread low level (mean concentrations 3 to 7 times higher than expected) anthropogenic contamination of soils and street dust in these

basins with Cr and Cu. In contrast, Ag contamination appears to be confined to only a few samples.

4. The results of the study indicate that the trace elements Cd, Pb, Hg, Tl, and Zn are present at much higher than expected concentrations in street dust and surface soils from the Calumet and Stickney WRP basins, and that there is a widespread, high level of anthropogenic contamination of soils and street dust by these trace elements in the basins. For these elements, the overall mean concentrations are approximately equal to, or are higher than the maximum expected concentrations for soils in the Stickney and Calumet WRP basins.

Assessment of the Impact of Run-off of Contaminated Street Dust and Surface Soils on Attainment of Part 503 EQ Biosolids Limits

We examined the potential for run-off of contaminated street dusts and surface soils to impact biosolids quality. Street dust and surface soil run-off poses no significant threat of producing non-attainment of the Part 503 Exceptional Quality (EQ) biosolids limits for As, Cd, Cu, Hg, Mo, Ni, Se, and Zn. These elements had concentrations above the Part 503 EQ limits in less than 1 percent of all street dust and surface soil samples collected from the basins of the Calumet and Stickney WRPs.

Lead poses a small but significant threat for non-attainment since it was present at concentrations above the Part 503 EQ biosolids limit in approximately 10 percent of all samples collected in the Stickney WRP basin and in approximately 7 percent of all samples collected in the Calumet WRP basin.

Run-off from automobile junkyards and scrap metal yards poses a very significant threat to non-attainment of Part 503 EQ biosolids limits for Pb. The mean concentration of Pb in street dust from the periphery of these sites in the Stickney WRP basin was approximately double the Part 503 EQ limit, with the maximum concentrations being 10 times higher than the EQ limit for Pb.

Assessment of the Potential Impact of Run-off of Contaminated Street Dust and Surface Soils on Current Biosolids Trace Element Concentrations

We also examined the potential impact of run-off of contaminated street dust and surface soil on the quality of biosolids currently being produced at the Stickney and Calumet

WRPs. Street dust and surface soil run-off may potentially be an important source of As, Cd and Pb in biosolids from the Stickney WRP. While street dust and surface soil in general do not appear to have a great potential to impact the concentration of Cu in biosolids at the Stickney WRP, street dust from automobile junkyards and scrap metal yards may potentially be a significant source of this trace element.

Street dust and surface soil run-off may potentially be significant sources of Cd, Cr, Pb and Ni in biosolids from the Calumet WRP.

These conclusions are all based strictly on the concentration of trace element observed in the street dust and surface soil samples collected. They are not based on the total mass flow into the WRPs because the measurement of this parameter was beyond the scope of the study.

<u>Comparison of Elemental Composition of Street Dust and Surface Soils in the Stickney WRP Basin with the Calumet WRP Basin</u>

Street dust samples from the Stickney WRP basin had greater mean concentrations of Ag, Ba, Cd, Cu, Mg, Pb, Sb, and Se than samples from the Calumet WRP basin, and the differences were significant ($p<0.05$) for Ag, Cd, Cu, and Se. Street dust samples from the Calumet WRP basin had higher mean concentrations of Al, As, Be, Ca, Cr, Fe, Hg, Mn, Mo, Ni, Tl, and Zn than samples from the Stickney WRP basin, and the differences were significant ($p<0.05$) for Al, Cr, Hg, and Mn.

Surface soil samples from the Stickney WRP basin had greater mean concentrations of Ag, Ba, Cd, Cr, Cu, Fe, Hg, Mn, Mo, Ni, Pb, Sb, Tl, and Zn than samples from the Calumet WRP basin, and the differences were significant ($p<0.05$) for Ag, Ba, Cd, Cr, Cu, Fe, Hg, Mo, Ni, Sb, and Tl. Surface soil samples from the Calumet WRP basin had higher mean concentrations of Al, As, Be, Ca, and Mg than samples from the Stickney WRP basin, but none of the differences were significant ($p<0.05$).

INTRODUCTION

The promulgation of the United States Environmental Protection Agency's (USEPA) Part 503 biosolids use and disposal regulation introduced criteria for defining high quality biosolids based on the concentration of 10 trace elements in Table 3 of Section 503.13 (USEPA, 1993). Since the promulgation of the USEPA's Part 503 regulation, the Metropolitan Water Reclamation District of Greater Chicago (District) has been committed to producing and beneficially utilizing high quality biosolids as a soil conditioner and soil substitute in the Metropolitan Chicago area.

In order to achieve the production of high quality biosolids, the District initiated an intensive industrial waste control enforcement program, referred to as the 503 initiative. This program produced dramatic reductions in the concentration of metals such as Cd, Cr, Ni, Pb, and Zn in the biosolids produced at the District's Water Reclamation Plants (WRPs), particularly the Stickney and Calumet WRPs (Pietz et al., 1999). However, Pb, in particular, did not show as large a decrease as other metals as the 503 initiative progressed.

With the emphasis of the 503 initiative on containing point source discharges of metals to the WRPs, the contribution of metals from non-point sources has been left largely unexamined. One of the largest non-point sources of mass of the biosolids produced at the Stickney and Calumet WRPs is sediment, which is transported to combined sewers by stormwater run-off. After final processing including anaerobic digestion, lagoon aging and air drying, the Calumet and Stickney WRP biosolids contain approximately 35 percent volatile solids and 65 percent nonvolatile solids. Mineral particles originating in topsoil and materials used in the construction of pavements for streets, sidewalks, driveways and parking lots, which are transported in storm water run-off to combined sewers, may comprise a large proportion of the nonvolatile solids content of the Stickney and Calumet WRP biosolids.

The R&D Department has previously conducted a survey of metal concentrations in surface soils collected from around the State of Illinois from 1935 through 1988 (Granato et al., 1992, 1994). It was found that trace element concentrations, particularly Pb, could change with time due to anthropogenic activity. Urban topsoils and street dusts are known to be contaminated with fallout from atmospheric emissions (automobile exhausts, incinerators, factory stacks, etc.); particles produced from wear of automobile parts; paint flakes from old frame homes, and wooden trim around buildings; and debris from a multitude of urban activities (Harrison et al., 1981; Krueger and Duguary, 1989; Lum et al., 1987; Mielke, 1991; Miller and McFee, 1983; Sadiq et al., 1989; and Senesi, et al., 1999).

Since topsoil and street dust in stormwater run-off are a potentially large non-point source of trace elements to biosolids, it is important to characterize their trace element content. The purpose of this study was to collect street dust and topsoil samples from throughout the Stickney and Calumet WRP drainage basins, particularly from the combined sewer areas, and to determine the concentrations of selected trace elements in these samples for the purpose of assessing the possible impact of non-point sources of trace elements on the concentrations of these same elements in the biosolids produced at the Calumet and Stickney WRPs.

MATERIALS AND METHODS

Sample Collection

Samples of surface soil and street dust were collected from the Stickney and Calumet WRP drainage basins. The samples were collected by sweeping loose particles on the street surface (street dust) along a randomly selected length of curb. Alley samples were collected by sweeping particles from the alley surface along an apparent drainage pathway. Surface soil samples were collected from parks, school yards, vacant lots, golf courses or forest preserves by sweeping approximately the top 5-mm depth of particles from areas not supporting appreciable vegetation. While no standard guidelines were followed, street dust was normally collected from several points along a one-block length of curb, and surface soil was sampled from several areas of the selected site.

After sweeping, the samples collected from a length of curb, alley, or from throughout a surface soil sampling site were thoroughly mixed (i.e. all samples taken at the sample point were composited), sieved through a 2-mm screen, air-dried at room temperature, and stored in sealed plastic 500 mL bottles at room temperature.

Stickney WRP Drainage Basin

In 1995, the Stickney WRP drainage basin was sampled. The portion of the Stickney drainage basin approximated by Fullerton Street on the north, 87th Street on the south, Lake Michigan on the east, and DuPage County on the west was divided into approximately 190 sectors, each about one square mile in size. In most cases, five samples were collected from each sector. The samples included street dust from a main street, a side street, and an alley (in sectors that have them), a surface soil, and an additional sample from a location thought to be most representative of the sector (e.g. in highly residential areas an additional side street dust sample was collected).

Special street dust samples were also collected from curbsides adjacent to 12 scrap metal yards and 18 automobile junkyards where drainage from the sites would run. The total number of samples collected in the Stickney WRP drainage basin was 519.

Calumet WRP Drainage Basin

In 1995, samples were taken from sections of the Calumet WRP drainage basin north of 95th Street. This area was divided into approximately one square mile sectors, and 14 sectors were sampled as described above for Stickney. In 1995, a total of 52 samples were collected in the Calumet WRP drainage basin.

In 1998, 197 additional samples were collected from the entire combined sewer service area of the Calumet WRP drainage basin. The 1998 samples were collected randomly from around the service area described above, and consisted primarily of surface soil samples. However, at 21 of the sites where surface soil was collected, a street dust sample was also collected from the adjacent curbsides.

Sample Analysis

ELEMENTAL ANALYSIS

All elements except Hg were extracted by digesting the samples in concentrated HNO_3 utilizing a procedure identical to that utilized by the Analytical Laboratories Division (ALD) to analyze biosolids samples from the treatment plants. The procedure consists of digesting 1.00-g samples in 7.5 mL of concentrated HNO_3 on a hot plate for approximately 1 hour at 90 degrees C. Following this 20 mL of H_2O is added and the samples are refluxed for an additional 30 minutes. Following digestion the samples are filtered and brought to 40 mL final volume with H_2O.

The digested samples were submitted to the ALD for trace element analysis using inductively coupled plasma atomic absorption. All samples collected in 1998 were analyzed for Ag, As, Ba, Be, Cd, Cr, Cu, Fe, Mn, Mo, Ni, Pb, Sb, Se, Tl, and Zn. All samples collected in 1995 were analyzed for Cd, Cr, Ni, and Pb, and selected samples received an expanded array of analysis, including all or some of the following elements: Ag, Al, As, Ba, Be, Ca, Cu, Fe, Mg, Mn, Mo, Sb, Se, Tl, and Zn.

MERCURY ANALYSIS

The samples were digested by a procedure described previously by Granato et al. (1995). The digests were submitted to the ALD for Hg analysis by cold vapor atomic absorption spectroscopy.

Data Review and Analysis

DATA REVIEW AND QUALITY CONTROL

All samples collected from the Stickney and Calumet WRP basins in 1995 were analyzed without replication. The resulting analytical data were subsequently reviewed and samples were selected to be reanalyzed to confirm high trace element concentrations. Samples were reanalyzed if they had Cd, Cr, Cu, Ni, or Pb concentrations above 30, 250, 300, 200, or 300 mg Kg^{-1}, respectively. The samples determined to be high in metal content were redigested in duplicate and submitted for analysis of the expanded set of trace elements that included Ag, As, Ba, Be, Cd, Cr, Cu, Fe, Mn, Mo, Ni, Pb, Se, Tl, and Zn.

If the concentrations in the re-run replicates were close to each other (<35 percent difference), but did not confirm the concentration in the original digest (>35 percent difference between the average of the re-run duplicates and the original), the re-run extracts were sent back to the analytical lab to confirm their concentrations. If this reanalysis confirmed the concentrations in the re-run extracts, then the original value was thrown out and the re-run replicate concentrations were averaged and reported.

If the trace element concentrations in the re-run replicates were close (<35 percent difference), and confirmed the concentration found in the original analysis (<35 percent difference between the average of the re-run duplicates and the original), the three values were averaged and reported.

All of the automobile junkyard and scrap metal yard samples (considered "special"), 32 total samples, were originally digested without replication and submitted for analysis. Then, they were subsequently redigested in duplicate and submitted for analysis. The difference between the trace element

concentrations in the original and redigested samples all came back with values <35 percent difference. These were averaged and reported.

All samples collected from the Calumet WRP basin in 1998 were analyzed in duplicate. The resulting analytical data were subsequently reviewed, and samples having poor reproducibility between duplicate analysis (>35 percent difference) were selected to be reanalyzed. Because the 1998 samples were analyzed in duplicate, no reruns were performed on these samples to confirm high trace element concentrations.

STATISTICAL ANALYSIS

The concentrations of twenty metals were evaluated in samples from alleys, main streets, side streets, surface soils, automobile junkyards, and scrap metal yards. Statistical analyses were performed to find out whether there were any significant differences among the mean concentrations of each metal between sample types including:

(a) Test of significant differences in mean metal concentrations among street dust types (alley, main street, and side street).

(b) Test of significant differences in mean metal concentrations between street dust (here defined as alley + main street + side street), surface soil, automobile junkyard, and scrap metal yard.

(c) Test of significant differences in mean metal concentrations between biosolids and surface soil, and between biosolids and all samples (alley + main street + side street + surface soil + automobile junkyard + scrap metal yard).

The data from each sample type was first tested for normality by Shapiro-Wilk's Test (SAS, 1995). If the test indicates that data in each sample type came from a normally distributed population, then the equality of variability was performed by Bartlett's test (Walpole and Meyers, 1989) or F-test (Walpole and Meyers, 1989). Both Shapiro-Wilk and Bartlett's tests were performed at the 10 percent level of significance to avoid large type II error.

Since these data were all found to violate the assumptions of either normality or equal variance, standard analysis of variance (ANOVA) was not performed. The data for each element were then ranked and the ranked data for each sample type was tested for normality and equality of variance. All ranked data were found to be normally distributed, but variance among sample types was not equal in a few instances. Standard ANOVA was performed on the ranked data regardless of whether the data came from populations with equal variance (SAS/STAT, 1995). If the ANOVA showed that there was a significant difference among means of different sample types, pair-wise comparison of the means was performed by the Student-Newman-Keuls (SNK) method. In the few instances where the ranked data did not have equal variance among sample types, no pair-wise comparisons of the mean were performed.

RESULTS AND DISCUSSION

Due to the large number of samples that were collected and the number of elements that were analyzed on each sample, this study generated a large database. In order to preserve all of the information that was generated for individual samples, we have created two detailed appendices. Appendix 1 contains all of the data generated on samples from the Stickney WRP drainage basin, and Appendix 2 contains all of the data generated on samples from the Calumet WRP drainage basin.

The Stickney and Calumet WRP drainage basins were divided into 21 and 17 areas, respectively, for convenience of locating individual samples. Detailed maps have been made of each area that include the location of each sample that was taken as well as a code indicating the type of sample/sampling point (e.g. street dust from main streets, side streets, or alleys, and surface soil). Also, for each area, detailed tables were prepared that present the results of analyses conducted on each of the samples that were taken.

In order to provide a more concise reporting of the results of the study, we have also computed summary statistics for elemental concentrations, which are presented in this section. The data were tabulated by element and drainage basin

(Calumet WRP and Stickney WRP). All elemental concentrations reported in this study are considered total elemental concentrations, as represented by the concentrated HNO_3 extractable fraction.

Each element concentration summary table, for both drainage basins (Stickney WRP and Calumet WRP), presents the mean; standard deviation; minimum; twenty-fifth percentile; median, or fiftieth percentile; seventy-fifth percentile; and maximum concentrations for the three types of street dust samples taken in this study (street dust from main streets, side streets, and alleys). Results of tests for the statistically significant differences among the mean elemental concentrations in these types of samples is also presented in each table.

In addition, the same summary statistics are presented for all street dust samples (designated as street dust and including main street plus side street plus alley) and surface soil samples for the Calumet WRP tables and for all street dust samples, surface soil samples, automobile junkyard samples and scrap metal yard samples (collected from curbsides adjacent to 18 automobile junkyards and 12 scrap metal yards where drainage from the sites would run) for the Stickney WRP. Results of tests for the statistically significant differences among mean elemental concentrations of these types of samples is also presented in each table.

All of the tables also contain overall summary statistics for elemental concentrations in the entire collection of samples.

Following is a discussion of the analytical results for each of the 20 elements analyzed in this study.

Aluminum (Al) Concentrations in Street Dust and Surface Soils

Aluminum is the most abundant metallic element in the earth's crust, having an average concentration of 81,000 mg Kg^{-1} (Foth, 1978). It occurs primarily in combination with oxygen in octahedral coordination in the crystal lattice of phyllosilicate minerals and as amorphous oxides. Its atomic weight is 26.982 Daltons and its atomic number is 13. Properties of Al, such as its light weight and resistance to oxidative corrosion, make it a very useful element with major anthropogenic sources being the manufacture and use in cans and other containers, in the aerospace industry, and in household foil.

STICKNEY WRP BASIN

The mean Al concentration in the 262 samples analyzed from the Stickney WRP basin was 2,762 mg Kg^{-1}, and the Al concentrations ranged from 9 to a maximum of 10,040 mg Kg^{-1} (Table 1).

The mean Al concentration in street dust samples from alleys, 3,216 mg Kg^{-1}, was found to be significantly higher than the mean Al concentration in street dust samples from main streets, 2,538 mg Kg^{-1}, and side streets, 2,690 mg Kg^{-1} (Table 1).

The mean concentration of Al in all street dust samples collected (alley plus side street plus main street), 2,686 mg Kg^{-1}, was not significantly different ($p<0.05$) from the mean Al concentration in surface soil samples, 3,006 mg Kg^{-1}.

The mean concentrations of Al in street dust samples from the perimeter of automobile junkyards and scrap metal yards were 3,191 and 2,678 mg Kg^{-1}, respectively, (Table 1). These mean Al concentrations were not significantly different than those observed for all other street dust samples or surface soil samples (Table 1).

These mean concentrations were low in comparison with the mean concentration for Earth's crust, as discussed above, because the analytical method utilized in this study did not completely dissolve the crystal lattice of mineral materials in the street dusts and surface soils. Hence, the method did not solubilize the Al contained within the phyllosilicate minerals.

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TABLE 1

CONCENTRATION OF ALUMINUM IN STREET DUST AND SURFACE SOIL
COLLECTED IN THE STICKNEY WATER RECLAMATION PLANT DRAINAGE BASIN

Sample Type[1]		No. Obs	Mean	STD	Min	25th	Median	75th	Max	Sig. Prob
			-----	-----	-----	mg/Kg	-----	-----	-----	
Alley	**A**	21	3216	1348	89	2208	3241	4015	5644	0.03*
Main Street	**B**	77	2538	1286	9	1912	2376	2612	10040	
Side Street	**B**	100	2690	1530	34	1842	2286	2996	9480	
Street Dust[2]	**X**	198	2686	1427	9	1868	2376	3147	10040	0.07**
Surface Soil	**X**	34	3006	2120	41	1780	2322	3256	9640	
Automobile Junkyard	**X**	18	3191	994	1797	2524	3151	4037	5121	
Scrap Metal Yard	**X**	12	2678	862	601	2284	2671	3430	3695	
Over All		262	2762	1492	9	1912	2407	3241	10040	

*There is a significant difference in Al mean concentrations among sample types.
**There is no significant difference in Al mean concentrations among sample types.
[1]Differences between sample types with at least one common bold letter are not significant.
[2]Street Dust includes the Alley, Main Street, and Side Street sample types.

CALUMET WRP BASIN

The mean Al concentration in the 43 samples analyzed from the Calumet WRP basin was 4,858 mg Kg^{-1}, and the Al concentrations ranged from 1,344 to 22,280 mg Kg^{-1} (Table 2).

The mean Al concentrations in samples from different street dust sources within the Calumet WRP basin were found to be: 8,065 mg Kg^{-1} for alleys, 3,384 mg Kg^{-1} for main streets, and 4,753 mg Kg^{-1} for side streets (Table 2). There were no significant differences ($p<0.05$) in the mean Al concentrations of these samples.

The mean Al concentration in all street dust samples was 4,708 mg Kg^{-1}, and it was significantly lower ($p<0.05$) than the mean Al concentration in surface soil, 6,855 mg Kg^{-1} (Table 2).

These mean concentrations were low in comparison with the mean concentration for Earth's crust, as discussed above, for the same reason as cited previously for samples from the Stickney WRP basin.

Antimony (Sb) Concentrations in Street Dust and Surface Soils

Antimony is a metallic element with an atomic weight of 121.75 Daltons and an atomic number of 51. Antimony is mainly derived from sulfide minerals. It is widely used in paints and lacquers, rubber compounds, ceramic enamels, glass, pottery

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TABLE 2

CONCENTRATION OF ALUMINUM IN STREET DUST AND SURFACE SOIL
COLLECTED IN THE CALUMET WATER RECLAMATION PLANT DRAINAGE BASIN

Sample Type[1]		No. Obs	Mean	STD	Min	25th	Median	75th	Max	Sig. Prob
			-----	-----	-----	----mg/Kg----	-----	-----	-----	
Alley	**A**	4	8065	6833	3384	3617	5425	12514	18028	0.14*
Main Street	**A**	11	3384	1797	1344	1988	2868	4828	7345	
Side Street	**A**	25	4753	4332	1528	2680	3291	4640	22280	
Street Dust[2]	**X**	40	4708	4197	1344	2652	3338	4814	22280	0.39**
Surface Soil	**X**	3	6855	5777	2057	2057	5240	13268	13268	
Over All		43	4858	4273	1344	2624	3384	5187	22280	

*There is no significant difference in Al mean concentrations among sample types.
**There is no significant difference in Al mean concentrations among sample types.
[1]Differences between sample types with at least one common bold letter are not significant.
[2]Street Dust includes the Alley, Main Street, and Side Street sample types.

and abrasives. Antimony is also alloyed with Pb and is used in bearings, batteries, sheet metals, pipes, tubes, foils, and ammunition.

Antimony is the sixty-second most abundant element in the Earth's crust (Krauskopf, 1979). Shacklette and Boerngen (1984) reported that the concentration of Sb in soils of the United States ranged from <1 to 8.8 mg Kg^{-1}, with a mean concentration of 0.66 mg Kg^{-1}. Bowen (1979) reported a range of soil Sb concentration of 0.2 to 10 mg Kg^{-1} with a median of 1 mg Kg^{-1}. The IEPA (2000) reported 4.0 mg Kg^{-1} as the mean concentration of Sb in surface soils of the metropolitan counties in Illinois. Therefore, it is expected that soils in the Metropolitan Chicago area should have Sb concentrations that ranging from approximately 0.2 to 10.0 mg Kg^{-1} with a mean concentration around 4.0 mg Kg^{-1}.

STICKNEY WRP BASIN

The mean Sb concentration in the 167 samples analyzed from the Stickney WRP basin was 1.29 mg Kg^{-1}, and the Sb concentrations ranged from not detected (126 samples) to 13.60 mg Kg^{-1} (Table 3).

The mean Sb concentrations in samples from different street dust sources within the Stickney WRP basin were found

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TABLE 3

CONCENTRATION OF ANTIMONY IN STREET DUST AND SURFACE SOIL
COLLECTED IN THE STICKNEY WATER RECLAMATION PLANT DRAINAGE BASIN

Sample Type[1]		No. Obs	Mean	STD	Min	25th	Median	75th	Max	Sig. Prob
			mg/Kg							
Alley		14	1.87	2.66	<0.80[3]	<0.80[3]	0.85	1.80	9.78	0.03*
Main Street		38	1.65	2.18	<0.80[3]	0.91	1.04	1.47	13.59	
Side Street		51	0.96	0.47	<0.80[3]	<0.80[3]	0.91	1.22	2.43	
Street Dust[2]	**XY**	103	1.34	1.70	<0.80[3]	<0.80[3]	0.98	1.31	13.59	0.02**
Surface Soil	**Y**	34	0.97	1.17	<0.80[3]	<0.80[3]	<0.80[3]	1.10	7.27	
Automobile Junkyard	**X**	18	1.32	0.68	<0.80[3]	<0.80[3]	1.24	1.71	2.74	
Scrap Metal Yard	**X**	12	1.35	1.04	<0.80[3]	<0.80[3]	0.88	2.20	3.67	
Over All		167	1.26	1.48	<0.80[3]	<0.80[3]	0.95	1.31	13.59	

*There is a significant difference in Sb mean concentrations among sample types.
**There is a significant difference in Sb mean concentrations among sample types.
[1]Differences between sample types with at least one common bold letter are not significant. Alley, Main Street, and Side Street samples were found to have unequal variance so pair-wise comparisons were not made by the SNK method, and no grouping indicators are displayed.
[2]Street Dust includes the Alley, Main Street, and Side Street sample types.
[3]Below the Minimum Detection Limit of 0.80 mg/Kg.

to be: 1.87 mg Kg^{-1} for alleys, 1.65 mg Kg^{-1} for main streets, and 0.96 mg Kg^{-1} for side streets (Table 3). The mean Sb concentrations in street dust samples from alleys, main streets, and side streets were significantly different ($p<0.05$).

The mean concentration of Sb in all street dust samples, 1.34 mg Kg^{-1}, was not significantly different ($p<0.05$) than in the surface soil samples, 0.97 mg Kg^{-1}, for the Stickney WRP basin (Table 3).

The mean concentrations of Sb in street dust collected from the perimeter of automobile junkyards, 1.32 mg Kg^{-1}, was not significantly different than the mean concentration of Sb in street dust collected from the perimeter of scrap metal yards, 1.35 mg Kg^{-1} (Table 3). These mean Sb concentrations were significantly higher ($p<0.05$) than those observed for surface soils in the Stickney WRP basin.

These mean Sb concentrations are within the normal range for Sb in surface soils in the Chicago metropolitan area, which was estimated above to be approximately 0.2 to 10.0 mg Kg^{-1}.

CALUMET WRP BASIN

The mean Sb concentration in the 197 samples analyzed from the Calumet WRP basin was 0.86 mg Kg^{-1}, and the Sb concentrations ranged from not detected (190 samples) to 17.40 mg Kg^{-1} (Table 4).

The mean Sb concentrations in samples from different street dust sources within the Calumet WRP basin were found to be: 0.97 mg Kg^{-1} for alleys, 1.94 mg Kg^{-1} for main streets, and 1.21 mg Kg^{-1} for side streets (Table 4). The mean Sb concentrations among these sources were significantly different ($p<0.05$).

The mean Sb concentration in all street dust samples, 1.31 mg Kg^{-1}, was significantly greater ($p<0.05$) than the mean Sb concentration in surface soil samples, 0.53 mg Kg^{-1}, for the Calumet WRP basin (Table 4). The mean Sb concentration reported for surface soils in the Calumet WRP basin is within the normal range for soils as summarized above.

Arsenic (As) Concentrations in Street Dust and Surface Soils

Arsenic is a metallic element that closely resembles phosphorus. Its atomic weight is 74.922 Daltons and its atomic number is 33. Arsenic is used in pesticides, algaecides and other poisons, wood preservatives, ceramic and glass manufacture, manufacture of lead and copper alloys, and dyes (Adriano, 1986). Arsenic is obtained mainly from smelting of Pb and Cu ores (Adriano, 1986).

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TABLE 4

CONCENTRATION OF ANTIMONY IN STREET DUST AND SURFACE SOIL
COLLECTED IN THE CALUMET WATER RECLAMATION PLANT DRAINAGE BASIN

Sample Type[1]		No. Obs	Mean	STD	Min	25th	Median	75th	Max	Sig. Prob
			---------------			mg/Kg			---------------	
Alley		3	0.97	0.24	<0.80[3]	<0.80[3]	0.99	1.20	1.20	0.00*
Main Street		13	1.94	2.12	<0.80[3]	1.06	1.51	1.79	8.86	
Side Street		68	1.21	2.13	<0.80[3]	<0.80[3]	<0.80[3]	1.20	17.40	
Street Dust[2]	**X**	84	1.31	2.10	<0.80[3]	<0.80[3]	0.87	1.25	17.40	0.00**
Surface Soil	**Y**	113	0.53	0.44	<0.80[3]	<0.80[3]	<0.80[3]	<0.80[3]	2.54	
Over All		197	0.86	1.46	<0.80[3]	<0.80[3]	<0.80[3]	0.98	17.40	

*There is a significant difference in Sb mean concentrations among sample types.
**There is a significant difference in Sb mean concentrations among sample types.
[1]Differences between sample types with at least one common bold letter are not significant. Alley, Main Street, and Side Street samples were found to have unequal variance so pair-wise comparisons were not made by the SNK method, and no grouping indicators are displayed.
[2]Street Dust includes the Alley, Main Street, and Side Street sample types.
[3]Below the Minimum Detection Limit of 0.80 mg/Kg.

Arsenic is the fifty-second most abundant element in the Earth's crust, having a mean concentration around 1.5 to 2.0 mg Kg^{-1} (Krauskopf, 1979). Adriano (1986) reviewed the literature on As concentration in soils and reported that As concentrations in soils not impacted by anthropogenic activities rarely exceed 10 mg Kg^{-1}. Shacklette and Boerngen (1984) reported an average concentration of 7.2 mg Kg^{-1} (range <0.1 to 97 mg Kg^{-1}) for As in surface soils in the United States. The IEPA estimated that the mean background As concentration in soils from rural counties in Illinois is 11.3 mg Kg^{-1}, while the mean background concentration in soils from urbanized counties is 13.0 mg Kg^{-1} (IEPA, 2000). Therefore, it is expected that the As concentration in street dust and surface soils from the Chicagoland area should range from <1 to 97 mg Kg^{-1}, with a mean concentration around 13.0 mg Kg^{-1}.

STICKNEY WRP BASIN

The mean As concentration in the 167 samples analyzed from the Stickney WRP basin was 4.97 mg Kg^{-1}, and the As concentrations ranged from not detected (3 samples) to a maximum of 33.47 mg Kg^{-1} (Table 5).

There were no significant differences ($p<0.05$) in the mean As concentrations in street dust samples from different

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TABLE 5

CONCENTRATION OF ARSENIC IN STREET DUST AND SURFACE SOIL
COLLECTED IN THE STICKNEY WATER RECLAMATION PLANT DRAINAGE BASIN

Sample Type[1]		No. Obs	Mean	STD	Min	25th	Median	75th	Max	Sig. Prob
			----------------------mg/Kg----------------------							
Alley	**A**	15	5.63	3.92	0.17	3.40	4.76	5.82	14.80	0.71*
Main Street	**A**	38	4.46	1.59	2.56	3.75	4.18	4.80	12.02	
Side Street	**A**	50	4.80	4.28	1.58	3.56	4.16	4.80	33.47	
Street Dust[2]	**X**	103	4.79	3.46	0.17	3.59	4.21	4.85	33.47	0.05**
Surface Soil	**X**	34	5.07	3.59	<0.10[3]	3.54	4.41	5.74	23.75	
Automobile Junkyard	**X**	18	5.34	1.60	2.65	4.58	4.84	5.97	9.17	
Scrap Metal Yard	**X**	12	5.73	4.12	1.89	3.72	4.78	6.11	17.71	
Over All		167	4.97	3.37	<0.10[3]	3.70	4.33	5.43	33.47	

*There is no significant difference in As mean concentrations among sample types.
**There is no significant difference in As mean concentrations among sample types.
[1]Differences between sample types with at least one common bold letter are not significant.
[2]Street Dust includes the Alley, Main Street, and Side Street sample types.
[3]Below the Minimum Detection Limit of 0.10 mg/Kg.

sources within the Stickney WRP basin, which were found to be: 5.63 mg Kg^{-1} for alleys, 4.46 mg Kg^{-1} for main streets, and 4.80 mg Kg^{-1} for side streets (Table 5).

The mean As concentration in all street dust samples was 4.79 mg Kg^{-1}, and in surface soil samples it was 5.07 mg Kg^{-1} (Table 5). The mean As concentrations in street dust samples from automobile junkyards and scrap metal yards was 5.34 mg Kg^{-1} and 5.73 mg Kg^{-1}, respectively, (Table 5). The difference was not significant, and these mean concentrations were not significantly different than those for all street dust samples and surface soil samples ($p<0.05$).

All As concentrations reported here are within the expected range for As in surface soils, which was summarized above. The mean As concentration in surface soils and street dusts of the Stickney WRP basin are less than the mean As concentration observed for surface soils of the United States reported by Shacklette and Boerngen (1984), 7.2 mg Kg^{-1}, and the mean background concentration in soils from urbanized counties of Illinois, 13.0 mg Kg^{-1} (IEPA, 2000).

CALUMET WRP BASIN

The mean As concentration in the 197 samples analyzed from the Calumet WRP basin was 5.05 mg Kg^{-1}, and the As concentrations ranged from below detection limits (4 samples) to 26.30 mg Kg^{-1} (Table 6).

The mean As concentrations in samples from different street dust sources within the Calumet WRP basin were found to be: 4.02 mg Kg^{-1} for alleys, 4.21 mg Kg^{-1} for main streets, and 5.16 mg Kg^{-1} for side streets (Table 6). The differences in the mean As concentrations were not statistically significant ($p<0.05$).

The mean As concentration for surface soil, 5.12 mg Kg^{-1}, was not significantly different from the mean As concentration for all street dust samples, 4.97 mg Kg^{-1} (Table 6).

The As concentrations for street dusts and surface soils in the Calumet WRP basin are all within the range expected for As in surface soils, as summarized above. Similar to the findings for the Stickney WRP, the mean As concentrations in street dust and surface soil samples from the Calumet WRP basin were less than the mean As concentration in surface soils of the United States, and they are below the mean background concentration in soils from urbanized counties of Illinois.

Barium (Ba) Concentrations in Street Dust and Surface Soils

Barium is a metallic element with an atomic weight of 137.36 Daltons and an atomic number of 56. Barium resembles

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TABLE 6

CONCENTRATION OF ARSENIC IN STREET DUST AND SURFACE SOIL
COLLECTED IN THE CALUMET WATER RECLAMATION PLANT DRAINAGE BASIN

Sample Type[1]		No. Obs	Mean	STD	Min	25th	Median	75th	Max	Sig. Prob
			-------------	-------------	-------------	----mg/Kg----	-------------	-------------	-------------	
Alley	**A**	3	4.02	0.19	3.83	3.83	4.02	4.21	4.21	0.08*
Main Street	**A**	13	4.21	1.25	0.76	4.05	4.32	4.87	5.88	
Side Street	**A**	68	5.16	2.53	<0.10[3]	4.09	4.85	5.77	21.20	
Street Dust[2]	**X**	84	4.97	2.35	<0.10[3]	4.06	4.64	5.49	21.20	0.74**
Surface Soil	**X**	113	5.12	2.54	2.07	3.96	4.89	5.81	26.30	
Over All		197	5.05	2.45	<0.10[3]	4.01	4.80	5.75	26.30	

*There is no significant difference in As mean concentrations among sample types.
**There is no significant difference in As mean concentrations among sample types.
[1]Differences between sample types with at least one common bold letter are not significant.
[2]Street Dust includes the Alley, Main Street, and Side Street sample types.
[3]Below the Minimum Detection Limit of 0.10 mg/Kg.

Ca and Sr in terms of its geochemical behavior. Barium is used as a weighting agent in oil- and gas-drilling fluids, and in the production of glass, paint, and rubber products (Adriano, 1986). Barium is obtained mainly from the barium sulfate mineral barite (Adriano, 1986).

Barium is the fourteenth most abundant element in the Earth's crust having a mean concentration around 500 mg Kg^{-1} (Krauskopf, 1979). Shacklette and Boerngen (1984) reported a geometric mean concentration of 440 mg Kg^{-1} (range 10 to 5000 mg Kg^{-1}) for Ba in surface soils in the United States. The IEPA reported a mean background Ba concentration of 110 mg Kg^{-1} for soils from urbanized counties of Illinois (IEPA, 2000). The expected Ba concentration in street dust and surface soils from the Chicagoland area should range from around 10 to 5,000 mg Kg^{-1}, with a mean concentration near 110 mg Kg^{-1}.

STICKNEY WRP BASIN

The mean Ba concentration in the 167 samples analyzed from the Stickney WRP basin was 100.5 mg Kg^{-1}, and the Ba concentrations ranged from 3.2 to 754.5 mg Kg^{-1} (Table 7).

The mean Ba concentrations in samples from the three street dust sources that were sampled within the Stickney WRP basin were found to be: 171.6 mg Kg^{-1} for alleys, 102.0 mg Kg^{-1}

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TABLE 7

CONCENTRATION OF BARIUM IN STREET DUST AND SURFACE SOIL
COLLECTED IN THE STICKNEY WATER RECLAMATION PLANT DRAINAGE BASIN

Sample Type[1]		No. Obs	Mean	STD	Min	25th	Median	75th	Max	Sig. Prob
			mg/Kg							
Alley	**A**	15	171.6	172.6	3.2	115.2	122.2	175.3	754.5	0.00*
Main Street	**B**	38	102.0	48.8	40.8	73.6	87.1	111.8	275.6	
Side Street	**C**	50	80.3	56.0	25.2	50.2	69.0	94.8	397.0	
Street Dust[2]	**XY**	103	101.6	86.0	3.2	64.7	84.6	117.6	754.5	0.01**
Surface Soil	**Y**	34	75.5	32.1	21.7	54.0	70.6	98.5	154.1	
Automobile Junkyard	**X**	18	129.3	66.8	58.7	83.0	117.5	154.7	328.6	
Scrap Metal Yard	**XY**	12	118.0	90.5	21.0	51.5	96.7	157.7	345.7	
Over All		167	100.5	77.4	3.2	63.9	84.6	117.7	754.5	

*There is a significant difference in Ba mean concentrations among sample types.
**There is a significant difference in Ba mean concentrations among sample types.
[1]Differences between sample types with at least one common bold letter are not significant.
[2]Street Dust includes the Alley, Main Street, and Side Street sample types.

for main streets, and 80.3 mg Kg^{-1} for side streets (Table 7). These differences in mean Ba concentration were all significantly different ($p<0.05$).

The mean concentration of Ba for all street dust samples was 101.6 mg Kg^{-1}, and for surface soils it was 75.5 mg Kg^{-1}. The difference in the mean Ba concentration for all street dusts and surface soils in the Stickney WRP basin was not significant ($p<0.05$). The mean concentrations of Ba collected from the perimeter of automobile junkyards and scrap metal yards were 129.4 and 118.0 mg Kg^{-1}, respectively, (Table 7). These mean Ba concentrations were not significantly different from each other or from the mean concentration for all street dust samples. However, the mean Ba concentration in street dust samples from automobile junkyards and scrap metal yards was significantly higher than the mean Ba concentration in surface soils in the Stickney WRP basin (Table 7).

The maximum observed Ba concentration of 755.0 mg Kg^{-1} (Table 7) observed in an alley is within the expected concentration range for the element in soils of the United States as summarized above. The mean concentrations of Ba in all street dusts and surface soils in the Stickney WRP basin, 101.6 and 75.5 mg Kg^{-1}, respectively, (Table 7), are below the IEPA's reported mean background concentration for soils in urbanized counties of Illinois, 110 mg Kg^{-1} (IEPA, 2000).

CALUMET WRP BASIN

The mean Ba concentration in the 195 samples analyzed from the Calumet WRP basin was 73.4 mg Kg^{-1} and the Ba concentrations ranged from 8.8 to 392.0 mg Kg^{-1} (Table 8).

The mean Ba concentrations in samples from different sources within the Calumet WRP basin were found to be: 127.7 mg Kg^{-1} for alleys, 93.8 mg Kg^{-1} for main streets, and 78.9 mg Kg^{-1} for side streets (Table 8). This was the same order observed in the Stickney WRP basin. Only the difference in mean Ba concentration of street dust from alleys and side streets was significant ($p<0.05$).

The mean Ba concentration for all street dust samples, 82.6 mg Kg^{-1}, was significantly higher than the mean Ba concentration for surface soils, 66.6 mg Kg^{-1}, for the Calumet WRP basin (Table 8).

The maximum Ba concentration reported for the Calumet WRP basin, 392.0 mg Kg^{-1} in a surface soil, is within the range expected for Ba in surface soils, as summarized above. The mean concentrations of Ba in all street dusts and surface soils in the Calumet WRP basin, 82.6 and 66.6 mg Kg^{-1}, respectively, (Table 8), are well below the IEPA's reported mean background

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TABLE 8

CONCENTRATION OF BARIUM IN STREET DUST AND SURFACE SOIL
COLLECTED IN THE CALUMET WATER RECLAMATION PLANT DRAINAGE BASIN

Sample Type[1]		No. Obs	Mean	STD	Min	25th	Median	75th	Max	Sig. Prob
			mg/Kg							
Alley	**A**	3	127.7	20.2	106.0	106.0	131.0	146.0	146.0	0.04*
Main Street	**AB**	11	93.8	37.6	42.1	73.2	85.0	130.0	171.0	
Side Street	**B**	68	78.9	47.3	11.5	43.2	75.2	103.5	266.0	
Street Dust[2]	**X**	82	82.6	46.3	11.5	48.6	78.9	106.0	266.0	0.00**
Surface Soil	**Y**	113	66.6	51.0	8.8	39.3	57.3	79.7	392.0	
Over All		195	73.4	49.6	8.8	42.2	61.4	90.0	392.0	

*There is a significant difference in Ba mean concentrations among sample types.
**There is a significant difference in Ba mean concentrations among sample types.
[1]Differences between sample types with at least one common bold letter are not significant.
[2]Street Dust includes the Alley, Main Street, and Side Street sample types.

concentration for soils in urbanized counties of Illinois, 110 mg Kg^{-1} (IEPA, 2000).

<u>Beryllium (Be) Concentrations in Street Dust and Surface Soils</u>

Beryllium is a metallic element with an atomic weight of 9.013 Daltons and an atomic number of 4. Beryllium is used as a hardening agent in alloys, primarily with Cu, Ni, and Zn; as a neutron moderator in nuclear reactors; in aircraft brakes; and in inertial guidance systems and structural materials for aircraft, missiles and spacecraft (Adriano, 1986). Beryllium is obtained mainly from the beryllium silicate mineral beryl (Adriano, 1986).

Beryllium is the forty-fifth most abundant element in the Earth's crust, having a mean concentration around 3 mg Kg^{-1} (Krauskopf, 1979). Shacklette and Boerngen (1984) reported an average concentration of 0.63 mg Kg^{-1} (range <1 to 15 mg Kg^{-1}) for Be in surface soils in the United States. The IEPA (2000) found the mean background concentration of Be to be 0.59 mg Kg^{-1} for urbanized counties of Illinois (IEPA, 2000). Therefore, it is expected that the Be concentrations in street dust and surface soils from the Chicagoland area should range from not detectable to 15 mg Kg^{-1} with a mean concentration around 0.60 mg Kg^{-1}.

STICKNEY WRP BASIN

The mean Be concentration in the 162 samples analyzed from the Stickney WRP basin was 0.07 mg Kg^{-1}, and the Be concentrations ranged from not detected (113 samples) to a maximum of 2.95 mg Kg^{-1} (Table 9).

The mean Be concentrations in street dust samples from alleys, 0.07 mg Kg^{-1}, and side streets, 0.03 mg Kg^{-1}, from within the Stickney WRP basin were not significantly different from each other ($p<0.05$), but they were significantly higher than the mean Be concentration observed in street dust from main streets within the basin, <0.01 mg Kg^{-1} (Table 9). The mean concentration of Be for all street dust samples collected was 0.02 mg Kg^{-1}, and the mean concentration of Be in surface soil samples was 0.09 mg Kg^{-1}. The mean Be concentrations in street dust collected from the perimeter of automobile junkyards was 0.11 mg Kg^{-1}, and from scrap metal yards was 0.34 mg Kg^{-1} (Table 9).

The maximum Be concentration observed in the Stickney WRP basin, 2.95 mg Kg^{-1} in a street dust sample, is within the expected range for surface soils as summarized above. The mean Be concentrations in all street dust samples and in surface soil samples are well below the mean concentration for soils

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TABLE 9

CONCENTRATION OF BERYLLIUM IN STREET DUST AND SURFACE SOIL COLLECTED IN THE STICKNEY WATER RECLAMATION PLANT DRAINAGE BASIN

Sample Type[1]		No. Obs	Mean	STD	Min	25th	Median	75th	Max	Sig. Prob
			mg/Kg							
Alley	**A**	14	0.07	0.16	<0.01[3]	<0.01[3]	<0.01[3]	0.01	0.56	0.00*
Main Street	**B**	35	<0.01[3]	0.01	<0.01[3]	<0.01[3]	<0.01[3]	<0.01[3]	0.03	
Side Street	**A**	49	0.03	0.06	<0.01[3]	<0.01[3]	<0.01[3]	0.03	0.30	
Street Dust[2]	**x**	98	0.02	0.08	<0.01[3]	<0.01[3]	<0.01[3]	<0.01[3]	0.56	0.01**
Surface Soil	**x**	34	0.09	0.27	<0.01[3]	<0.01[3]	<0.01[3]	0.06	1.38	
Automobile Junkyard	**x**	18	0.11	0.26	<0.01[3]	<0.01[3]	0.01	0.10	1.11	
Scrap Metal Yard	**x**	12	0.34	0.87	<0.01[3]	<0.01[3]	<0.01[3]	0.07	2.95	
Over All		162	0.07	0.29	<0.01[3]	<0.01[3]	<0.01[3]	0.03	2.95	

* There is a significant difference in Be mean concentrations among sample types.

**There is a significant difference in Be mean concentrations among sample types.

[1]Difference between sample types with at least one common bold letter are not significant. Street Dust, Surface Soil, Automobile Junkyard, and Scrap Metal yard samples were found to have unequal variance so pair-wise comparisions were not made by the SNK method, and grouping indicators are displayed.

[2]Street Dust includes the Alley, Main Street, and Side street sample types.

[3]Below the Minimum Detection Limit of 0.01 mg/kg.

of the United States and the background concentration in soils from urbanized counties of Illinois (IEPA, 2000).

CALUMET WRP BASIN

The mean Be concentration in the 197 samples analyzed from the Calumet WRP basin was 0.13 mg Kg^{-1} and the Be concentrations ranged from below detection limits (103 samples) to 2.120 mg Kg^{-1} (Table 10).

The mean Be concentrations in samples from different street dust sources within the Calumet WRP basin were found to be: 0.71 mg Kg^{-1} for alleys, 0.02 mg Kg^{-1} for main streets, and 0.07 mg Kg^{-1} for side streets (Table 10). The differences in the mean Be concentration among these street dust sources were not statistically significant ($p<0.05$).

The mean Be concentration observed in surface soil in the Calumet WRP basin, 0.17 mg Kg^{-1}, was significantly higher ($p<0.05$) than the mean Be concentration in all street dust samples, 0.09 mg Kg^{-1} (Table 10).

The maximum Be concentration observed in the Calumet WRP basin, 2.12 mg Kg^{-1} in a street dust sample, is within the expected range for surface soils as summarized above. The mean Be concentrations in all street dust samples and in surface soil samples are well below the mean concentration for soils

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TABLE 10

CONCENTRATION OF BERYLLIUM IN STREET DUST AND SURFACE SOIL
COLLECTED IN THE CALUMET WATER RECLAMATION PLANT DRAINAGE BASIN

Sample Type[1]		No. Obs	Mean	STD	Min	25th	Median	75th	Max	Sig. Prob
			mg/Kg							
Alley	**A**	3	0.71	1.22	<0.01[3]	<0.01[3]	<0.01[3]	2.12	2.12	0.16*
Main Street	**A**	13	0.02	0.06	<0.01[3]	<0.01[3]	<0.01[3]	<0.01[3]	0.15	
Side Street	**A**	68	0.07	0.14	<0.01[3]	<0.01[3]	<0.01[3]	0.06	0.91	
Street Dust[2]	**Y**	84	0.09	0.26	<0.01[3]	<0.01[3]	<0.01[3]	0.06	2.12	0.00**
Surface Soil	**X**	113	0.17	0.20	<0.01[3]	0.02	0.11	0.23	1.14	
Over All		197	0.13	0.23	<0.01[3]	<0.01[3]	0.05	0.19	2.12	

*There is no significant difference in Be mean concentrations among sample types.
**There is a significant difference in Be mean concentrations among sample types.
[1]Differences between sample types with at least one common bold letter are not significant.
[2]Street Dust includes the Alley, Main Street, and Side Street sample types.
[3]Below the Minimum Detection Limit of 0.01 mg/Kg.

of the United States and the background concentration in soils from urbanized counties of Illinois (IEPA, 2000).

Cadmium (Cd) Concentrations in Street Dust and Surface Soils

Cadmium is a metallic element with an atomic weight of 112.40 Daltons and an atomic number of 48. Cadmium behaves similarly to Zn geochemically, and it is produced commercially as a by-product of the Zn smelting and refining industry (Adriano, 1986).

Cadmium is used as an additive to metal alloys to impart low melting or corrosion resistant properties; in pigments; as a stabilizer of polyvinyl plastics; in photography and lithography; in process engraving; for rubber curing; as a fungicide, primarily for golf course greens; and in batteries (Ni-Cd) (Adriano, 1986). Since Cd is an impurity in Zn, it is also present in galvanized metals.

Cadmium is the sixty-forth most abundant element in the Earth's crust, having an average concentration around 0.15 to 0.20 mg Kg^{-1} (Krauskopf, 1979). For uncontaminated soils the Cd concentration of the soil is largely governed by the amount of Cd in the parent material. Soils derived from igneous rocks can be expected to contain <0.1 to roughly 0.3 mg Kg^{-1} Cd, soils derived from metamorphic rocks would be expected to contain approximately 0.1 to 1.0 mg Kg^{-1} Cd, and soils derived from sedimentary rocks may contain from 0.3 to 11 mg Kg^{-1} of Cd (Adriano, 1986).

The National Research Council of Canada (NRCC, 1979b) found that normal glacial tills and other glacial materials, which are the parent materials for many soils in the Metropolitan Chicago area, had Cd concentrations ranging from 0.01 to 0.7 mg Kg^{-1}. Granato et al. (1994) found that the Cd concentration in uncontaminated soils at the University of Illinois agricultural experiment stations across the state of Illinois ranged from 0.06 to 0.45 mg Kg^{-1}. Holmgren et al. (1993) reported that the background Cd concentration in soils of the United States ranged from <0.005 to 2.00 mg Kg^{-1}, with the geometric mean for Illinois of 0.181 mg Kg^{-1}. The mean background concentration of Cd for soils from urbanized counties in Illinois was found by the IEPA to be 0.60 mg Kg^{-1} (IEPA, 2000). Therefore, it is expected that the Cd concentration in street dust and surface soils from the Metropolitan Chicago area should range from not detected to 2.00 mg Kg^{-1}, with a mean concentration around 0.20 mg Kg^{-1}. Soils and street dusts with concentrations significantly beyond this range should be considered as contaminated by anthropogenic activity.

STICKNEY WRP BASIN

The mean Cd concentration in the 519 samples analyzed from the Stickney WRP basin was 4.15 mg Kg^{-1}, and the Cd concentrations ranged from not detected (56 samples) to 26.40 mg Kg^{-1} (Table 11).

The mean Cd concentrations in samples from different street dust sources within the Stickney WRP basin were found to be: 4.83 mg Kg^{-1} for alleys, 4.56 mg Kg^{-1} for main streets, and 3.49 mg Kg^{-1} for side streets (Table 11). Only the difference between the mean Cd concentration in the alley and side street samples was significant ($p<0.05$).

The mean concentration of Cd in all street dust samples collected in the Stickney WRP basin was 3.98 mg Kg^{-1}, and in surface soils it was 3.86 mg Kg^{-1} (Table 11). The difference between these two mean concentrations was not significant ($p<0.05$). These values are higher than the normal range for Cd in non-contaminated surface soils, which was summarized above.

The mean concentrations of Cd in street dust collected from the perimeter of automobile junkyards and scrap metal yards were 7.86 and 6.17 mg Kg^{-1}, respectively, (Table 11). These mean Cd concentrations were significantly higher than those for the street dust and surface soil samples ($p<0.05$). However,

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TABLE 11

CONCENTRATION OF CADMIUM IN STREET DUST AND SURFACE SOIL
COLLECTED IN THE STICKNEY WATER RECLAMATION PLANT DRAINAGE BASIN

Sample Type[1]		No. Obs	Mean	STD	Min	25th	Median	75th	Max	Sig. Prob
			mg/Kg							
Alley	**A**	38	4.83	3.97	<0.01[3]	2.40	3.62	7.20	15.40	0.01*
Main Street	**AB**	141	4.56	4.71	<0.01[3]	2.00	3.20	5.40	26.40	
Side Street	**B**	229	3.49	3.68	<0.01[3]	0.80	2.80	4.80	25.00	
Street Dust[2]	**Y**	408	3.98	4.12	<0.01[3]	1.20	3.01	5.16	26.40	0.00**
Surface Soil	**Y**	81	3.86	4.05	<0.01[3]	1.55	2.78	5.07	23.40	
Automobile Junkyard	**X**	18	7.86	3.09	2.84	5.90	6.86	10.07	15.41	
Scrap Metal Yard	**X**	12	6.17	2.00	3.15	4.59	5.90	7.58	9.43	
Over All		519	4.15	4.11	<0.01[3]	1.40	3.20	5.41	26.40	

*There is a significant difference in Cd mean concentrations among sample types.
**There is a significant difference in Cd mean concentrations among sample types.
[1]Differences between sample types with at least one common bold letter are not significant.
[2]Street Dust includes the Alley, Main Street, and Side Street sample types.
[3]Below the Minimum Detection Limit of 0.01 mg/Kg.

the highest Cd concentrations observed in the Stickney WRP basin were not found in samples collected from around these facilities (Table 11). The coefficients of variability for Cd were 103 and 105 percent for street dusts and surface soils, respectively, as opposed to only 39 and 32 percent for automobile junkyards and scrap metal yards, respectively. This indicates that the street dust around these facilities is more consistently elevated in Cd concentration than other street dusts and surface soils (Table 11).

The maximum Cd concentration observed in the Stickney WRP basin, 26.40 mg Kg^{-1} in a street dust sample, is thirteen times greater than the maximum for surface soils, 2.00 mg Kg^{-1}, as summarized above. The mean Cd concentrations in all street dust samples and in surface soil samples, 3.98 and 3.86 mg Kg^{-1} (Table 11), are also well above the mean concentration for Illinois soils as determined by Holmgren et al. (1993), 0.181 mg Kg^{-1}, and the background concentration of 0.60 mg Kg^{-1} in soils from urbanized counties of Illinois (IEPA, 2000).

In fact, the twenty-fifth percentile concentrations of Cd in all street dust samples, 1.20 mg Kg^{-1}, and in surface soil samples, 1.55 mg Kg^{-1}, were approximately 3 times greater than the highest Cd concentration observed in surface soils from the University of Illinois agricultural experiment station fields, 0.45 mg Kg^{-1} (Granato et al., 1994), and they were two to three times higher than the mean background concentration of 0.60 mg Kg^{-1} that the IEPA reported for soils from urbanized counties in Illinois (IEPA, 2000).

While soils with naturally occurring Cd concentrations of over 20 mg Kg^{-1} have been observed in residual soils developed from shale in California and other parts of the world (Adriano, 1986), these soils do not exist in the Chicago metropolitan area, and it is apparent that widespread and significant anthropogenic Cd contamination of soils and street dusts has occurred in the Stickney WRP basin.

CALUMET WRP BASIN

The mean Cd concentration in the 249 samples analyzed from the Calumet WRP basin was 2.62 mg Kg^{-1}, and the Cd concentrations ranged from not detected (17 samples) to 21.00 mg Kg^{-1} (Table 12).

The mean Cd concentrations in samples from different street dust sources within the Calumet WRP basin were found to be: 4.09 mg Kg^{-1} for alleys, 4.02 mg Kg^{-1} for main streets, and 2.88 mg Kg^{-1} for side streets (Table 12). The differences in mean Cd concentration were not statistically significant ($p<0.05$).

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TABLE 12

CONCENTRATION OF CADMIUM IN STREET DUST AND SURFACE SOIL
COLLECTED IN THE CALUMET WATER RECLAMATION PLANT DRAINAGE BASIN

Sample Type[1]		No. Obs	Mean	STD	Min	25th	Median	75th	Max	Sig. Prob
			mg/Kg							
Alley	**A**	5	4.09	3.24	1.60	2.40	2.88	3.88	9.70	0.21*
Main Street	**A**	24	4.02	4.46	<0.01[3]	0.40	3.65	4.51	21.00	
Side Street	**A**	103	2.88	3.04	<0.01[3]	1.13	2.05	3.66	18.80	
Street Dust2	**X**	132	3.14	3.35	<0.01[3]	1.16	2.40	4.07	21.00	0.00**
Surface Soil	**Y**	117	2.03	1.72	<0.01[3]	1.26	1.56	2.23	14.50	
Over All		249	2.62	2.76	<0.01[3]	1.23	1.86	3.20	21.00	

*There is no significant difference in Cd mean concentrations among sample types.
**There is a significant difference in Cd mean concentrations among sample types.
[1]Differences between sample types with at least one common bold letter are not significant.
[2]Street Dust includes the Alley, Main Street, and Side Street sample types.
[3]Below the Minimum Detection Limit of 0.01 mg/Kg.

The mean Cd concentration in all street dust samples, 3.14 mg Kg^{-1}, was significantly greater than the mean Cd concentration of 2.03 mg Kg^{-1} in surface soils (Table 12).

The maximum Cd concentration of 21.00 mg Kg^{-1} observed in a street dust sample from the Calumet WRP basin, is more than ten times higher than the maximum of the expected range for surface soils, 2.00 mg Kg^{-1}, as summarized above. The mean Cd concentrations in all street dust samples and in surface soil samples, 3.14 and 2.03 mg Kg^{-1} (Table 12), respectively, are also well above the mean concentration of 0.181 mg Kg^{-1} for Illinois soils as determined by Holmgren et al. (1993), and the background concentration of 0.60 mg Kg^{-1} in soils from urbanized counties of Illinois (IEPA, 2000).

In fact, the twenty-fifth percentile concentrations of Cd in all street dust samples, 1.16 mg Kg^{-1}, and in surface soil samples, 1.26 mg Kg^{-1}, were approximately 3 times greater than the highest Cd concentration observed in surface soils from the University of Illinois agricultural experiment station fields, 0.45 mg Kg^{-1} (Granato et al., 1994), and they were nearly twice as high as the mean background concentration of 0.60 mg Kg^{-1} reported by the IEPA for soils from urbanized counties in Illinois (IEPA, 2000).

Widespread and significant anthropogenic Cd contamination of soils and street dusts has occurred in the Calumet WRP basin.

Calcium (Ca) Concentrations in Street Dust and Surface Soils

Calcium is a metallic element with an atomic weight of 40.08 Daltons and an atomic number of 20. Calcium is an essential element for plants, animals and humans. Calcium is not normally classified as a pollutant, but it was analyzed on a small subset of samples in this study to provide some background data on its occurrence in street dusts and surface soils in the Chicago metropolitan area.

Calcium occurs in all mineral soils and ranges in concentration between 700 and 36,000 mg Kg^{-1} with concentrations typically around 4,000 mg Kg^{-1} (Brady, 1974). The IEPA (2000) found the mean background concentration of Ca to be 5,525 and 9,300 mg Kg^{-1} for rural and urbanized counties, respectively. Calcium sources in the soil are primarily the calcium carbonate, phosphate and sulfate minerals (Dixon and Weed, 1977).

STICKNEY WRP BASIN

The mean Ca concentration in the 111 samples analyzed from the Stickney WRP basin was 39,438 mg Kg^{-1}, and the Ca concentrations ranged from 812 to 82,994 mg Kg^{-1} (Table 13).

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TABLE 13

CONCENTRATION OF CALCIUM IN STREET DUST AND SURFACE SOIL
COLLECTED IN THE STICKNEY WATER RECLAMATION PLANT DRAINAGE BASIN

Sample Type[1]		No. Obs	Mean	STD	Min	25th	Median	75th	Max	Sig. Prob
			mg/Kg							
Alley	**B**	14	32736	11248	812	31457	33125	39588	45252	0.01*
Main Street	**A**	27	43578	12507	28349	37462	40250	44409	82994	
Side Street	**AB**	32	37332	7908	18809	32285	37720	40196	63468	
Street Dust[2]	**X**	73	38761	11087	812	33642	38189	42838	82994	0.10**
Surface Soil	**X**	8	38035	4216	33498	34754	37587	39747	46604	
Automobile Junkyard	**X**	18	41171	6282	30153	37259	40362	44912	52251	
Scrap Metal Yard	**X**	12	41895	5034	33614	38022	42223	44842	52451	
Over All		111	39438	9582	812	34970	39008	43263	82994	

*There is a significant difference in Ca mean concentrations among sample types.
**There is no significant difference in Ca mean concentrations among sample types.
[1]Differences between sample types with at least one common bold letter are not significant.
[2]Street Dust includes the Alley, Main Street, and Side Street sample types.

The mean Ca concentrations in samples from different street dust sources within the Stickney WRP basin were found to be: 32,736 mg Kg^{-1} for alleys, 43,578 mg Kg^{-1} for main streets, and 37,332 mg Kg^{-1} for side streets (Table 13). Only the difference in mean Ca concentration in street dust samples from main streets and alleys was significant ($p<0.05$).

The mean Ca concentration in all street dust samples was 38,761 mg Kg^{-1}, which was not significantly different from the mean Ca concentration of 38,035 mg Kg^{-1} in surface soils of the Stickney basin (Table 13).

The mean concentrations of Ca in street dust collected from the perimeter of automobile junkyards and scrap metal yards were 41,171 and 41,895 mg Kg^{-1}, respectively, (Table 13). These mean Ca concentrations were not significantly different than the mean Ca concentrations in all street dust samples and surface soil samples ($p<0.05$).

The Ca concentration in street dusts and surface soils was relatively uniform in the Stickney WRP basin. While the observed concentrations ranged over two orders of magnitude, the coefficient of variability for all samples was calculated to be only 24.3 percent, the lowest of all of the 20 elements studied. The maximum Ca concentration observed in the Stickney WRP basin, 82,994 mg Kg^{-1} in a street dust sample, is well beyond the expected range for surface soils as summarized above. The mean Ca concentrations in all street dust samples and in surface soil samples are also well above the mean background concentration in soils from urbanized counties of Illinois (IEPA, 2000). Even the twenty-fifth percentile concentration of Ca in street dusts and surface soils, 33,642 and 34,754 mg Kg^{-1}, respectively, are far above the mean background concentration for soil from urbanized counties of Illinois (IEPA, 2000).

Possible explanations for the high concentrations of Ca in the samples collected in the Stickney WRP basin are that the soils may be derived from calcareous parent materials. In addition, the presence of Ca oxides in the cements contained in concrete which is utilized in driveways, sidewalks and curbs throughout the metropolitan area may contribute to the elevated level of Ca in surface soils and dusts in the urban environment.

CALUMET WRP BASIN

Only nine samples from the Calumet WRP basin were analyzed for Ca and the mean concentration was 42,921 mg Kg^{-1}. The Ca concentrations in the nine samples ranged from 28,700 to 49,080 mg Kg^{-1} (Table 14).

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TABLE 14

CONCENTRATION OF CALCIUM IN STREET DUST AND SURFACE SOIL
COLLECTED IN THE CALUMET WATER RECLAMATION PLANT DRAINAGE BASIN

Sample Type[1]		No. Obs	Mean	STD	Min	25th	Median	75th	Max	Sig. Prob
			-------	-------	-------	mg/Kg	-------	-------	-------	
Alley	**A**	1	28700	0	28700	28700	28700	28700	28700	0.31*
Main Street	**A**	2	43952	7253	38823	38823	43952	49080	49080	
Side Street	**A**	5	44698	3509	39891	43527	43802	47721	48549	
Street Dust[2]	**X**	8	42512	6768	28700	39357	43665	48135	49080	0.69**
Surface Soil	**X**	1	46197	0	46197	46197	46197	46197	46197	
Over All		9	42921	6449	28700	39891	43802	47721	49080	

*There is no significant difference in Ca mean concentrations among sample types.
**There is no significant difference in Ca mean concentrations among sample types.
[1]Differences between sample types with at least one common bold letter are not significant.
[2]Street Dust includes the Alley, Main Street, and Side Street sample types.

The mean Ca concentrations in samples from different street dust sources within the Calumet WRP basin were: 28,700 mg Kg^{-1} for alleys, 43,952 mg Kg^{-1} for main streets, and 44,698 mg Kg^{-1} for side streets (Table 14). There was no significant difference between these concentrations ($p<0.05$). The mean Ca concentration in all street dust samples was 42,512 mg Kg^{-1}, and the Ca concentration in the one surface soil that was analyzed was 46,197 mg Kg^{-1} (Table 14). While there was a very small number of samples from the Calumet WRP basin analyzed for Ca, the overall mean Ca concentration reported for the Calumet WRP basin is very similar to that observed for the Stickney WRP basin.

Chromium (Cr) Concentrations in Street Dust and Surface Soils

Chromium is a metallic element with an atomic weight of 51.996 Daltons and an atomic number of 24. Chromium is produced commercially from chromite ore (a ferrous chromium oxide) (Adriano, 1986). Chromium is used as an additive to metal alloys to impart corrosion resistant properties and high luster, most notable is stainless steel; in pigments; as a wood preservative; as a tanning agent; and in other plating applications (Adriano, 1986).

Chromium is the twenty-first most abundant element in the Earth's crust. The National Academy of Sciences (NAS, 1974) reported that Cr can be found in soils from trace concentrations to 52,300 mg Kg^{-1}. Adriano (1986) reports a geometric mean concentration of 37 mg Kg^{-1} for soils of the United States. The National Academy of Sciences (NAS, 1974) reported that worldwide soil Cr concentrations typically range from 10 to 150 mg Kg^{-1}, with a mean concentration of 40 mg Kg^{-1}. Soils derived from ultramafic igneous rocks known as serpentines have mean Cr concentrations around 1,800 mg Kg^{-1} (Adriano, 1986). However, these soils are not found in the Chicago metropolitan area. Granato et al. (1994) found that the mean Cr concentration in uncontaminated soils at the University of Illinois agricultural experiment stations across the state was 13.8 mg Kg^{-1}, and ranged from 7.33 to 18.9 mg Kg^{-1}.

The mean background Cr concentrations in soils from rural and urbanized counties of Illinois were 13.0 and 16.2 mg Kg^{-1}, respectively, (IEPA, 2000).

The expected range in Cr concentrations in street dust and surface soils from the Metropolitan Chicago area should be from 7.0 to 150.0 mg Kg^{-1}, with mean concentration around 15.0 mg Kg^{-1}. Soils and street dusts with concentrations significantly beyond this range should be considered as contaminated by anthropogenic activity.

STICKNEY WRP BASIN

The mean Cr concentration in the 519 samples analyzed from the Stickney WRP basin was 44.1 mg Kg^{-1}, and the Cr concentrations ranged from 0.8 to 734.9 mg Kg^{-1} (Table 15).

The mean Cr concentrations in samples from different street dust sources within the Stickney WRP basin were found to be: 21.0 mg Kg^{-1} for alleys, 50.6 mg Kg^{-1} for main streets, and 41.5 mg Kg^{-1} for side streets (Table 15). All of these mean Cr concentrations were significantly different ($p<0.05$). The mean concentrations of Cr in all street dust samples, 42.7 mg Kg^{-1}, was not significantly different from the concentration of 49.7 mg Kg^{-1} in surface soils of the Stickney WRP basin, (Table 15).

The mean Cr concentrations in street dust collected from the perimeter of automobile junkyards and scrap metal yards were 51.4 and 42.0 mg Kg^{-1}, respectively, (Table 15). These mean Cr concentrations were not significantly higher ($p<0.05$) than the mean Cr concentration in surface soils or in all street dust samples. This was surprising since many metals and automotive parts contain Cr.

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TABLE 15

CONCENTRATION OF CHROMIUM IN STREET DUST AND SURFACE SOIL
COLLECTED IN THE STICKNEY WATER RECLAMATION PLANT DRAINAGE BASIN

Sample Type[1]		No. Obs	Mean	STD	Min	25th	Median	75th	Max	Sig. Prob
			mg/Kg							
Alley	**C**	38	21.0	12.5	2.4	11.2	19.1	25.1	58.8	0.00*
Main Street	**A**	141	50.6	27.2	0.8	28.4	47.9	67.8	137.2	
Side Street	**B**	229	41.5	30.0	0.8	20.4	33.6	56.0	170.8	
Street Dust[2]	**X**	408	42.7	28.9	0.8	20.8	36.3	59.2	170.8	0.21**
Surface Soil	**X**	81	49.7	84.3	4.4	16.0	30.0	60.2	734.9	
Automobile Junkyard	**X**	18	51.4	27.1	20.8	38.2	44.0	58.7	123.5	
Scrap Metal Yard	**X**	12	42.0	22.0	6.9	28.3	40.6	56.6	82.6	
Over All		519	44.1	42.4	0.8	20.8	36.3	59.2	734.9	

*There is a significant difference in Cr mean concentrations among sample types.
**There is no significant difference in Cr mean concentrations among sample types.
[1]Differences between sample types with at least one common bold letter are not significant.
[2]Street Dust includes the Alley, Main Street, and Side Street sample types.

The maximum Cr concentration observed in the Stickney WRP basin, 734.9 mg Kg^{-1} in a surface soil sample, is well beyond the expected range for surface soils as summarized above (approximately 7.0 to 150.0 mg Kg^{-1}). The mean concentrations of Cr in street dusts and surface soils in the Stickney WRP basin, 42.7 and 49.7 mg Kg^{-1}, respectively, are approximately three times higher than the mean background concentrations of 16.2 mg Kg^{-1} for soil from urbanized counties (IEPA, 2000), and 13.8 mg Kg^{-1} for agricultural experiment station fields in Illinois (Granato et al., 1994).

While the mean Cr concentrations in street dust and surface soils are greater than the expected mean Cr concentration in the Stickney WRP basin, the vast majority of the samples (>75 percent) had Cr concentrations that were within the expected range for soils (Adriano, 1986).

CALUMET WRP BASIN

The mean Cr concentration in the 249 samples analyzed from the Calumet WRP basin was 52.9 mg Kg^{-1}, and the Cr concentrations ranged from 2.0 to 1,817 mg Kg^{-1} (Table 16).

The mean Cr concentrations in samples from different street dust sources within the Calumet WRP basin were not significantly different ($p<0.05$), and they were found to be:

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TABLE 16

CONCENTRATION OF CHROMIUM IN STREET DUST AND SURFACE SOIL
COLLECTED IN THE CALUMET WATER RECLAMATION PLANT DRAINAGE BASIN

Sample Type[1]		No. Obs	Mean	STD	Min	25th	Median	75th	Max	Sig. Prob
			----------	----------	----------	---mg/Kg---	----------	----------	----------	
Alley	**A**	5	44.5	12.3	31.2	33.8	44.0	54.1	59.3	0.10*
Main Street	**A**	24	77.7	58.8	3.2	36.8	74.9	105.0	277.0	
Side Street	**A**	103	74.2	184.2	2.8	21.5	42.0	68.0	1817	
Street Dust[2]	**X**	132	73.7	164.5	2.8	23.6	49.2	78.4	1817	0.00**
Surface Soil	**Y**	117	29.3	35.3	2.0	11.7	16.1	31.6	224.0	
Over All		249	52.9	124.0	2.0	14.0	28.8	61.2	1817	

*There is no significant difference in Cr mean concentrations among sample types.
**There is a significant difference in Cr mean concentrations among sample types.
[1]Differences between sample types with at least one common bold letter are not significant.
[2]Street Dust includes the Alley, Main Street, and Side Street sample types.

44.5 mg Kg^{-1} for alleys, 77.7 mg Kg^{-1} for main streets, and 74.2 mg Kg^{-1} for side streets (Table 16). The mean Cr concentration of 73.7 mg Kg^{-1} in all street dust samples was significantly higher than the mean Cr concentration of 29.3 mg Kg^{-1} in surface soils of the Calumet WRP basin (Table 16).

The maximum Cr concentration observed in the Calumet WRP basin, 1,817 mg Kg^{-1} in a street dust sample, is well beyond the expected range for surface soils as summarized above (approximately 7.0 to 150.0 mg Kg^{-1}). The mean concentrations of Cr in street dusts and surface soils in the Calumet WRP basin, 73.7 and 29.3 mg Kg^{-1}, respectively, are substantially higher than the mean background concentration of 16.2 mg Kg^{-1} for soil from urbanized counties (IEPA, 2000), and 13.8 mg Kg^{-1} in the agricultural experiment station fields in Illinois (Granato et al., 1994). However, the Cr concentration in the vast majority (>75 percent) of the street dusts and surface soils was within the expected range for soils (Adriano, 1986).

Copper (Cu) Concentrations in Street Dust and Surface Soils

Copper is a metallic element with an atomic weight of 63.546 Daltons and an atomic number of 29. Copper is second only to silver in its ability to conduct heat and electricity. Copper is produced commercially from oxide, carbonate and most importantly sulfide ores (bornite and chalcopyrite which are ferric cupric sulfides) (Adriano, 1986). Copper is widely used in the production of electrical wire and other electrical apparatus, and in alloys with Sn, Pb, Zn, Ni, Al, and Mn (most notably in bronze as a Cu-Sn alloy and brass as a Cu-Zn alloy). Copper is also extensively utilized for production of boilers, steam and water distribution pipes, automobile radiators, and cooking utensils. Copper is also used extensively in agriculture as a fertilizer, bactericide, and fungicide algaecide; in antibiotics, and drugs; and as feed supplements (Adriano, 1986).

Copper is the twenty-sixth most abundant element in the Earth's crust (Krauskopf, 1979). Shacklette and Boerngen (1984) reported that the concentrations of Cu in soils of the United States ranged from <1 mg Kg^{-1} to 700 mg Kg^{-1}, with a mean concentration of 25 mg Kg^{-1}. Holmgren et al. (1993) reported that the Cu concentrations in uncontaminated soils of the United States ranged from <0.6 to 495.0 mg Kg^{-1}, with a mean concentration of 29.6 mg Kg^{-1}. Holmgren et al. (1993) also reported that the geometric mean Cu concentration for uncontaminated soils in Illinois was 16.2 mg Kg^{-1}. Granato et al. (1994) found that the mean Cu concentration in uncontaminated soils at the University of Illinois agricultural experiment stations across the state was 8.8 mg Kg^{-1} and ranged from 4.60 to 13.5 mg Kg^{-1}. The IEPA (2000) reported a mean Cu concentration of 19.6 mg Kg^{-1} in surface soils from urbanized counties of Illinois. Therefore, it is expected that soils in the Metropolitan Chicago area should have Cu concentrations that range from not detected to approximately 700 mg Kg^{-1}, with a mean concentration of approximately 20.0 mg Kg^{-1}.

STICKNEY WRP BASIN

The mean Cu concentration in the 300 samples analyzed from the Stickney WRP basin was 152.3 mg Kg^{-1}, and the Cu concentrations ranged from not detected (three samples) to 2,523 mg Kg^{-1} (Table 17).

The mean Cu concentrations in samples from different street dust sources within the Stickney WRP basin were found to be: 70.0 mg Kg^{-1} for alleys, 173.4 mg Kg^{-1} for main streets, and 89.6 mg Kg^{-1} for side streets (Table 17).

The mean Cu concentration in street dust samples from main streets was significantly higher than those for the side streets and alleys.

The mean concentration of Cu in all street dust samples, 118.9 mg Kg^{-1}, was not significantly different ($p<0.05$) than the mean for surface soil samples, 95.1 mg Kg^{-1}, in the Stickney

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TABLE 17

CONCENTRATION OF COPPER IN STREET DUST AND SURFACE SOIL
COLLECTED IN THE STICKNEY WATER RECLAMATION PLANT DRAINAGE BASIN

Sample Type[1]		No. Obs	Mean	STD	Min	25th	Median	75th	Max	Sig. Prob
			mg/Kg							
Alley	**B**	22	70.0	58.4	1.85	34.4	55.4	77.2	248.5	0.00*
Main Street	**A**	82	173.4	300.9	<0.083	66.4	106.8	184.6	2523	
Side Street	**B**	116	89.6	128.8	4.4	27.0	48.5	100.4	901.8	
Street Dust2	**Y**	220	118.9	210.6	<0.083	33.0	73.4	123.3	2523	0.00**
Surface Soil	**Y**	50	95.1	145.9	7.6	28.4	55.9	102.7	973.8	
Automobile Junkyard	**X**	18	490.6	533.9	51.07	114.7	225.7	603.7	1855	
Scrap Metal Yard	**X**	12	495.4	629.1	17.4	89.8	168.3	804.3	2073	
Over All		300	152.3	282.3	<0.083	34.9	74.4	135.7	2523	

*There is a significant difference in Cu mean concentrations among sample types.
**There is a significant difference in Cu mean concentrations among sample types.
[1]Differences between sample types with at least one common bold letter are not significant.
[2]Street Dust includes the Alley, Main Street, and Side Street sample types.
[3]Below the Minimum Detection Limit of 0.08 mg/Kg.

WRP basin (Table 17). The mean concentrations of Cu in street dust collected from the perimeter of automobile junkyards and scrap metal yards were 490.8 and 495.3 mg Kg^{-1}, respectively, (Table 17). As would be expected, these mean Cu concentrations were significantly higher than those observed for all street dusts and for surface soils in the Stickney WRP basin.

The maximum Cu concentration observed in the Stickney WRP basin, 2523 mg Kg^{-1} in a street dust sample, is well beyond the expected range for surface soils as summarized above (not detected to 700.0 mg Kg^{-1}). However, the seventy-fifth percentile concentrations for street dusts and surface soils, 123.3 and 102.7 mg Kg^{-1}, are well within this range. The mean concentrations of Cu in street dusts and surface soils in the Stickney WRP basin, 118.9 and 95.1 mg Kg^{-1}, respectively, are five to six times higher than the mean background concentration of 19.6 mg Kg^{-1} for soil from urbanized counties in Illinois (IEPA, 2000).

CALUMET WRP BASIN

The mean Cu concentration in the 219 samples analyzed from the Calumet WRP basin was 52.6 mg Kg^{-1}, and the Cu concentrations ranged from not detected (one sample) to 784.0 mg Kg^{-1} (Table 18).

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TABLE 18

CONCENTRATION OF COPPER IN STREET DUST AND SURFACE SOIL
COLLECTED IN THE CALUMET WATER RECLAMATION PLANT DRAINAGE BASIN

Sample Type[1]		No. Obs	Mean	STD	Min	25th	Median	75th	Max	Sig. Prob
			mg/Kg							
Alley	**A**	4	71.0	37.6	37.2	44.2	61.8	97.8	123.0	0.00*
Main Street	**A**	19	105.5	63.5	<0.08[3]	65.2	99.4	131.0	236.0	
Side Street	**A**	83	69.2	98.2	5.95	27.8	46.3	72.5	784.0	
Street Dust[2]	**X**	106	75.8	92.0	<0.08[3]	32.3	54.3	83.1	784.0	0.00**
Surface Soil	**Y**	113	30.9	22.4	4.33	18.1	24.0	39.8	155.4	
Over All		219	52.6	69.5	<0.08[3]	20.3	35.4	62.2	784.0	

*There is a significant difference in Cu mean concentrations among sample types.

**There is a significant difference in Cu mean concentrations among sample types.

[1]Differences between sample types with at least one common bold letter are not significant. Alley, Main Street, and Side Street samples were found to have unequal variance so pair-wise comparisons were not made by the SNK method, and no grouping indicators are displayed.

[2]Street Dust includes the Alley, Main Street, and Side Street sample types.

[3]Below the Minimum Detection Limit of 0.08 mg/Kg.

The mean Cu concentrations in samples from different street dust sources within the Calumet WRP basin were found to be: 71.0 mg Kg^{-1} for alleys, 105.5 mg Kg^{-1} for main streets, and 69.2 mg Kg^{-1} for side streets (Table 18). The mean Cu concentrations among these sources were significantly different ($p<0.05$).

The mean Cu concentration in all street dust samples, 75.8 mg Kg^{-1}, was significantly higher ($p<0.05$) than the mean Cu concentration in surface soils, 30.9 mg Kg^{-1}, for the Calumet WRP basin (Table 18).

The maximum Cu concentration observed in the Calumet WRP basin, 784.0 mg Kg^{-1} in a street dust sample, is just the expected range for surface soils as summarized above (not detected to 700.0 mg Kg^{-1}). However, the seventy-fifth percentile concentrations for street dusts and surface soils, 83.1 and 39.8 mg Kg^{-1}, are well within this range. The mean concentration of Cu in street dusts in the Calumet WRP basin, 75.8 mg Kg^{-1}, is four times higher than the mean background concentration of 19.6 mg Kg^{-1} for soil from urbanized counties in Illinois (IEPA, 2000), while the mean Cu concentration in surface soils, 30.9 mg Kg^{-1}, is only slightly greater than the mean background concentration for soil from urbanized counties in Illinois.

Iron (Fe) Concentrations in Street Dust and Surface Soils

Iron is a metallic element with an atomic weight of 55.847 Daltons and an atomic number of 26. Iron is an abundant metallic element in the earth's crust, normally ranging in concentration from 5,000 to 50,000 mg Kg^{-1} (Brady, 1974). It occurs within the crystal lattice of most igneous rocks and in combination with oxygen in amorphous oxides in the soil. Iron has magnetic properties and is the most used metallic element. It is also essential for plant and animal life. The IEPA (2000) determined that the mean background Fe concentration in surface soils from urbanized counties of Illinois is 15,900 mg Kg^{-1}.

Therefore, it is expected that Fe concentrations in soils of the Metropolitan Chicago area should range from 5,000 to 50,000 mg Kg^{-1}, with a mean concentration of approximately 16,000 mg Kg^{-1}.

STICKNEY WRP BASIN

The mean Fe concentration in the 297 samples analyzed from the Stickney WRP basin was 21,828 mg Kg^{-1}, and the Fe concentrations ranged from not detected (one sample) to a maximum of 68,270 mg Kg^{-1} (Table 19).

The mean Fe concentrations in samples from different street dust sources within the Stickney WRP basin were found to be: alley, 15,169 mg Kg^{-1}, main street, 25,901 mg Kg^{-1}, and side street 18,877 mg Kg^{-1} (Table 19). The mean Fe concentration in street dusts from main streets was significantly higher ($p<0.05$) than in street dusts from side streets and alleys.

The mean concentration of Fe in all street dust samples was 21,155 mg Kg^{-1}, which was not significantly different from the mean Fe concentration in surface soils, 21,583 mg Kg^{-1} (Table 19). The mean concentrations of Fe in street dust samples collected from the perimeter of automobile junkyards and scrap metal yards were 29,470 and 23,561 mg Kg^{-1}, respectively, (Table 19). These mean Fe concentrations were not significantly different ($p<0.05$). However, they were both significantly higher ($p<0.05$) than the mean Fe concentrations in all street dust samples and surface soil samples.

The maximum concentrations of Fe reported in this study for street dusts and surface soils in the Stickney basin were a little higher than the expected range (5,000 to 50,000 mg Kg^{-1}), but the seventy-fifth percentile Fe concentration in

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TABLE 19

CONCENTRATION OF IRON IN STREET DUST AND SURFACE SOIL
COLLECTED IN THE STICKNEY WATER RECLAMATION PLANT DRAINAGE BASIN

Sample Type[1]		No. Obs	Mean	STD	Min	25th	Median	75th	Max	Sig. Prob
			mg/Kg							
Alley	**B**	22	15169	7676	403.62	10709	13241	17463	34379	0.00*
Main Street	**A**	82	25901	12274	<0.30[3]	18462	24727	33375	54655	
Side Street	**B**	113	18877	10994	3942.8	11810	17193	22811	68270	
Street Dust[2]	**Y**	217	21155	11824	<0.30[3]	12658	19061	26932	68270	0.00**
Surface Soil	**Y**	50	21583	14660	5105.3	11026	16421	29868	57110	
Automobile Junkyard	**X**	18	29470	10520	16188.34	19123	29371	34664	49913	
Scrap Metal Yard	**XY**	12	23561	9870	4512.54	17579	24451	29390	40784	
Over All		297	21828	12312	<0.30[3]	12873	19455	28017	68270	

*There is a significant difference in Fe mean concentrations among sample types.
**There is a significant difference in Fe mean concentrations among sample types.
[1]Differences between sample types with at least one common bold letter are not significant.
[2]Street Dust includes the Alley, Main Street, and Side Street sample types.
[3]Below the Minimum Detection Limit of 0.30 mg/Kg.

street dust and surface soils, 26,932 and 29,868 mg Kg^{-1}, were well within the range. The mean concentrations of Fe for street dusts and surface soils in the Stickney basin, 21,155 and 21,583 mg Kg^{-1}, respectively, were somewhat higher than the mean concentration of 15,900 mg Kg^{-1} reported for surface soils in urbanized counties of Illinois (IEPA, 2000).

CALUMET WRP BASIN

The mean Fe concentration in the 219 samples analyzed from the Calumet WRP basin was 17,904 mg Kg^{-1}, and the Fe concentrations ranged from 110 to 100,424 mg Kg^{-1} (Table 20).

The mean Fe concentrations in samples from different street dust sources within the Calumet WRP basin were found to be: alley, 21,643 mg Kg^{-1}, main street, 29,540 mg Kg^{-1}, and side street, 21,219 mg Kg^{-1} (Table 20). The differences in mean Fe concentration in these samples were statistically significant ($p<0.05$).

The mean concentration of Fe in all street dust samples was 22,726 mg Kg^{-1}, which was significantly higher than the concentrations observed within the normal range for surface soils as discussed above.

The maximum concentrations of Fe reported in this study for street dusts and surface soils in the Calumet basin,

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TABLE 20

CONCENTRATION OF IRON IN STREET DUST AND SURFACE SOIL
COLLECTED IN THE CALUMET WATER RECLAMATION PLANT DRAINAGE BASIN

Sample Type[1]		No. Obs	Mean	STD	Min	25th	Median	75th	Max	Sig. Prob
			mg/Kg							
Alley		4	21643	6294	15071	16347	21631	26940	28240	0.03*
Main Street		19	29540	16326	3812	15867	32163	38989	67325	
Side Street		83	21219	16887	4463	11988	16098	23700	100424	
Street Dust[2]	**X**	106	22726	16727	3812	12984	17327	28759	100424	0.00**
Surface Soil	**Y**	113	13381	7628	110	9546	12016	15255	46279	
Over All		219	17904	13659	110	10143	13702	21417	100424	

*There is no significant difference in Fe mean concentrations among sample types.
**There is a significant difference in Fe mean concentrations among sample types.
[1]Differences between sample types with at least one common bold letter are not significant. Alley, Main Street, and Side Street samples were found to have unequal variance so pair-wise comparisons were not made by the SNK method, and no grouping indicators are displayed.
[2]Street Dust includes the Alley, Main Street, and Side Street sample types.

100,424 and 46,279 mg Kg^{-1}, were far beyond and just within, respectively, the expected range (5,000 to 50,000 mg Kg^{-1}) for soils of the Metropolitan Chicago area. The seventy-fifth percentile Fe concentration in street dust and surface soils in the Calumet basin, 28,759 and 15,255 mg Kg^{-1}, were well within the range. The mean concentrations of Fe for street dusts and surface soils in the Calumet basin, 22,726 and 13,381 mg Kg^{-1}, were somewhat higher than and slightly lower than, respectively, the mean concentration of 15,900 mg Kg^{-1} reported for surface soils in urbanized counties of Illinois (IEPA, 2000).

Lead (Pb) Concentrations in Street Dust and Surface Soils

Lead is a metallic element with an atomic weight of 207.19 Daltons and an atomic number of 82. Lead is widely used in batteries, as a solder in the automotive and construction industries, as a former gasoline additive, and as a pigment in paints. Lead is also used in ammunition, in metal alloys, as a former ingredient of pesticides, in the manufacture of glass, in radiation shields, and in caulking and varnishes (Adriano, 1986).

Lead is the thirty-sixth most abundant element in the Earth's crust (Krauskopf, 1979). Shacklette and Boerngen (1984) reported that the concentrations of Pb in soils of the

United States ranged from <1 to 700 mg Kg^{-1}, with a mean concentration of 25 mg Kg^{-1}. Holmgren et al. (1993) reported that Pb concentrations in uncontaminated surface soils of the United States ranged from <1.0 to 135 mg Kg^{-1}, with a mean concentration of 12.3 mg Kg^{-1}. Holmgren et al. (1993) also reported that mean Pb concentration in uncontaminated surface soils of Illinois was 16.0 mg Kg^{-1}. Granato et al. (1994) found that the mean Pb concentration in soils at the University of Illinois agricultural experiment stations across the state of Illinois was 7.59 mg Kg^{-1} and ranged from 6.06 to 19.8 mg Kg^{-1}. The IEPA (2000) determined the mean concentration of Pb in surface soils of metropolitan counties of Illinois to be 36.0 mg Kg^{-1}.

Therefore, it is expected that soils in the Metropolitan Chicago area would have Pb concentrations that range from not detected to approximately 150 mg Kg^{-1}, with a mean concentration of 36 mg Kg^{-1}. Soils and street dusts having Pb concentrations beyond this range can be considered to have been contaminated by anthropogenic sources.

STICKNEY WRP BASIN

The mean Pb concentration in the 518 samples analyzed from the Stickney WRP basin was 182 mg Kg^{-1}, and the Pb concentrations ranged from not detected (five samples) to 3,359 mg Kg^{-1} (Table 21).

The mean Pb concentrations in samples from different street dust sources within the Stickney WRP basin were found to be: 268 mg Kg^{-1} for alleys, 163 mg Kg^{-1} for main streets, and 135 mg Kg^{-1} for side streets (Table 21). The mean Pb concentration in street dust samples from alleys was significantly higher ($p<0.05$) than for main streets and side streets.

The mean concentration of Pb in all street dust samples, 157 mg Kg^{-1}, was not significantly different ($p<0.05$) than in surface soil samples, 137 mg Kg^{-1}, for the Stickney WRP basin (Table 21). The mean concentrations of Pb in street dust collected from the perimeter of automobile junkyards, 700 mg Kg^{-1}, was significantly higher than the mean concentration of Pb in street dust collected from the perimeter of scrap metal yards, 573 mg Kg^{-1} (Table 21). These mean Pb concentrations were significantly higher ($p<0.05$) than those observed for all street dusts and surface soils in the Stickney WRP basin.

The maximum and the mean Pb concentrations observed in street dust samples in the Stickney basin, 3,359 and 157 mg Kg^{-1}, respectively, (Table 21) were higher than the maximum of the expected range for Metropolitan Chicago soils (150 mg Kg^{-1}). The maximum and seventy-fifth percentile Pb concentration in

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TABLE 21

CONCENTRATION OF LEAD IN STREET DUST AND SURFACE SOIL
COLLECTED IN THE STICKNEY WATER RECLAMATION PLANT DRAINAGE BASIN

Sample Type[1]		No. Obs	Mean	STD	Min	25th	Median	75th	Max	Sig. Prob
			----------mg/Kg----------							
Alley	**A**	37	268	244	9.6	82	187	350	950	0.00*
Main Street	**B**	141	163	166	<0.08[3]	73	123	211	1373	
Side Street	**B**	229	135	120	<0.08[3]	52	105	181	884	
Street Dust[2]	**Z**	407	157	156	<0.08[3]	64	113	211	1373	0.00**
Surface Soil	**Z**	81	137	108	<0.08[3]	72	111	167	644	
Automobile Junkyard	**X**	18	700	441	172.4	331	543	920	1650	
Scrap Metal Yard	**Y**	12	573	911	30.21	177	206	515	3359	
Over All		518	182	242	<0.08[3]	67	121	216	3359	

*There is a significant difference in Pb mean concentrations among sample types.
**There is a significant difference in Pb mean concentrations among sample types.
[1]Differences between sample types with at least one common bold letter are not significant.
[2]Street Dust includes the Alley, Main Street, and Side Street sample types.
[3]Below the Minimum Detection Limit of 0.08 mg/Kg.

surface soils of the Stickney basin, 644 and 167 mg Kg^{-1}, respectively, (Table 21) were greater than the maximum of 150 mg Kg^{-1} for the expected range for Metropolitan Chicago area soils, and the mean of 137 mg Kg^{-1} was just below it. These data indicate that soils and street dusts in the Stickney WRP basin are contaminated with anthropogenic sources of Pb, and the contamination is widespread and significant.

CALUMET WRP BASIN

The mean Pb concentration in the 249 samples analyzed from the Calumet WRP basin was 127 mg Kg^{-1}, and the Pb concentrations ranged from not detected (one sample) to 1,513 mg Kg^{-1} (Table 22).

The mean Pb concentrations in samples from different street dust sources within the Calumet WRP basin were found to be: 204 mg Kg^{-1} for alleys, 176 mg Kg^{-1} for main streets, and 128 mg Kg^{-1} for side streets (Table 22). The differences in mean Pb concentrations among these sources was not statistically significant ($p<0.05$), although they follow the same trend as for the Stickney WRP basin.

The mean Pb concentration in all street dust samples, 140 mg Kg^{-1}, was significantly higher ($p<0.05$) than the mean Pb

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TABLE 22

CONCENTRATION OF LEAD IN STREET DUST AND SURFACE SOIL
COLLECTED IN THE CALUMET WATER RECLAMATION PLANT DRAINAGE BASIN

Sample Type[1]		No. Obs	Mean	STD	Min	25th	Median	75th	Max	Sig. Prob
			---mg/Kg---							
Alley	**A**	5	204	152	<0.08[3]	95	242	340	341	0.23*
Main Street	**A**	24	176	172	4.4	58	142	227	654	
Side Street	**A**	103	128	141	4.4	48	93	160	1003	
Street Dust[2]	**X**	132	140	148	<0.08[3]	49	100	181	1003	0.02**
Surface Soil	**Y**	117	112	158	5.2	42	68	138	1513	
Over All		249	127	153	<0.08[3]	44	81	154	1513	

*There is no significant difference in Pb mean concentrations among sample types.
**There is a significant difference in Pb mean concentrations among sample types.
[1]Differences between sample types with at least one common bold letter are not significant.
[2]Street Dust includes the Alley, Main Street, and Side Street sample types.
[3]Below the Minimum Detection Limit of 0.08 mg/Kg.

concentration in surface soil samples, 112 mg Kg^{-1}, for the Calumet WRP basin (Table 22).

The maximum and seventy-fifth percentile Pb concentrations in street dust from the Calumet basin, 1,003 and 181 mg Kg^{-1}, respectively, (Table 22) were both greater than the maximum of 150 mg Kg^{-1} for the expected range for soils of the Chicagoland area. The maximum Pb concentration in surface soil in the Calumet basin, 1,513 mg Kg^{-1}, is ten times higher than the maximum of the expected range for soils of the Metropolitan Chicago area. The mean Pb concentrations for street dust and surface soils in the Calumet basin, 140 and 112 mg Kg^{-1}, respectively, were more than three times higher than the mean concentration of 36 mg Kg^{-1} determined for surface soils in urbanized counties of Illinois (IEPA, 2000), and they were around ten times higher than the mean Pb concentration in uncontaminated surface soils of the state of Illinois (Holmgren et al., 1993; Granato et al., 1994). These data indicate that soils and street dusts in the Calumet WRP basin are contaminated with anthropogenic sources of Pb, and the contamination is widespread and significant.

Magnesium (Mg) Concentrations in Street Dust and Surface Soils

Magnesium is a metallic element with an atomic weight of

24.312 Daltons and an atomic number of 12. Magnesium is an essential element for plants and animals, and it is widely used in the production of lightweight alloys, flares, optical mirrors, precision instruments, and it is a Zn substitute in batteries. However, Mg is quite abundant in soils and anthropogenic sources of the element are normally not significant in changing the total concentration of this element in soils.

Magnesium is the eighth most abundant element in the Earth's crust (Krauskopf, 1979). Brady (1974) reported that typical concentrations of Mg in soils of the United States range from 1,200 to 15,000 mg Kg^{-1}, with a mean concentration of 3,000 mg Kg^{-1} for humid region soils. Boerngen and Shacklette (1981) reported that the Mg concentration in soils of the United States ranged from 50 to >100,000 mg Kg^{-1}. The IEPA (2000) indicated that the mean concentration of Mg in surface soils of metropolitan counties of Illinois was 4,820 mg Kg^{-1}. Therefore, it is expected that soils in the Chicagoland area should have Mg concentrations that range from 1,200 to 15,000 mg Kg^{-1}, with a mean Mg concentration of around 4,820 mg Kg^{-1}.

STICKNEY WRP BASIN

The mean Mg concentration in the 111 samples analyzed from the Stickney WRP basin was 22,776 mg Kg^{-1}, and the Mg concentrations ranged from 388 to 43,204 mg Kg^{-1} (Table 23).

The mean Mg concentrations in samples from different street dust sources within the Stickney WRP basin were found to be: 15,840 mg Kg^{-1} for alleys, 24,466 mg Kg^{-1} for main streets, and 21,443 mg Kg^{-1} for side streets (Table 23). The mean Mg concentrations in street dust samples from main streets and side streets were significantly higher ($p<0.05$) than for alleys.

The mean concentration of Mg in all street dust samples was 21,487 mg Kg^{-1}, and the mean of the surface soil samples was 22,471 mg Kg^{-1} for the Stickney WRP basin (Table 23).

The mean concentrations of Mg in street dust collected from the perimeter of automobile junkyards and scrap metal yards were 25,426 and 26,845 mg Kg^{-1}, respectively, (Table 23).

The mean Mg concentrations determined for street dust and surface soils of the Stickney basin in this study, 21,487 and 22,471 mg Kg^{-1}, are nearly five times higher than the mean Mg concentration of 4,820 mg Kg^{-1} reported for surface soils in urbanized counties of Illinois (IEPA, 2000). However, all Mg concentrations observed in this study are well within the range observed for Mg in surface soils of the United States reported by Boerngen and Shacklette (1981), which was 1,200 to 100,000 mg Kg^{-1}.

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TABLE 23

CONCENTRATION OF MAGNESIUM IN STREET DUST AND SURFACE SOIL
COLLECTED IN THE STICKNEY WATER RECLAMATION PLANT DRAINAGE BASIN

Sample Type[1]		No. Obs	Mean	STD	Min	25th	Median	75th	Max	Sig. Prob
			mg/Kg							
Alley	**B**	14	15840	6134	388	13094	16393	19988	26549	0.00*
Main Street	**A**	27	24466	7218	12164	18631	23199	28946	43204	
Side Street	**A**	32	21443	5149	9690	18209	21899	24073	35006	
Street Dust[2]		73	21487	6823	388	18059	21141	24414	43204	0.01**
Surface Soil		8	22471	3763	18574	20069	21284	24063	30359	
Automobile Junkyard		18	25426	6027	16704	20334	25179	31375	38425	
Scrap Metal Yard		12	26845	6257	17059	22887	27281	29760	41460	
Over All		111	22776	6706	388	18619	22204	26519	43204	

*There is a significant difference in Mg mean concentrations among sample types.
**There is a significant difference in Mg mean concentrations among sample types.
[1]Differences between sample types with at least one common bold letter are not significant. Street Dust, Surface Soil, Automobile Junkyard, and Scrap Metal Yard samples were found to have unequal variance so pair-wise comparisions were not made by the SNK method, and no grouping indicators are displayed.
[2]Street Dust includes the Alley, Main Street, and Side Street sample types.

CALUMET WRP BASIN

The mean Mg concentration in the 9 samples analyzed from the Calumet WRP basin was 21,737 mg Kg^{-1}, and the Mg concentrations ranged from 14,190 to 34,898 mg Kg^{-1} (Table 24).

The mean Mg concentrations in samples from different street dust sources within the Calumet WRP basin were found to be: 14,190 mg Kg^{-1} for alleys, 14,801 mg Kg^{-1} for main streets, and 23,388 mg Kg^{-1} for side streets (Table 24). The differences in mean Mg concentration among these sources were not statistically significant ($p<0.05$).

The mean Mg concentration in all street dust samples, 20,092 mg Kg^{-1}, was not significantly different ($p<0.05$) from the Mg concentration observed in the lone surface soil sample that was analyzed, 34,898 mg Kg^{-1}, for the Calumet WRP basin (Table 24).

All of the Mg concentrations that were determined in this study for street dust and surface soils in the Calumet WRP basin were approximately three or more times higher than the mean Mg concentration determined for soils of urbanized counties of Illinois by the IEPA (2000), but they were well within the range of the Mg concentrations observed in the United States soils by Boerngen and Shacklette (1981).

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TABLE 24

CONCENTRATION OF MAGNESIUM IN STREET DUST AND SURFACE SOIL
COLLECTED IN THE CALUMET WATER RECLAMATION PLANT DRAINAGE BASIN

Sample Type[1]		No. Obs	Mean	STD	Min	25th	Median	75th	Max	Sig. Prob
			mg/Kg							
Alley	**A**	1	14190	0	14190	14190	14190	14190	14190	0.07*
Main Street	**A**	2	14801	467	14470	14470	14801	15131	15131	
Side Street	**A**	5	23388	2056	20946	22017	23779	23863	26336	
Street Dust[2]	**X**	8	20092	4815	14190	14801	21482	23821	26336	0.12**
Surface Soil	**X**	1	34898	0	34898	34898	34898	34898	34898	
Over All		9	21737	6682	14190	15131	22017	23863	34898	

*There is no significant difference in Mg mean concentrations among sample types.
**There is no significant difference in Mg mean concentrations among sample types.
[1]Differences between sample types with at least one common bold letter are not significant.
[2]Street Dust includes the Alley, Main Street, and Side Street sample types.

Manganese (Mn) Concentrations in Street Dust and Surface Soils

Manganese is a metallic element with an atomic weight of 54.938 Daltons and an atomic number of 25. Manganese is an essential element for plants and animals, and it is widely used in the production of steel. It is also used in steel, aluminum, and copper alloys. Manganese and its compounds are used extensively as oxidizing agents; in alkaline batteries, ceramics, glass, dyes, paints; and as an anti-knock additive for internal combustion engines (Adriano, 1986).

Manganese is the twelfth most abundant element in the Earth's crust (Krauskopf, 1979). Boerngen and Shacklette (1981) reported that the concentration of Mn in soils of the United States ranged from <2 to 7,000 mg Kg^{-1}. Bowen (1979) found Mn concentrations in surface soils worldwide to range from 20 to 10,000 mg Kg^{-1}, with a mean concentration of 1,000 mg Kg^{-1}. Shacklette et al. (1971) reported that Mn concentrations in soils of the United States ranged from <1 to 7,000 mg Kg^{-1}, with a mean concentration of 560 mg Kg^{-1}. The IEPA (2000) determined the mean background Mn concentration for urbanized counties in Illinois to be 636 mg Kg^{-1}. Therefore, it is expected that uncontaminated soils in the Chicagoland area would have Mn concentrations that range from not detected to 7,000 mg Kg^{-1}, with a mean concentration approximately 636 mg Kg^{-1}.

STICKNEY WRP BASIN

The mean Mn concentration in the 299 samples analyzed from the Stickney WRP basin was 420 mg Kg^{-1}, and the Mn concentrations ranged from 5 to 12,420 mg Kg^{-1} (Table 25).

The mean Mn concentrations in samples from different street dust sources within the Stickney WRP basin were found to be: 320 mg Kg^{-1} for alleys, 373 mg Kg^{-1} for main streets, and 357 mg Kg^{-1} for side streets (Table 25). The mean Mn concentration in street dust samples from main streets and side streets was significantly greater ($p<0.05$) than for alleys.

The mean concentration of Mn in all street dust samples, 359 mg Kg^{-1}, was not significantly different ($p<0.05$) from the mean of surface soil samples, 655 mg Kg^{-1}, for the Stickney WRP basin (Table 25).

The mean concentrations of Mn in street dust collected from the perimeter of automobile junkyards and scrap metal yards were 499 and 433 mg Kg^{-1}, respectively, (Table 25). These mean Mn concentrations were not significantly different ($p<0.05$).

The mean Mn concentrations in street dust and surface soils in the Stickney basin are within the expected concentration range for Mn in surface soils, which was estimated above to be less than detected to 7,000 mg Kg^{-1}. While there were a

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TABLE 25

CONCENTRATION OF MANGANESE IN STREET DUST AND SURFACE SOIL
COLLECTED IN THE STICKNEY WATER RECLAMATION PLANT DRAINAGE BASIN

Sample Type[1]		No. Obs	Mean	STD	Min	25th	Median	75th	Max	Sig. Prob
			-----------	-----------	-----------	-----mg/Kg	-----------	-----------	-----------	
Alley	**B**	23	320	301	5	198	257	361	1600	0.02*
Main Street	**A**	82	373	175	48	262	351	419	1048	
Side Street	**AB**	114	357	243	68	221	299	407	1588	
Street Dust[2]	**Y**	219	359	227	5	226	307	411	1600	0.00**
Surface Soil	**Y**	50	655	1724	156	221	317	505	12420	
Automobile Junkyard	**X**	18	499	182	230	351	496	679	756	
Scrap Metal Yard	**XY**	12	433	231	169	276	392	485	1015	
Over All		299	420	736	5	228	320	424	12420	

*There is a significant difference in Mn mean concentrations among sample types.
**There is a significant difference in Mn mean concentrations among sample types.
[1]Differences between sample types with at least one common bold letter are not significant.
[2]Street Dust includes the Alley, Main Street, and Side Street sample types.

surface soil Mn concentration for Stickney, 655 mg Kg^{-1}, is very similar to the mean of 636 mg Kg^{-1} for metropolitan counties of Illinois (IEPA, 2000), and the mean street dust Mn concentration, 359 mg Kg^{-1}, is well below it.

CALUMET WRP BASIN

The mean Mn concentration in the 215 samples analyzed from the Calumet WRP basin was 835 mg Kg^{-1}, and the Mn concentrations ranged from 81 to 17,778 mg Kg^{-1} (Table 26).

The mean Mn concentrations in samples from different street dust sources within the Calumet WRP basin were found to be: 821 mg Kg^{-1} for alleys, 910 mg Kg^{-1} for main streets, and 1,231 mg Kg^{-1} for side streets (Table 26). The differences in mean Mn concentration among these sources was not statistically significant ($p<0.05$).

The mean Mn concentration in all street dust samples, 1,158 mg Kg^{-1}, was significantly higher ($p<0.05$) than the mean Mn concentration 542 mg Kg^{-1} in surface soil samples for the Calumet WRP basin (Table 26).

The Mn concentration in street dust in the Calumet basin was notably higher than that observed for street dust in the Stickney basin. While the mean Mn concentration in the street dust samples from the Calumet basin was 1158 mg Kg^{-1}, the

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TABLE 26

CONCENTRATION OF MANGANESE IN STREET DUST AND SURFACE SOIL
COLLECTED IN THE CALUMET WATER RECLAMATION PLANT DRAINAGE BASIN

Sample Type[1]		No. Obs	Mean	STD	Min	25th	Median	75th	Max	Sig. Prob
			-----	-----	-----	mg/Kg	-----	-----	-----	
Alley	**A**	4	821	291	560	570	807	1071	1108	0.53*
Main Street	**A**	18	910	557	144	517	754	1517	1867	
Side Street	**A**	80	1231	2268	112	314	557	1332	17778	
Street Dust[2]	**X**	102	1158	2025	112	336	640	1328	17778	0.00**
Surface Soil	**Y**	113	542	571	81	250	367	576	3241	
Over All		215	835	1483	81	272	459	808	17778	

*There is no significant difference in Mn mean concentrations among sample types.
**There is a significant difference in Mn mean concentrations among sample types.
[1]Differences between sample types with at least one common bold letter are not significant.
[2]Street Dust includes the Alley, Main Street, and Side Street sample types.

median concentration was 640 mg Kg^{-1}, which is very close to the mean Mn concentration of 636 mg Kg^{-1} determined for soils of urbanized counties in Illinois by IEPA (2000). All Mn concentrations reported for surface soils in the Calumet WRP basin were in the expected range for soils, and the mean Mn concentration, 542 mg Kg^{-1}, is similar to the mean for soils from metropolitan counties of Illinois.

Mercury (Hg) Concentrations in Street Dust and Surface Soils

Mercury is a metallic element with an atomic weight of 200.59 Daltons and an atomic number of 80. Mercury is produced commercially from sulfide ores, predominantly cinnabar (Adriano, 1986). Mercury is used in the dental industry to form a silver amalgam for tooth fillings; by the chlor-alkali industry in the manufacture of chlorine and caustic soda; by the paint industry; in catalysis; in the manufacture of electrical and control instruments; in the pulp and paper industry; in the pharmaceutical industry; and in agriculture as a seed dressing and pesticide (Adriano, 1986).

Adriano (1986) reported that most soils are expected to have concentrations of Hg below 0.10 mg Kg^{-1}. Shacklette et al. (1971) reported that the arithmetic mean Hg concentration in surface soils of the United States was 0.11 mg Kg^{-1}, with a geometric mean concentration of 0.071 mg Kg^{-1}. The National Research Council of Canada (NRCC, 1979a) reported that the Hg concentration in surface soils in Canada ranged from 0.02 to 0.15 mg Kg^{-1}, with the mean Hg concentration being 0.07 mg Kg^{-1}. The IEPA (2000) observed a mean Hg concentration of 0.06 mg Kg^{-1} in surface soils of urbanized counties in Illinois.

Therefore, it is expected that the Hg concentration in soils in the Chicagoland area should be in the approximate range of 0.02 to 0.15 mg Kg^{-1}, with a mean Hg concentration of 0.06 mg Kg^{-1}.

STICKNEY WRP BASIN

The mean Hg concentration in the 51 samples analyzed from the Stickney WRP basin was 0.157 mg Kg^{-1}, and the Hg concentrations ranged from 0.030 to 0.930 mg Kg^{-1} (Table 27). The mean Hg concentration in street dust from main streets and side streets was 0.184 and 0.109 mg Kg^{-1}, respectively, and these concentrations were not significantly different (Table 27).

The mean Hg concentration in all street dust samples was 0.145 mg Kg^{-1}, and the mean Hg concentration in surface soils from the Stickney basin was 0.176 mg Kg^{-1}.

While only a small number of the samples collected from the Stickney basin were analyzed for Hg, they indicate that

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TABLE 27

CONCENTRATION OF MERCURY IN STREET DUST AND SURFACE SOIL
COLLECTED IN THE STICKNEY WATER RECLAMATION PLANT DRAINAGE BASIN

Sample Type[1]		No. Obs	Mean	STD	Min	25th	Median	75th	Max	Sig. Prob
			mg/Kg							
Alley		0								0.09*
Main Street	**A**	15	0.184	0.215	0.060	0.070	0.140	0.200	0.930	
Side Street	**A**	16	0.109	0.078	0.030	0.060	0.085	0.145	0.340	
Street Dust[2]	**X**	31	0.145	0.161	0.030	0.060	0.100	0.180	0.930	0.65**
Surface Soil	**X**	20	0.176	0.167	0.030	0.070	0.125	0.220	0.610	
Automobile Junkyard		0								
Scrap Metal Yard		0								
Over All		51	0.157	0.163	0.030	0.070	0.100	0.180	0.930	

*There is no significant difference in Hg mean concentrations among sample types.
**There is no significant difference in Hg mean concentrations among sample types.
[1]Differences between sample types with at least one common bold letter are not significant.
[2]Street Dust includes the Alley, Main Street, and Side Street sample types.

street dust and surface soils are contaminated with Hg from anthropogenic sources. The seventy-fifth percentile concentrations of Hg in street dust and surface soils, 0.180 and 0.220 mg Kg^{-1} (Table 27), respectively, were both greater than 0.15 mg Kg^{-1}, the expected maximum concentration for Chicagoland soils. In addition, mean Hg concentrations in street dust and surface soils from the Stickney basin were nearly three times higher than the mean Hg concentration in surface soils of urbanized counties in Illinois reported by IEPA (2000).

CALUMET WRP BASIN

The mean Hg concentration in the 34 samples analyzed from the Calumet WRP basin was 0.148 mg Kg^{-1}, and the Hg concentrations ranged from 0.010 to 0.980 mg Kg^{-1} (Table 28). The mean Hg concentration in samples from side streets was 0.335 mg Kg^{-1}, and the Hg concentration in samples from surface soil was 0.090 mg Kg^{-1} (Table 28). The difference in mean Hg concentration between these two types of samples was statistically significant ($p<0.05$). None of the samples collected from main streets or alleys in the Calumet WRP basin were analyzed for Hg.

While only a small number of the samples collected from the Calumet basin were analyzed for Hg, they indicate that

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TABLE 28

CONCENTRATION OF MERCURY IN STREET DUST AND SURFACE SOIL
COLLECTED IN THE CALUMET WATER RECLAMATION PLANT DRAINAGE BASIN

Sample Type[1]		No. Obs	Mean	STD	Min	25th	Median	75th	Max	Sig. Prob
			mg/Kg							
Alley		0								
Main Street		0								
Side Street		8	0.335	0.334	0.070	0.090	0.200	0.525	0.980	
Street Dust[2]	**X**	8	0.335	0.334	0.070	0.090	0.200	0.525	0.980	0.00*
Surface Soil	**Y**	26	0.090	0.154	0.010	0.030	0.060	0.080	0.820	
Over All		34	0.148	0.229	0.010	0.050	0.070	0.110	0.980	

*There is a significant difference in Hg mean concentrations among sample types.
[1]Differences between sample types with at least one common bold letter are not significant.
[2]Street Dust includes the Alley, Main Street, and Side Street sample types.

street dust, to a much greater degree than surface soils, are contaminated with Hg from anthropogenic sources. The median concentration of Hg in street dust, 0.200 mg Kg^{-1} (Table 28), was greater than the maximum of 0.15 mg Kg^{-1} expected for the highest concentration in Metropolitan Chicago area soils. In addition, the mean Hg concentrations in street dust from the Calumet basin were more than five times higher than the mean Hg concentration in surface soils of urbanized counties in Illinois reported by IEPA (2000). In contrast, surface soil Hg concentrations were largely within the expected range for soils of the Metropolitan Chicago area as summarized above, and the median Hg concentration (Table 28) was equivalent to the mean concentration for soils of urbanized counties in Illinois as determined by IEPA (2000).

Molybdenum (Mo) Concentrations in Street Dust and Surface Soils

Molybdenum is a metallic element with an atomic weight of 95.94 Daltons and an atomic number of 42. Molybdenum is an essential element for plants and animals, and it is widely used in steel alloys, in pigments, and as a disinfectant in cooling tower waters. Unlike most metals, Mo exists as an anion in soils (predominantly in the hexavalent molybdate form: MoO_4^{-2}).

Molybdenum is the fifty-third most abundant element in the Earth's crust (Krauskopf, 1979). Shacklette and Boerngen (1984) reported that the concentration of Mo in soils of the United States ranged from not detected to 15 mg Kg^{-1}, with a mean concentration of 0.97 mg Kg^{-1}. Adriano (1986) summarized the literature on Mo concentrations in soils of the United States. He reported that the range of Mo concentrations in these soils is 0.08 to >30 mg Kg^{-1} with the median Mo concentration being approximately 1 mg Kg^{-1}. Therefore, it is expected that soils in the Metropolitan Chicago area would have Mo concentrations that range from not detected to 30 mg Kg^{-1}, with a mean concentration of approximately 1 mg Kg^{-1}.

STICKNEY WRP BASIN

The mean Mo concentration in the 167 samples analyzed from the Stickney WRP basin was 2.54 mg Kg^{-1}, and the Mo concentrations ranged from not detected (11 samples) to 74.72 mg Kg^{-1} (Table 29).

The mean Mo concentrations in samples from different street dust sources within the Stickney WRP basin were found to be: 0.94 mg Kg^{-1} for alleys, 4.22 mg Kg^{-1} for main streets,

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TABLE 29

CONCENTRATION OF MOLYBDENUM IN STREET DUST AND SURFACE SOIL
COLLECTED IN THE STICKNEY WATER RECLAMATION PLANT DRAINAGE BASIN

Sample Type[1]		No. Obs	Mean	STD	Min	25th	Median	75th	Max	Sig. Prob
			mg/Kg							
Alley	**B**	14	0.94	0.58	<0.08[3]	0.70	0.87	1.20	2.20	0.03*
Main Street	**A**	38	4.22	12.09	<0.08[3]	0.91	1.68	2.81	74.72	
Side Street	**AB**	51	1.72	1.79	<0.08[3]	0.61	1.11	2.13	8.13	
Street Dust[2]	**XY**	103	2.54	7.51	<0.08[3]	0.73	1.17	2.13	74.72	0.01**
Surface Soil	**Y**	34	1.85	3.57	<0.08[3]	0.39	1.04	1.74	20.89	
Automobile Junkyard	**X**	18	4.20	5.26	0.82	1.06	2.03	2.89	18.91	
Scrap Metal Yard	**X**	12	2.03	1.19	0.47	1.23	1.98	2.52	4.75	
Over All		167	2.54	6.37	<0.08[3]	0.77	1.28	2.19	74.72	

*There is a significant difference in Mo mean concentrations among sample types.
**There is a significant difference in Mo mean concentrations among sample types.
[1]Differences between sample types with at least one common bold letter are not significant.
[2]Street Dust includes the Alley, Main Street, and Side Street sample types.
[3]Below the Minimum Detection Limit of 0.08 mg/Kg.

and 1.72 mg Kg^{-1} for side streets (Table 29). The mean Mo concentration in street dust samples from main streets and side streets was significantly higher ($p<0.05$) than for alleys.

The mean concentration of Mo in all street dust samples, 2.54 mg Kg^{-1}, was not significantly different ($p<0.05$) than in surface soil samples, 1.85 mg Kg^{-1}, for the Stickney WRP basin (Table 29). The mean concentrations of Mo in street dust collected from the perimeter of automobile junkyards and scrap metal yards were 4.20 and 2.03 mg Kg^{-1}, respectively, (Table 29). These mean Mo concentrations were not significantly different ($p<0.05$) than those observed for all street dusts, but they were significantly higher than for surface soils in the Stickney WRP basin.

For surface soils in the Stickney basin, the mean and maximum Mo concentrations (Table 29) are within the normal range for Mo in surface soils, which was estimated above to be approximately 0.1 to 30 mg Kg^{-1}. For street dust samples from the Stickney basin, the mean and seventy-fifth percentile Mo concentrations (Table 29) are within the expected range for Mo in surface soils.

CALUMET WRP BASIN

The mean Mo concentration in the 197 samples analyzed from the Calumet WRP basin was 4.06 mg Kg^{-1}, and the Mo concentrations ranged from not detected (62 samples) to 422.0 mg Kg^{-1} (Table 30).

The mean Mo concentrations in samples from different street dust sources within the Calumet WRP basin were found to be: 1.29 mg Kg^{-1} for alleys, 2.83 mg Kg^{-1} for main streets, and 10.13 mg Kg^{-1} for side streets (Table 30). The differences in mean Mo concentration among these sources were statistically significant ($p<0.05$).

The mean Mo concentration in all street dust samples, 8.68 mg Kg^{-1}, was significantly higher ($p<0.05$) than the mean Mo concentration in surface soil samples, 0.62 mg Kg^{-1}, for the Calumet WRP basin (Table 30). All Mo concentrations reported for samples collected in the Calumet WRP basin, with the exception of the maximum Mo concentration in street dust (Table 30), are at the low end of the normal range for soils as summarized above.

Nickel (Ni) Concentrations in Street Dust and Surface Soils

Nickel is a metallic element with an atomic weight of 58.71 Daltons and an atomic number of 28. Nickel is widely used in alloys such as stainless steel, and because it does not readily oxidize, it is widely utilized in plating. Nickel

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TABLE 30

CONCENTRATION OF MOLYBDENUM IN STREET DUST AND SURFACE SOIL
COLLECTED IN THE CALUMET WATER RECLAMATION PLANT DRAINAGE BASIN

Sample Type[1]		No. Obs	Mean	STD	Min	25th	Median	75th	Max	Sig. Prob
			--------	--------	--------	mg/Kg	--------	--------	--------	
Alley	**A**	3	1.29	0.47	0.82	0.82	1.29	1.76	1.76	0.01*
Main Street	**A**	13	2.83	1.38	1.33	2.19	2.35	2.98	5.82	
Side Street	**A**	68	10.13	52.50	<0.08[3]	0.50	0.90	2.50	422.0	
Street Dust[2]	**X**	84	8.68	47.26	<0.08[3]	0.63	1.36	2.67	422.0	0.00**
Surface Soil	**Y**	113	0.62	0.92	<0.08[3]	<0.08[3]	0.37	0.82	6.78	
Over All		197	4.06	31.02	<0.08[3]	0.16	0.66	1.48	422.0	

*There is a significant difference in Mo mean concentrations among sample types.
**There is a significant difference in Mo mean concentrations among sample types.
[1]Differences between sample types with at least one common bold letter are not significant. Alley, Main Street, and Side Street samples were found to have unequal variance so pair-wise comparisons were not made by the SNK method, and no grouping indicators are displayed.
[2]Street Dust includes the Alley, Main Street, and Side Street sample types.
[3]Below the Minimum Detection Limit of 0.08 mg/Kg.

is also a valuable catalyst in organic chemical synthesis, and it is used in batteries, coins, jewelry, surgical implements, appliances, marine and electrical equipment (Adriano, 1986).

Nickel is the twenty-third most abundant element in the Earth's crust (Krauskopf, 1979). Shacklette and Boerngen (1984) reported that the concentrations of Ni in soils of the United States ranged from <5 to 700 mg Kg^{-1}, with a mean concentration of 19 mg Kg^{-1}. Holmgren et al. (1993) determined that Ni concentrations ranged from 0.7 to 269.0 mg Kg^{-1}, and it had a mean concentration of 23.9 mg Kg^{-1} in unpolluted surface soils of the United States. Holmgren et al. (1993) reported a mean Ni concentration of 19.1 mg Kg^{-1} for unpolluted Illinois soils. Granato et al. (1994) found that the mean Ni concentration in uncontaminated soils at the University of Illinois agricultural experiment stations across the state was 12.5 mg Kg^{-1} and ranged from 5.3 to 17.1 mg Kg^{-1}. The IEPA (2000) determined the mean concentration of Ni in surface soils of urbanized counties of Illinois was 18.0 mg Kg^{-1}.

Therefore, it is expected that soils in the Metropolitan Chicago area should have Ni concentrations that range from approximately 1 mg Kg^{-1} to 250.0 mg Kg^{-1}, with a mean Ni concentration of approximately 18.0 mg Kg^{-1}.

STICKNEY WRP BASIN

The mean Ni concentration in the 518 samples analyzed from the Stickney WRP basin was 16.81 mg Kg^{-1}, and the Ni concentrations ranged from 0.80 to 357.8 mg Kg^{-1} (Table 31).

The mean Ni concentrations in samples from different street dust sources within the Stickney WRP basin were found to be: 11.82 mg Kg^{-1} for alleys, 18.95 mg Kg^{-1} for main streets, and 13.80 mg Kg^{-1} for side streets (Table 31). The mean Ni concentration in street dust samples from main streets was significantly higher ($p<0.05$) than for alleys and side streets.

The mean concentration of Ni in all street dust samples, 15.39 mg Kg^{-1}, was not significantly different ($p<0.05$) than in surface soil samples, 14.30 mg Kg^{-1}, for the Stickney WRP basin (Table 31).

The mean concentrations of Ni in street dust collected from the perimeter of automobile junkyards and scrap metal yards were 57.70 and 20.16 mg Kg^{-1}, respectively, (Table 31). These mean Ni concentrations were significantly higher ($p<0.05$) than those observed for all street dusts and surface soils in the Stickney WRP basin.

The maximum Ni concentration reported for the Stickney basin, 357.8 mg Kg^{-1} in a street dust sample from an automobile junkyard

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TABLE 31

CONCENTRATION OF NICKEL IN STREET DUST AND SURFACE SOIL
COLLECTED IN THE STICKNEY WATER RECLAMATION PLANT DRAINAGE BASIN

Sample Type[1]		No. Obs	Mean	STD	Min	25th	Median	75th	Max	Sig. Prob
			mg/Kg							
Alley	**B**	38	11.82	6.62	1.20	7.60	10.77	16.91	34.93	0.00*
Main Street	**A**	141	18.95	19.56	0.80	10.80	15.20	21.72	206.6	
Side Street	**B**	229	13.80	12.53	1.20	8.00	11.60	16.40	161.0	
Street Dust[2]	**Z**	408	15.39	15.18	0.80	8.80	12.40	18.00	206.6	0.00**
Surface Soil	**Z**	80	14.30	9.75	3.81	8.44	12.56	17.80	76.80	
Automobile Junkyard	**X**	18	57.70	81.54	15.62	23.45	30.98	44.42	357.8	
Scrap Metal Yard	**Y**	12	20.16	10.01	5.97	14.70	17.81	22.95	41.57	
Over All		518	16.81	21.86	0.80	8.80	12.80	18.85	357.8	

*There is a significant difference in Ni mean concentrations among sample types.

**There is a significant difference in Ni mean concentrations among sample types.

[1]Differences between sample types with at least one common bold letter are not significant.

[2]Street Dust includes the Alley, Main Street, and Side Street sample types.

(Table 31), is beyond the expected range for soils of the Metropolitan Chicago area, which was estimated above to be 1 to 250 mg Kg^{-1}. However, the seventy-fifth percentile street dust and surface soil Ni concentrations, 18.00 and 17.80 mg Kg^{-1} (Table 31), respectively, are well within the expected range for Ni in Chicagoland surface soils. These concentrations are, in fact, below the mean Ni concentration of 19.1 mg Kg^{-1} for unpolluted soils of Illinois, as determined by Holmgren et al. (1993). The mean street dust and surface soil Ni concentrations in the Stickney basin, 15.39 and 14.30 mg Kg^{-1} (Table 31), respectively, are below the mean background soil Ni concentration of 18.0 mg Kg^{-1} determined by the IEPA (2000) for urbanized counties of Illinois. Contamination of street dust and surface soil in the Stickney WRP basin appears not to be widespread or very significant.

CALUMET WRP BASIN

The mean Ni concentration in the 249 samples analyzed from the Calumet WRP basin was 14.05 mg Kg^{-1}, and the Ni concentrations ranged from 2.00 to 106.0 mg Kg^{-1} (Table 32).

The mean Ni concentrations in samples from different street dust sources within the Calumet WRP basin were found to be: 14.86 mg Kg^{-1} for alleys, 20.71 mg Kg^{-1} for main streets,

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TABLE 32

CONCENTRATION OF NICKEL IN STREET DUST AND SURFACE SOIL
COLLECTED IN THE CALUMET WATER RECLAMATION PLANT DRAINAGE BASIN

Sample Type[1]		No. Obs	Mean	STD	Min	25th	Median	75th	Max	Sig. Prob
			mg/Kg							
Alley	**A**	5	14.86	8.76	2.00	11.60	15.20	21.00	24.50	0.08*
Main Street	**A**	24	20.71	17.93	2.40	11.65	17.05	23.45	78.00	
Side Street	**A**	103	15.69	15.06	2.80	8.33	11.80	16.40	106.0	
Street Dust[2]	**X**	132	16.57	15.47	2.00	8.45	12.20	18.45	106.0	0.00**
Surface Soil	**Y**	117	11.21	6.86	3.01	7.53	10.10	13.20	62.60	
Over All		249	14.05	12.47	2.00	7.82	11.20	15.20	106.0	

*There is no significant difference in Ni mean concentrations among sample types.
**There is a significant difference in Ni mean concentrations among sample types.
[1]Differences between sample types with at least one common bold letter are not significant.
[2]Street Dust includes the Alley, Main Street, and Side Street sample types.

and 15.69 mg Kg^{-1} for side streets (Table 32). The differences in mean Ni concentration among these sources were not statistically significant ($p<0.05$).

The mean Ni concentration in all street dust samples, 16.57 mg Kg^{-1}, was significantly higher ($p<0.05$) than the mean Ni concentration of 11.21 mg Kg^{-1} in surface soil samples for the Calumet WRP basin (Table 32).

All Ni concentrations determined for street dusts and surface soils in the Calumet basin, even the maximum concentrations, were within the expected range of 1 to 250 mg Kg^{-1} for Chicagoland soils as estimated above. As was determined for the Stickney basin, the mean concentrations of Ni in street dust and surface soil, 16.57 and 11.21 mg Kg^{-1} (Table 32), respectively, were below the mean Ni concentration of 18.0 mg Kg^{-1} for soils from urbanized counties of Illinois (IEPA 2000). Contamination of street dust and surface soil in the Calumet WRP basin appears not to be widespread or significant.

Selenium (Se) Concentrations in Street Dust and Surface Soils

Selenium is a metallic element with an atomic weight of 78.96 Daltons and an atomic number of 34. Selenium is widely used in electronic and photocopier components, glass manufacturing, chemicals and pigments, as a plastic and ceramic additive, as an alloy of steel and Cu, as a lubricant, and as an additive of shampoos.

Selenium is the sixty-eighth most abundant element in the Earth's crust (Krauskopf, 1979). Boerngen and Shacklette (1981) reported that the concentrations of Se in soils of the United States ranged from <0.1 mg Kg^{-1} to 4.3 mg Kg^{-1}. Shacklette and Boerngen (1984) reported that the mean Se concentration in soils of the United States was 0.39 mg Kg^{-1}. The IEPA (2000) determined that the mean concentration of Se in surface soils from metropolitan counties of Illinois is 0.48 mg Kg^{-1}.

Therefore, it is expected that soils in the Chicagoland area should have Se concentrations that range from <0.1 to 4.3 mg Kg^{-1}, with a mean Se concentration of 0.48 mg Kg^{-1}.

STICKNEY WRP BASIN

The mean Se concentration in the 167 samples analyzed from the Stickney WRP basin was 0.120 mg Kg^{-1}, and the Se concentrations ranged from not detected (163 samples) to 8.000 mg Kg^{-1} (Table 33).

The mean Se concentrations in samples from different street dust sources within the Stickney WRP basin were found to be: 0.286 mg Kg^{-1} for alleys, 0.211 mg Kg^{-1} for main

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TABLE 33

CONCENTRATION OF SELENIUM IN STREET DUST AND SURFACE SOIL
COLLECTED IN THE STICKNEY WATER RECLAMATION PLANT DRAINAGE BASIN

Sample Type[1]		No. Obs	Mean	STD	Min	25th	Median	75th	Max	Sig. Prob
			-----	-----	-----	mg/Kg	-----	-----	-----	
Alley	**A**	14	0.286	1.069	<0.20[3]	<0.20[3]	<0.20[3]	<0.20[3]	4.000	0.59*
Main Street	**A**	38	0.211	0.905	<0.20[3]	<0.20[3]	<0.20[3]	<0.20[3]	4.000	
Side Street	**A**	51	0.157	1.120	<0.20[3]	<0.20[3]	<0.20[3]	<0.20[3]	8.000	
Street Dust[2]	**X**	103	0.194	1.030	<0.20[3]	<0.20[3]	<0.20[3]	<0.20[3]	8.000	0.46**
Surface Soil	**X**	34	0.000	0.000	<0.20[3]	<0.20[3]	<0.20[3]	<0.20[3]	<0.20[3]	
Automobile Junkyard	**X**	18	0.000	0.000	<0.20[3]	<0.20[3]	<0.20[3]	<0.20[3]	<0.20[3]	
Scrap Metal Yard	**X**	12	0.000	0.000	<0.20[3]	<0.20[3]	<0.20[3]	<0.20[3]	<0.20[3]	
Over All		167	0.120	0.813	<0.20[3]	<0.20[3]	<0.20[3]	<0.20[3]	8.000	

*There is no significant difference in Se mean concentrations among sample types.
**There is no significant difference in Se mean concentrations among sample types.
[1]Differences between sample types with at least one common bold letter are not significant.
[2]Street Dust includes the Alley, Main Street, and Side Street sample types.
[3]Below the Minimum Detection Limit of 0.20 mg/Kg.

streets, and 0.157 mg Kg^{-1} for side streets (Table 33). The mean Se concentrations in street dust samples from alleys, main streets, and side streets were not significantly different ($p<0.05$).

The mean concentration of Se in all street dust samples was 0.194 mg Kg^{-1}. Selenium was not detected in any surface soil samples that were analyzed from the Stickney WRP basin (Table 33). These mean Se concentrations are within the normal range for Se in surface soils, which was estimated above to be <0.1 to 0.5 mg Kg^{-1}.

Selenium was not detected in any of the street dust samples collected from the perimeter of automobile junkyards and scrap metal yards.

Selenium was not commonly detected in surface soils or street dusts in the Stickney basin, and all but one detected value was in the expected concentration range of <0.1 to 4.3 mg Kg^{-1} for Chicagoland soils.

CALUMET WRP BASIN

Selenium was not detected in any of the 197 samples analyzed from the Calumet WRP basin. Selenium was not detected in street dust or surface soil samples (Table 34).

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TABLE 34

CONCENTRATION OF SELENIUM IN STREET DUST AND SURFACE SOIL
COLLECTED IN THE CALUMET WATER RECLAMATION PLANT DRAINAGE BASIN

Sample Type[1]		No. Obs	Mean	STD	Min	25th	Median	75th	Max	Sig. Prob
			mg/Kg							
Alley	**A**	3	0.000	0.000	<0.20[3]	<0.20[3]	<0.20[3]	<0.20[3]	<0.20[3]	1*
Main Street	**A**	13	0.000	0.000	<0.20[3]	<0.20[3]	<0.20[3]	<0.20[3]	<0.20[3]	
Side Street	**A**	68	0.000	0.000	<0.20[3]	<0.20[3]	<0.20[3]	<0.20[3]	<0.20[3]	
Street Dust[2]	**X**	84	0.000	0.000	<0.20[3]	<0.20[3]	<0.20[3]	<0.20[3]	<0.20[3]	1**
Surface Soil	**X**	113	0.000	0.000	<0.20[3]	<0.20[3]	<0.20[3]	<0.20[3]	<0.20[3]	
Over All		197	0.000	0.000	<0.20[3]	<0.20[3]	<0.20[3]	<0.20[3]	<0.20[3]	

*There is no significant difference in Se mean concentrations among sample types.
**There is no significant difference in Se mean concentrations among sample types.
[1]Differences between sample types with at least one common bold letter are not significant.
[2]Street Dust includes the Alley, Main Street, and Side Street sample types.
[3]Below the Minimum Detection Limit of 0.20 mg/Kg.

Silver (Ag) Concentrations in Street Dust and Surface Soils

Silver is a metallic element that has the highest thermal and electrical conductivity of any substance. Its atomic weight is 107.868 Daltons and its atomic number is 47. It is naturally occurring in the earth's crust. Major anthropogenic sources of Ag include smelting of Ag, Pb, Pb-Zn, Cu, Cu-Ni, and Ni ores; use of silver as a photographic pigment; use of Ag in silverware and jewelry; inclusion of Ag in dental alloys; in manufacture of Ag-Zn and Ag-Cd batteries; use of Ag in mirror production; and use of AgI as a nucleating agent for weather modification (Adriano, 1986).

Silver is the sixty-sixth most abundant element in the Earth's crust, having a mean concentration of 0.07 mg Kg^{-1} (Krauskopf, 1979). Adriano (1986) reviewed the literature on Ag concentration in soils and reported that Ag concentrations in soils can be expected to range from <0.1 to 5 mg Kg^{-1} in typical agricultural soils. Studies conducted on surface soils in the United States and Canada found mean Ag concentrations in surface soils of 0.4 to 0.7 mg Kg^{-1}, and Ag concentrations ranging as high as 5.0 mg Kg^{-1} in soils high in organic matter. Soils impacted by mining activities in the United Kingdom were reported to contain up to 65.0 mg Kg^{-1} Ag (Adriano, 1986). The IEPA (2000) determined that the background concentration of Ag in rural counties of Illinois is 0.50 mg Kg^{-1}, and for urbanized counties the mean background Ag concentration in soil is 0.55 mg Kg^{-1}.

Therefore, it is expected that Ag concentrations would range from <0.1 to 5.0 mg Kg^{-1} in soils in the Metropolitan Chicago area, with a mean concentration around 0.55 mg Kg^{-1}.

STICKNEY WRP BASIN

The mean Ag concentration in the 167 samples analyzed from the Stickney WRP basin was 3.20 mg Kg^{-1}, and the Ag concentrations ranged from not detected (16 samples) to 34.76 mg Kg^{-1} (Table 35).

There were no significant differences ($p<0.05$) in the mean Ag concentrations in samples from different street dust sources within the Stickney WRP basin, which were found to be: 3.77 mg Kg^{-1} for alleys, 2.11 mg Kg^{-1} for main streets, and 3.68 mg Kg^{-1} for side streets (Table 35).

The mean silver concentration for all street dust samples, 3.11 mg Kg^{-1}, was significantly higher ($p<0.05$) than the mean silver concentration of 1.57 mg Kg^{-1} in surface soil samples (Table 35).

The mean concentrations of Ag in samples collected from the perimeter of automobile junkyards and scrap metal yards

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TABLE 35

CONCENTRATION OF SILVER IN STREET DUST AND SURFACE SOIL
COLLECTED IN THE STICKNEY WATER RECLAMATION PLANT DRAINAGE BASIN

Sample Type[1]		No. Obs	Mean	STD	Min	25th	Median	75th	Max	Sig. Prob
			mg/Kg							
Alley	**A**	15	3.77	5.34	0.19	0.57	1.83	5.60	19.85	0.19*
Main Street	**A**	38	2.10	2.52	0.35	0.47	1.03	2.28	10.75	
Side Street	**A**	50	3.67	6.77	<0.01[3]	0.38	0.59	2.57	34.76	
Street Dust[2]	**Y**	103	3.11	5.37	<0.01[3]	0.45	0.76	2.56	34.76	0.00**
Surface Soil	**Z**	34	1.57	2.38	0.13	0.29	0.43	1.25	8.64	
Automobile Junkyard	**X**	18	4.82	3.64	1.04	1.74	3.23	6.83	13.14	
Scrap Metal Yard	**X**	12	6.19	6.13	0.71	2.12	4.63	7.01	22.25	
Over All		167	3.20	4.92	<0.01[3]	0.44	1.03	4.43	34.76	

*There is no significant difference in Ag mean concentrations among sample types.
**There is a significant difference in Ag mean concentrations among sample types.
[1]Differences between sample types with at least one common bold letter are not significant.
[2]Street Dust includes the Alley, Main Street, and Side Street sample types.
[3]Below the Minimum Detection Limit of 0.01 mg/Kg.

were 4.82 and 6.19 mg Kg^{-1} (Table 35), respectively. These mean Ag concentrations were significantly higher ($p<0.05$) than the mean Ag concentrations in samples from main streets, side streets, alleys, and surface soils.

The maximum Ag concentrations in street dust and surface soil samples from the Stickney basin, 34.76 and 8.64 mg Kg^{-1} (Table 35), respectively, are higher than the maximum expected concentration of 5.0 mg Kg^{-1} for Chicagoland soils. In addition, the mean Ag concentrations for street dust and surface soil samples in the Stickney basin, 3.11 and 1.57 mg Kg^{-1} (Table 35), respectively, are nearly six and three times higher, respectively, than the mean background concentration of 0.55 mg Kg^{-1} in surface soils of urbanized counties of Illinois (IEPA, 2000). However, the seventy-fifth percentile Ag concentrations in street dust and surface soil, 2.56 and 1.25 mg Kg^{-1} (Table 35), respectively, were within the expected range for Metropolitan Chicago soils, and the median Ag concentrations for street dust and surface soils, 0.76 and 0.43 mg Kg^{-1} (Table 35), respectively, were very similar to the mean background concentration of 0.55 mg Kg^{-1} in surface soils of urbanized counties of Illinois (IEPA, 2000).

These results suggest that some significant anthropogenic contamination of street dusts and surface soils with Ag occurred in the Stickney basin, but it is not widespread.

CALUMET WRP BASIN

The mean Ag concentration in the 197 samples analyzed from the Calumet WRP basin was 0.91 mg Kg^{-1}, and the Ag concentrations ranged from 0.04 to 11.95 mg Kg^{-1} (Table 36).

The mean Ag concentrations in samples from different street dust sources within the Calumet WRP basin were found to be: 4.03 mg Kg^{-1} for alleys, 1.59 mg Kg^{-1} for main streets, and 1.44 mg Kg^{-1} for side streets. (Table 36). Differences between these mean Ag concentrations were not statistically significant ($p<0.05$).

The mean silver concentration for all street dust samples, 1.56 mg Kg^{-1}, was significantly higher ($p<0.05$) than the mean silver concentration in surface soil samples, 0.43 mg Kg^{-1} (Table 36).

There appears to be no significant anthropogenic contamination of surface soils with Ag in the Calumet basin. The maximum Ag concentration observed in surface soil samples in the Calumet basin, 1.94 mg Kg^{-1} (Table 36), is within the expected range for

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TABLE 36

CONCENTRATION OF SILVER IN STREET DUST AND SURFACE SOIL
COLLECTED IN THE CALUMET WATER RECLAMATION PLANT DRAINAGE BASIN

Sample Type[1]		No. Obs	Mean	STD	Min	25th	Median	75th	Max	Sig. Prob
			---mg/Kg---							
Alley	**A**	3	4.03	5.95	0.47	0.47	0.73	10.90	10.90	0.41*
Main Street	**A**	13	1.59	2.07	0.42	0.63	0.76	1.00	6.98	
Side Street	**A**	68	1.44	2.32	0.07	0.41	0.67	1.28	11.95	
Street Dust[2]	**X**	84	1.56	2.46	0.07	0.42	0.69	1.24	11.95	0.00**
Surface Soil	**Y**	113	0.43	0.32	0.04	0.23	0.35	0.50	1.94	
Over All		197	0.91	1.71	0.04	0.30	0.43	0.75	11.95	

*There is no significant difference in Ag mean concentrations among sample types.
**There is a significant difference in Ag mean concentrations among sample types.
[1]Differences between sample types with at least one common bold letter are not significant.
[2]Street Dust includes the Alley, Main Street, and Side Street sample types.

Chicagoland soils, and the mean Ag concentration in these samples was 0.43 mg Kg^{-1}, which is very close to the mean background Ag concentration in surface soils of urbanized counties of Illinois (IEPA, 2000).

The maximum Ag concentration observed in street dust samples in the Calumet basin, 11.95 mg Kg^{-1} (Table 36), is higher than the expected maximum of 5.0 mg Kg^{-1} for Chicagoland soils, and the mean Ag concentration in these samples was 1.56 mg Kg^{-1}, which is approximately three times higher than the mean background Ag concentration in surface soils of urbanized counties of Illinois (IEPA, 2000). However, the seventy-fifth percentile Ag concentration in street dust samples in the Calumet basin, 1.24 mg Kg^{-1} (Table 36), was well within the expected range for Metropolitan Chicago soils, <0.1 to 5.0 mg Kg^{-1}.

These data suggest that some significant anthropogenic Ag contamination of street dusts in the Calumet basin has occurred, but it is not widespread.

Thallium (Tl) Concentrations in Street Dust and Surface Soils

Thallium is a metallic element with an atomic weight of 204.31 Daltons and an atomic number of 81. Thallium was commonly used in rodenticides and insecticides until it was banned in the 1970s. Thallium is used in low friction bearing alloys, in the electronics industry, and as a catalyst for organic compound synthesis (Adriano, 1986).

Thallium is the fifty-ninth most abundant element in the Earth's crust (Krauskopf, 1979). Bowen (1979) reported that the concentrations of Tl in soils of the United States ranged from 0.1 to 0.8 mg Kg^{-1}, with a mean concentration of 0.2 mg Kg^{-1}. The IEPA (2000) determined that the mean concentration of Tl in surface soils from urbanized counties in Illinois is 0.32 mg Kg^{-1}. Therefore, it is expected that the Tl concentration should range from 0.1 to 0.8 mg Kg^{-1} in soils of the Chicagoland area, with a mean concentration of approximately 0.32 mg Kg^{-1}.

STICKNEY WRP BASIN

The mean Tl concentration in the 167 samples analyzed from the Stickney WRP basin was 2.10 mg Kg^{-1}, and the Tl concentrations ranged from not detected (34 samples) to 7.51 mg Kg^{-1} (Table 37).

The mean Tl concentrations in samples from different street dust sources within the Stickney WRP basin were found to be: 1.86 mg Kg^{-1} for alleys, 2.15 mg Kg^{-1} for main streets, and 2.06 mg Kg^{-1} for side streets (Table 37). The mean Tl concentrations in street dust samples from alleys, main

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TABLE 37

CONCENTRATION OF THALLIUM IN STREET DUST AND SURFACE SOIL
COLLECTED IN THE STICKNEY WATER RECLAMATION PLANT DRAINAGE BASIN

Sample Type[1]		No. Obs	Mean	STD	Min	25th	Median	75th	Max	Sig. Prob
			mg/Kg							
Alley	**A**	14	1.86	1.04	<0.20[3]	1.02	1.76	2.60	4.00	0.64*
Main Street	**A**	38	2.15	1.06	<0.20[3]	1.56	2.09	2.87	4.44	
Side Street	**A**	51	2.06	1.07	<0.20[3]	1.33	2.06	2.77	4.57	
Street Dust[2]	**X**	103	2.06	1.05	<0.20[3]	1.33	2.06	2.77	4.57	0.79**
Surface Soil	**X**	34	2.16	1.20	<0.20[3]	1.68	2.26	2.91	5.14	
Automobile Junkyard	**X**	18	1.83	0.88	<0.20[3]	1.15	2.17	2.37	3.33	
Scrap Metal Yard	**X**	12	2.59	1.89	1.02	1.55	1.85	3.04	7.51	
Over All		167	2.10	1.15	<0.20[3]	1.33	2.07	2.74	7.51	

*There is no significant difference in Tl mean concentrations among sample types.
**There is no significant difference in Tl mean concentrations among sample types.
[1]Differences between sample types with at least one common bold letter are not significant.
[2]Street Dust includes the Alley, Main Street, and Side Street sample types.
[3]Below the Minimum Detection Limit of 0.20 mg/Kg.

streets, and side streets were not significantly different ($p<0.05$).

The mean concentration of Tl in all street dust samples, 2.06 mg Kg^{-1}, was not significantly different ($p<0.05$) than in surface soil samples, 2.16 mg Kg^{-1}, for the Stickney WRP basin (Table 37).

The mean concentrations of Tl in street dust collected from the perimeter of automobile junkyards, 1.83 mg Kg^{-1}, was not significantly different than the mean concentration of Tl in street dust collected from the perimeter of scrap metal yards, 2.59 mg Kg^{-1} (Table 37). These mean Tl concentrations were not significantly different ($p<0.05$) from those observed for all street dust and surface soils in the Stickney WRP basin. There appears to be widespread and significant anthropogenic Tl contamination of street dust and surface soils of the Stickney basin. The mean Tl concentrations in street dust and surface soils in the Stickney basin, 2.06 and 2.16 mg Kg^{-1} (Table 37), respectively, are much greater than the expected maximum in surface soils, which was estimated above to be approximately 0.8 mg Kg^{-1}.

CALUMET WRP BASIN

The mean Tl concentration in the 197 samples analyzed from the Calumet WRP basin was 1.62 mg Kg^{-1}, and the Tl concentrations ranged from not detected (107 samples) to 5.00 mg Kg^{-1} (Table 38).

The mean Tl concentrations in samples from different street dust sources within the Calumet WRP basin were found to be: 1.90 mg Kg^{-1} for alleys, 2.06 mg Kg^{-1} for main streets, and 2.24 mg Kg^{-1} for side streets (Table 38). The differences in mean Tl concentration among these sources were not statistically significant ($p<0.05$).

The mean Tl concentration in all street dust samples, 2.20 mg Kg^{-1}, was significantly higher ($p<0.05$) than the mean Tl concentration in surface soil samples, 1.18 mg Kg^{-1}, for the Calumet WRP basin (Table 38).

There appears to be widespread and significant anthropogenic Tl contamination of street dust and surface soils of the Calumet basin. The mean Tl concentrations in street dust and surface soils in the Calumet basin, 2.20 and 1.18 mg Kg^{-1} (Table 38), respectively, are higher than the expected maximum concentration of 0.8 mg Kg^{-1} for Tl in surface soils.

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TABLE 38

CONCENTRATION OF THALLIUM IN STREET DUST AND SURFACE SOIL
COLLECTED IN THE CALUMET WATER RECLAMATION PLANT DRAINAGE BASIN

Sample Type[1]		No. Obs	Mean	STD	Min	25th	Median	75th	Max	Sig. Prob
			mg/Kg							
Alley	**A**	3	1.90	0.52	1.35	1.35	1.95	2.39	2.39	0.66*
Main Street	**A**	13	2.06	1.05	0.26	1.34	2.44	2.71	3.57	
Side Street	**A**	68	2.24	1.35	<0.20[3]	0.99	2.40	3.32	5.00	
Street Dust[2]	**X**	84	2.20	1.29	<0.20[3]	1.24	2.39	3.22	5.00	0.00**
Surface Soil	**Y**	113	1.18	1.18	<0.20[3]	0.26	0.83	1.85	4.94	
Over All		197	1.62	1.32	<0.20[3]	0.47	1.40	2.58	5.00	

*There is no significant difference in Tl mean concentrations among sample types.
**There is a significant difference in Tl mean concentrations among sample types.
[1]Differences between sample types with at least one common bold letter are not significant.
[2]Street Dust includes the Alley, Main Street, and Side Street sample types.
[3]Below the Minimum Detection Limit of 0.20 mg/Kg.

Zinc (Zn) Concentrations in Street Dust and Surface Soils

Zinc is a metallic element with an atomic weight of 65.37 Daltons and an atomic number of 30. Zinc is predominantly produced from sulfide ores including sphalerite and wurtzite. Zinc ranks fourth among metals of the world in annual consumption behind iron, aluminum and copper (Adriano, 1986). Zinc is widely used as a protective coating on a number of metals to prevent corrosion and in alloys such as brass and bronze. Zinc and its compounds are commonly found in household items including galvanized pipe, utensils, cosmetics, powders, ointments, antiseptics, astringents, varnishes, televisions, and linoleum.

Zinc may be introduced into the urban environment through galvanized metals, which are commonly utilized in the building, transportation, and appliance industries; through paints, rubber products, and automobile tires; in cement and concrete (where it is used as a hardener); from dry cell batteries and other electrical apparatus; and from woods impregnated with preservatives.

Zinc is the twenty-fourth most abundant element in the Earth's crust with a reported average concentration of 70 mg Kg^{-1} (Krauskopf, 1979). Bowen (1979) reported that the concentrations of Zn in soils of the United States ranged from 1 to

900 mg Kg^{-1}, with a mean concentration of 90 mg Kg^{-1}. Shacklette and Boerngen (1984) reported a range of soil Zn for the United States of <5 to 2,900 mg Kg^{-1} with a mean of 60 mg Kg^{-1}. Holmgren et al. (1993) determined that the concentrations of Zn in uncontaminated soils of the United States ranged from <3 to 294 mg Kg^{-1}, and the mean Zn concentration was 56.5 mg Kg^{-1}. Holmgren et al. (1993) determined that the mean concentration of Zn in uncontaminated soils of Illinois was 52.4 mg Kg^{-1}. Granato et al. (1994) found that the mean Zn concentration in uncontaminated soils at the University of Illinois agricultural experiment stations across the state was 30.6 mg Kg^{-1} and ranged from 13.7 to 43.5 mg Kg^{-1}. The IEPA (2000) determined that the mean concentration of Zn in surface soils from urbanized counties of Illinois is 95.0 mg Kg^{-1}.

Therefore, it is expected that soils in the Metropolitan Chicago area should have Zn concentrations that range from not detected to 300 mg Kg^{-1}, with a mean Zn concentration of approximately 95.0 mg Kg^{-1}.

STICKNEY WRP BASIN

The mean Zn concentration in the 302 samples analyzed from the Stickney WRP basin was 361 mg Kg^{-1}, and the Zn concentrations ranged from not detected (one sample) to 5,828 mg Kg^{-1} (Table 39).

The mean Zn concentrations in samples from different street dust sources within the Stickney WRP basin were found to be: 442 mg Kg^{-1} for alleys, 364 mg Kg^{-1} for main streets, and 258 mg Kg^{-1} for side streets (Table 39). The mean Zn concentrations in street dust samples from alleys and main streets were significantly higher ($p<0.05$) than side streets.

The mean Zn concentration of 315 mg Kg^{-1} in all street dust samples was not significantly different ($p<0.05$) from the concentration of 266 mg Kg^{-1} observed in surface soil samples for the Stickney WRP basin (Table 39).

The mean concentration of Zn in street dust collected from the perimeter of automobile junkyards, 1,011 mg Kg^{-1}, was significantly higher than the mean concentration of 622 mg Kg^{-1} in street dust collected from the perimeter of scrap metal yards (Table 39). These mean Zn concentrations were significantly higher ($p<0.05$) than those observed for all street dust and surface soils in the Stickney WRP basin.

The maximum Zn concentration observed in the Stickney WRP basin, 5,828 mg Kg^{-1} in a street dust sample, is well beyond the expected maximum of 300 mg Kg^{-1} for surface soils, as summarized above. The mean Zn concentrations in all street dust

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TABLE 39

CONCENTRATION OF ZINC IN STREET DUST AND SURFACE SOIL
COLLECTED IN THE STICKNEY WATER RECLAMATION PLANT DRAINAGE BASIN

Sample Type[1]		No. Obs	Mean	STD	Min	25th	Median	75th	Max	Sig. Prob
			mg/Kg							
Alley	**A**	22	442	438	11.56	258	318	512	2247	0.00*
Main Street	**A**	82	364	254	<0.02[3]	215	347	436	1919	
Side Street	**B**	120	258	225	34.4	131	214	319	2003	
Street Dust[2]	**Z**	224	315	269	<0.02[3]	166	269	386	2247	0.00**
Surface Soil	**Z**	48	266	142	56.2	169	245	351	726	
Automobile Junkyard	**X**	18	1011	1252	224.54	560	644	824	5828	
Scrap Metal Yard	**Y**	12	622	503	102.09	199	477	919	1645	
Over All		302	361	431	<0.02[3]	173	275	408	5828	

*There is a significant difference in Zn mean concentrations among sample types.
**There is a significant difference in Zn mean concentrations among sample types.
[1]Differences between sample types with at least one common bold letter are not significant.
[2]Street Dust includes the Alley, Main Street, and Side Street sample types.
[3]Below the Minimum Detection Limit of 0.02 mg/Kg.

samples and in surface soil samples, 315 and 266 mg Kg^{-1} (Table 39), respectively, are also well above the mean concentration of 52.4 mg Kg^{-1} for Illinois soils, as determined by Holmgren et al. (1993), and the background concentration of 95.0 mg Kg^{-1} in soils from urbanized counties of Illinois (IEPA, 2000).

In fact, the twenty-fifth percentile Zn concentrations of 166 and 169 mg Kg^{-1} in all street dust and surface soil samples, respectively, were approximately 4 times greater than the highest Zn concentration of 43.5 mg Kg^{-1} observed in surface soils from the University of Illinois agricultural experiment station fields, (Granato et al., 1994), and they were higher than the mean background Zn concentration of 95.0 mg Kg^{-1} reported by the IEPA for soils from urbanized counties in Illinois (IEPA, 2000).

There is widespread and significant anthropogenic Zn contamination of street dusts and surface soils in the Stickney WRP basin.

CALUMET WRP BASIN

The mean Zn concentration in the 219 samples analyzed from the Calumet WRP basin was 302 mg Kg^{-1}, and the Zn concentrations ranged from 19 to 3,343 mg Kg^{-1} (Table 40).

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TABLE 40

CONCENTRATION OF ZINC IN STREET DUST AND SURFACE SOIL
COLLECTED IN THE CALUMET WATER RECLAMATION PLANT DRAINAGE BASIN

Sample Type[1]		No. Obs	Mean	STD	Min	25th	Median	75th	Max	Sig. Prob
			---mg/Kg---							
Alley	**A**	4	537	146	409	416	516	659	708	0.01*
Main Street	**B**	19	334	191	25	244	351	457	812	
Side Street	**B**	83	354	462	34	129	222	356	3343	
Street Dust[2]	**X**	106	358	418	25	147	254	391	3343	0.00**
Surface Soil	**Y**	113	249	266	19	100	180	259	1737	
Over All		219	302	351	19	112	210	341	3343	

*There is a significant difference in Zn mean concentrations among sample types.
**There is a significant difference in Zn mean concentrations among sample types.
[1]Differences between sample types with at least one common bold letter are not significant.
[2]Street Dust includes the Alley, Main Street, and Side Street sample types.

The mean Zn concentrations in samples from different street dust sources within the Calumet WRP basin were found to be: 537 mg Kg^{-1} for alleys, 334 mg Kg^{-1} for main streets, and 354 mg Kg^{-1} for side streets (Table 40). The mean Zn concentration in alley samples was significantly ($p<0.05$) higher than the mean Zn concentration in main street and side street samples.

The mean Zn concentration in all street dust samples, 358 mg Kg^{-1}, was significantly higher ($p<0.05$) than the mean Zn concentration in surface soil samples, 249 mg Kg^{-1}, for the Calumet WRP basin (Table 40).

The maximum Zn concentration of 3,343 mg Kg^{-1} observed in a street dust sample from the Calumet WRP basin is well beyond the maximum of the expected range of Zn concentration for surface soils, 300 mg Kg^{-1}, as summarized above. The mean Zn concentrations in all street dust samples and in surface soil samples, 358 and 249 mg Kg^{-1} (Table 40), respectively, are also well above the mean concentration of 52.4 mg Kg^{-1} for Illinois soils, as determined by Holmgren, et al. (1993), and the background concentration of 95.0 mg Kg^{-1} in soils from urbanized counties of Illinois (IEPA, 2000).

In fact, the twenty-fifth percentile concentrations of Zn in all street dust samples, 147 mg Kg^{-1}, and in surface soil samples, 100 mg Kg^{-1}, were much greater than the highest Zn concentration of 43.5 mg Kg^{-1} observed in surface soils from the University of Illinois agricultural experiment station fields (Granato et al., 1994), and they were higher than the mean background Zn concentration of 95.0 mg Kg^{-1} reported by the IEPA for soils from urbanized counties in Illinois (IEPA, 2000).

There is widespread and significant anthropogenic Zn contamination of street dusts and surface soils in the Calumet WRP basin.

Potential Impact of Street Dust and Surface Soil Run-off on Biosolids Quality

Much of the Stickney and Calumet WRP basins is drained by combined sanitary and storm water sewers. This means that suspended street dust and surface soil carried into sewers in these basins with storm water run-off can potentially be a significant source of nonvolatile solids that comprise approximately 65 percent of the aged air-dried biosolids that are produced by the District. As such, trace elements contained in surface soils and street dusts in the Calumet and Stickney WRP basins contribute to the total concentration of these elements in biosolids.

This study was not designed to provide quantitative estimation of mass loading of trace elements in street dusts and surface soils to the Calumet and Stickney WRPs. However, to give some perspective of the potential impact of this trace element source on biosolids quality, we tabulated the percent of street dust and surface soil trace element concentrations that were below or equal with the concentration limit in exceptional quality (EQ) biosolids, as defined in Table 3 of Section 503.13 of the Part 503 rule (USEPA, 1993) for that trace element (Table 41).

Potential Impact of Street Dust and Surface Soil Run-Off on Attainment of Part 503 EQ Biosolids

All street dust and surface soil samples collected in the Stickney WRP basin had As, Cd, Hg, Mo, Ni, Se, and Zn concentrations below the Part 503 EQ biosolids limits (Table 41). Therefore, it does not seem likely that street dust and surface soils can cause non-attainment of the EQ biosolids limits for As, Cd, Hg, Mo, Ni, Se, and Zn at the Stickney WRP. Street dust and surface soils also do not pose a significant threat to attainment of Part 503 EQ biosolids status with respect to Cu. Only one of the 270 total street dust and surface soil samples, a street dust sample, had Cu concentration above the Part 503 EQ limit. The greatest potential threat to

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TABLE 41

PERCENTAGE OF STREET DUST AND SURFACE SOIL SAMPLES WITH TRACE ELEMENT CONCENTRATIONS BELOW THE PART 503 EQ BIOSOLIDS LIMIT

			Stickney			Calumet		
Sample Type	Element	Part 503 EQ limit (mg/Kg)	No. Obs	No. below EQ limit	Percent below EQ limit	No. Obs	No. below EQ limit	Percent below EQ limit
Street Dust	Arsenic	41	103	103	100.0	84	84	100.0
	Cadmium	39	408	408	100.0	132	132	100.0
	Copper	1500	220	219	99.5	106	106	100.0
	Lead	300	407	363	89.2	132	120	90.9
	Mercury	17	31	31	100.0	8	8	100.0
	Molybdenum	75	103	103	100.0	84	82	97.6
	Nickel	420	408	408	100.0	132	132	100.0
	Selenium	100	103	103	100.0	84	84	100.0
	Zinc	2800	224	224	100.0	106	105	99.1
Surface Soil	Arsenic	41	34	34	100.0	113	113	100.0
	Cadmium	39	81	81	100.0	117	117	100.0
	Copper	1500	50	50	100.0	113	113	100.0
	Lead	300	81	74	91.4	117	111	94.9
	Mercury	17	20	20	100.0	26	26	100.0
	Molybdenum	75	34	34	100.0	113	113	100.0
	Nickel	420	80	80	100.0	117	117	100.0
	Selenium	100	34	34	100.0	113	113	100.0
	Zinc	2800	48	48	100.0	113	113	100.0

attainment of Part 503 EQ biosolids posed by street dust and surface soil in the Stickney WRP basin comes from Pb. There were 10.8 percent of the street dust samples and 8.6 percent of the surface soil samples that had Pb concentration above the Part 503 EQ limits (Table 41).

All street dust and surface soil samples collected in the Calumet WRP basin had As, Cd, Cu, Hg, Ni, and Se concentrations below the Part 503 EQ biosolids limits (Table 41). Therefore, it does not seem likely that street dust and surface soils can produce non-attainment of Part 503 EQ biosolids limits for As, Cd, Cu, Hg, Ni, and Se at the Calumet WRP. Street dust and surface soils also do not pose a significant threat to attainment of the Part 503 EQ biosolids status for Mo and Zn. Only one of the 219 total street dust and surface soil samples, a street dust sample, had Zn concentration above the Part 503 EQ limit, and only two of the 197 total street dust and surface soil samples, both street dust samples, had Mo concentration above the Part 503 EQ limit (Table 41). The greatest potential threat to attainment of Part 503 EQ biosolids posed by street dust and surface soil in the Calumet WRP basin comes from Pb. There were 9.1 percent of the street dust samples and 5.1 percent of the surface soil samples that had Pb concentration above the Part 503 EQ limits (Table 41).

Closer examination of the data for Pb reveals that street dust from alleys and the periphery of automobile junkyards and scrap metal yards are the greatest sources of Pb among sample types collected in this study. Alley street dust samples had mean Pb concentrations of 268 and 204 mg Kg^{-1}, respectively, for the Stickney and Calumet WRP basins, with the seventy-fifth percentile Pb concentrations above the Part 503 EQ biosolids limit of 300 mg Kg^{-1} (Tables 21 and 22). The mean Pb concentrations in street dust samples from the periphery of automobile junkyards and scrap metal yards in the Stickney WRP basin were 700 and 573 mg Kg^{-1}, respectively, with maximum concentrations that were five to ten times higher than the Part 503 EQ biosolids limit of 300 mg Kg^{-1} (Tables 21 and 22).

Potential Impact of Street Dust and Surface Soil Run-off on Trace Element Concentrations in 2000 Biosolids

The biosolids that were produced by the Stickney and Calumet WRPs in 2000 had trace element concentrations that were well below the Part 503 EQ limits. To assess the potential importance of street dust and surface soil as sources of trace elements to biosolids, we computed the percent of samples collected in the Stickney and Calumet WRP basins that had trace element concentrations higher than the mean concentration of that trace element in centrifuge cake biosolids from the respective treatment plant in 2000.

We found that the concentrations of Cr, Cu, Hg, Mo, Ni, Se, and Zn in over 96 percent of the street dust and surface soil samples from the Stickney WRP basin were below the mean concentration of these elements in 2000 Stickney WRP biosolids (Table 42). This gives the general indication that the concentration of these elements cannot be further reduced in Stickney biosolids by limiting street dust and surface soil input to the plant.

However, the mean Cu concentration in street dust from automobile junkyards and scrap metal yards, 490.6 and 495.4 mg Kg^{-1}, respectively, (Table 17) were higher than the mean concentration of 395.6 mg Kg^{-1} in 2000 Stickney WRP biosolids (Table 42).

The mean Ni concentration in street dust from automobile junkyards, 57.70 mg Kg^{-1} (Table 31), was higher than the mean concentration of 53.21 mg Kg^{-1} in 2000 Stickney WRP biosolids (Table 42). Therefore, control of street dust run-off from the periphery of automobile junkyards and scrap metal yards could provide further reductions in the concentration of Ni and Cu in Stickney WRP biosolids.

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TABLE 42

PERCENTAGE OF STREET DUST AND SURFACE SOIL SAMPLES WITH TRACE ELEMENT CONCENTRATIONS BELOW THE MEAN CENTRIFUGE CAKE BIOSOLIDS CONCENTRATION - STICKNEY WRP

Sample Type	Element	Mean Cake Concentration[1] (mg/Kg)	No. Obs	No. Below Mean Cake Concentration	Percent Below Mean Cake Concentration
Street Dust	Aluminum	14606	198	198	100.0
	Arsenic	5.69	103	89	86.4
	Cadmium	4.50	408	285	69.9
	Calcium	34393	73	21	28.8
	Chromium	251.2	408	408	100.0
	Copper	395.6	220	212	96.4
	Iron	13723	217	65	30.0
	Lead	144	407	245	60.2
	Magnesium	14314	73	8	11.0
	Manganese	453	219	180	82.2
	Mercury	0.945	31	31	100.0
	Molybdenum	15.02	103	101	98.1
	Nickel	53.21	408	402	98.5
	Selenium	2.608	103	99	96.1
	Zinc	897	224	219	97.8

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 42 (Continued)

PERCENTAGE OF STREET DUST AND SURFACE SOIL SAMPLES WITH TRACE ELEMENT CONCENTRATIONS BELOW THE MEAN CENTRIFUGE CAKE BIOSOLIDS CONCENTRATION - STICKNEY WRP

Sample Type	Element	Mean Cake Concentration[1] (mg/Kg)	No. Obs	No. Below Mean Cake Concentration	Percent Below Mean Cake Concentration
Surface Soil	Aluminum	14606	34	34	100.0
	Arsenic	5.69	34	25	73.5
	Cadmium	4.50	81	57	70.4
	Calcium	34392	8	2	25.0
	Chromium	251.2	81	80	98.8
	Copper	395.6	50	49	98.0
	Iron	13723	50	21	42.0
	Lead	144	81	52	64.2
	Magnesium	14314	8	0	0.0
	Manganese	453	50	35	70.0
	Mercury	0.945	20	20	100.0
	Molybdenum	15.02	34	33	97.1
	Nickel	53.21	80	79	98.8
	Selenium	2.608	34	34	100.0
	Zinc	897	48	48	100.0

[1]Cake Concentrations are means for 2000.

The street dust and surface soils of the Stickney WRP basin appear to be potentially significant sources of As, Cd, and Pb to the Stickney WRP biosolids.

The mean As concentration in 2000 Stickney WRP biosolids was exceeded in 13.6 and 26.5 percent of the street dust and surface soil samples, respectively, that were collected in the Stickney WRP basin (Table 42).

The mean Cd concentration in 2000 Stickney WRP biosolids was exceeded in 30.1 and 29.6 percent of the street dust and surface soil samples, respectively, that were collected in the Stickney WRP basin (Table 42).

The mean Pb concentration in 2000 Stickney WRP biosolids was exceeded in 39.8 and 35.8 percent of the street dust and surface soil samples, respectively, that were collected in the Stickney WRP basin (Table 42).

We found that the concentrations of As, Cu, Hg, Mo, Se, and Zn in over 95 percent of the street dust and surface soil samples from the Calumet WRP basin were below the mean concentration of these elements in 2000 Calumet WRP biosolids (Table 43). This gives the general indication that the concentration of these elements cannot be further reduced in Calumet biosolids by limiting street dust and surface soil input to the plant.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 43

PERCENTAGE OF STREET DUST AND SURFACE SOIL SAMPLES WITH TRACE ELEMENT CONCENTRATIONS BELOW THE MEAN CENTRIFUGE CAKE BIOSOLIDS CONCENTRATION - CALUMET WRP

Sample Type	Element	Mean Cake Concentration[1] (mg/Kg)	No. Obs	No. Below Mean Cake Concentration	Percent Below Mean Cake Concentration
Street Dust	Aluminum	8147	40	36	90.0
	Antimony	0.18	84	4	4.8
	Arsenic	8.41	84	81	96.4
	Barium	416.0	82	82	100.0
	Beryllium	0.33	84	81	96.4
	Cadmium	4.32	132	105	79.5
	Calcium	45864	8	5	62.5
	Chromium	82.5	132	102	77.3
	Copper	347.6	106	104	98.1
	Iron	36995	106	89	84.0
	Lead	110	132	73	55.3
	Magnesium	12428	8	0	0.0
	Manganese	551	102	44	43.1
	Mercury	0.605	8	8	100.0
	Molybdenum	11.42	84	80	95.2
	Nickel	32.48	132	119	90.2
	Selenium	12.65	84	84	100.0
	Silver	8.15	84	79	94.0
	Thallium	110.8	84	84	100.0
	Zinc	1133	106	102	96.2

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 43 (Continued)

PERCENTAGE OF STREET DUST AND SURFACE SOIL SAMPLES WITH TRACE ELEMENT CONCENTRATIONS BELOW THE MEAN CENTRIFUGE CAKE BIOSOLIDS CONCENTRATION - CALUMET WRP

Sample Type	Element	Mean Cake Concentration[1] (mg/Kg)	No. Obs	No. Below Mean Cake Concentration	Percent Below Mean Cake Concentration
Surface Soil	Aluminum	8147	3	2	66.7
	Antimony	0.18	113	17	15.0
	Arsenic	8.41	113	109	96.5
	Barium	416.0	113	113	100.0
	Beryllium	0.33	113	99	87.6
	Cadmium	4.32	117	109	93.2
	Calcium	45863	1	0	0.0
	Chromium	82.5	117	112	95.7
	Copper	347.6	113	113	100.0
	Iron	36995	113	111	98.2
	Lead	110	117	81	69.2
	Magnesium	12428	1	0	0.0
	Manganese	551	113	81	71.7
	Mercury	0.605	26	26	100.0
	Molybdenum	11.42	113	113	100.0
	Nickel	32.48	117	115	98.3
	Selenium	12.65	113	113	100.0
	Silver	8.15	113	113	100.0
	Thallium	110.8	113	113	100.0
	Zinc	1133	113	110	97.3

[1] Cake concentrations are means for 2000.

The street dust and or surface soils of the Calumet WRP basin appear to be potentially significant sources of Cd, Cr, Pb, and Ni to the Calumet WRP biosolids.

The mean Cd concentration in 2000 Calumet WRP biosolids was exceeded in 20.5 and 6.8 percent of the street dust and surface soil samples, respectively, that were collected in the Calumet WRP basin (Table 43).

The mean Cr concentration in 2000 Calumet WRP biosolids was exceeded in 22.7 percent of the street dust samples that were collected in the Calumet WRP basin (Table 43). However, only 4.3 percent of surface soil samples had Cr concentrations above the mean concentration in 2000 Calumet WRP biosolids.

The mean Pb concentration in 2000 Calumet WRP biosolids was exceeded in 39.8 and 44.7 percent of the street dust and surface soil samples, respectively, that were collected in the Calumet WRP basin (Table 43).

The mean Ni concentration in 2000 Calumet WRP biosolids was exceeded in 9.8 percent of the street dust samples that were collected in the Calumet WRP basin (Table 43). However, only 1.7 percent of surface soil samples had Ni concentrations above the mean concentration in 2000 Calumet WRP biosolids.

Comparison of Elemental Composition of Stickney and Calumet WRP Biosolids with Surface Soils Collected from Both Basins

Biosolids from the Stickney and Calumet WRP are being utilized as a topsoil substitute and soil conditioner throughout the Metropolitan Chicago area. We have compared the mean concentrations of trace elements in Stickney and Calumet WRP biosolids with the mean trace element concentrations in all topsoil samples collected from both the Calumet and Stickney WRP basins (Table 44). Nearly all of the trace elements studied had significantly ($p<0.05$) higher trace element concentrations in biosolids than in topsoil.

The exceptions were that the mean Sb concentration was significantly ($p<0.05$) lower in biosolids from the Calumet WRP than in topsoil; the mean Mn concentration was significantly ($p<0.05$) lower in Stickney WRP biosolids than in topsoil; the mean Pb and Mn concentrations in Calumet WRP biosolids were not significantly different than topsoil; and the mean As concentration in Stickney WRP biosolids was not significantly different than the mean As concentration in topsoil (Table 44). Also noteworthy was the fact that the mean concentration of As, Be, and Cd in biosolids from the Calumet WRP and Cd and Pb from the Stickney WRP were less than twice as high as the mean concentrations in topsoil.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 44

COMPARISON OF TRACE ELEMENT CONCENTRATION IN BIOSOLIDS FROM CALUMET WATER RECLAMATION PLANT AND STICKNEY WATER RECLAMATION PLANT WITH TOPSOIL COLLECTED FROM BOTH BASINS

	Surface Soil		Stickney Biosolids (2000)		Calumet Biosolids (2000)	
Element	No. of Obs.	Mean Conc. (mg/Kg)	Mean Conc. (mg/Kg)	Wilcoxen Sig. Prob*	Mean Conc. (mg/Kg)	Wilcoxen Sig. Prob*
Aluminum	37	3318	14607	0.000	8147	0.350
Antimony	113	0.6	NA	NA	0.2	0.000
Arsenic	147	5.1	5.7	0.193	8.4	0.000
Barium	113	68.7	NA	NA	416.0	0.000
Beryllium	113	0.2	NA	NA	0.3	0.000
Cadmium	198	2.8	4.5	0.008	4.3	0.000
Calcium	9	38942	34392	0.071	45864	0.973
Chromium	198	37.6	251.2	0.000	82.5	0.000
Copper	163	50.6	395.6	0.000	347.6	0.000
Iron	163	15897	13723	0.202	36995	0.000
Lead	198	122.4	144.4	0.029	110.0	0.000
Magnesium	9	23852	14314	0.000	12428	0.102

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TABLE 44 (Continued)

COMPARISON OF TRACE ELEMENT CONCENTRATION IN BIOSOLIDS FROM CALUMET WATER RECLAMATION PLANT AND STICKNEY WATER RECLAMATION PLANT WITH TOPSOIL COLLECTED FROM BOTH BASINS

Element	Surface Soil		Stickney Biosolids (2000)		Calumet Biosolids (2000)	
	No. of Obs.	Mean Conc. (mg/Kg)	Mean Conc. (mg/Kg)	Wilcoxen Sig. Prob*	Mean Conc. (mg/Kg)	Wilcoxen Sig. Prob*
Manganese	163	576.8	452.8	0.008	550.9	0.000
Mercury	46	0.1	0.9	0.000	0.6	0.000
Molybdenum	147	0.9	15.0	0.000	11.4	0.000
Nickel	197	12.0	53.2	0.000	32.5	0.000
Selenium	147	0.0	2.6	0.000	12.7	0.000
Silver	113	0.7	NA	NA	8.1	0.000
Thallium	113	1.4	NA	NA	110.8	0.000
Zinc	161	254.0	896.8	0.000	1133	0.000

While most trace elements are present at greater concentrations in biosolids than in topsoil, they do not pose a significant risk to human health or the environment due to the ability of biosolids to tightly bind and sequester them (USEPA, 1995).

Comparison of Elemental Composition of Street Dust and Surface Soils in the Stickney WRP Basin with the Calumet WRP Basin

The mean trace element concentrations in street dust and surface soils from the Stickney WRP basin were compared with the mean concentrations in street dust and surface soils from the Calumet WRP basin. Parametric analyses were utilized to make the comparisons when the data for both the Stickney and Calumet samples fulfilled the assumptions of normality and had equal variance, or when both datasets had greater than 30 samples. In all other cases, the Wilcoxon Rank-Sum Test was utilized.

The mean concentrations of Ag, Ba, Cd, Cu, Pb, Se, and Sb were higher in street dust and surface soil samples from the Stickney WRP basin than they were in samples from the Calumet WRP basin. For Ag, Cd, and Cu, the differences were significant ($p<0.05$) for both street dust and surface soil. The difference was only significant ($p<0.05$) for surface soil for Ba and Sb. For Se the difference was only significant for surface soil, and for Pb the differences were not significant, although the overall mean Pb concentration for all street dust and surface soil samples was significantly higher for the Stickney WRP basin than for the Calumet WRP basin (Table 45).

The mean concentrations of Al, Be, and Ca were higher in street dust and surface soil samples from the Calumet WRP basin than they were in samples from the Stickney WRP basin. The differences were only significant ($p<0.05$) for Al in street dust. However, the overall mean Al, Be, and Ca concentrations for all street dust and surface soil samples were significantly greater ($p<0.05$) in samples from the Calumet WRP basin than in the Stickney WRP basin (Table 45).

There were no significant differences ($p<0.05$) in the mean concentrations of As, Mg, and Zn in street dust and surface soil samples from the Stickney WRP basin and the Calumet WRP basin.

The mean concentrations of Cr, Fe, Hg, Mn, Mo, Ni, and Tl in street dust were higher in samples from the Calumet WRP basin than for samples from the Stickney WRP basin, and the differences were significant ($p<0.05$) for Cr, Hg, and Mn (Table 45). The mean concentrations of Cr, Fe, Hg, Mn, Mo, Ni, and Tl in surface soils were higher in samples from the Stickney

WRP basin than for samples from the Calumet WRP basin, and the differences were significant ($p<0.05$) for Cr, Fe, Hg, Mo, Ni, and Tl (Table 45).

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 45

COMPARISON OF MEAN ELEMENT CONCENTRATIONS IN STICKNEY AND CALUMET WATER RECLAMATION PLANT BASINS FOR STREET DUST AND SURFACE SOIL

		Stickney			Calumet			Sig.[1]
Sample Type	Parameter	Obs	Mean	Std	Obs	Mean	Std	P-Value
Street Dust	Al	198	2686	1427	40	4708	4197	0.003
Surface Soil	Al	34	3006	2120	3	6855	5777	0.181
Over All	Al	232	2733	1547	43	4858	4273	0.001
Street Dust	Sb	103	1.34	1.70	84	1.31	2.10	0.923
Surface Soil	Sb	34	0.97	1.17	113	0.53	0.44	0.032
Over All	Sb	137	1.25	1.59	197	0.86	1.46	0.025
Street Dust	As	103	4.79	3.46	84	4.97	2.35	0.679
Surface Soil	As	34	5.07	3.59	113	5.12	2.54	0.939
Over All	As	137	4.86	3.48	197	5.05	2.45	0.575
Street Dust	Ba	103	101.6	86.0	82	82.6	46.3	0.055
Surface Soil*	Ba	34	68.2	1.6	113	55.6	1.8	0.000
Over All	Ba	137	95.1	77.0	195	73.4	49.6	0.004
Street Dust**	Be	20	0.06	3.27	35	0.10	3.01	0.134
Surface Soil	Be	34	0.09	0.27	113	0.17	0.20	0.141
Over All	Be	132	0.04	0.16	197	0.13	0.23	0.000
Street Dust	Cd	408	3.98	4.12	132	3.14	3.35	0.017
Surface Soil	Cd	81	3.86	4.05	117	2.03	1.72	0.000
Over All	Cd	489	3.96	4.10	249	2.62	2.76	0.000
Street Dust	Ca	73	38761	11087	8	42512	6768	0.060
Surface Soil	Ca	8	38035	4216	1	46197	DNE	0.361
Over All	Ca	81	38689	10594	9	42921	6449	0.025

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 45 (Continued)

COMPARISON OF MEAN ELEMENT CONCENTRATIONS IN STICKNEY AND CALUMET WATER RECLAMATION PLANT BASINS FOR STREET DUST AND SURFACE SOIL

Sample Type	Parameter	Stickney Obs	Stickney Mean	Stickney Std	Calumet Obs	Calumet Mean	Calumet Std	Sig.[1] P-Value
Street Dust	Cr	408	42.7	28.9	132	73.7	164.5	0.031
Surface Soil	Cr	81	49.7	84.3	117	29.3	35.3	0.040
Over All	Cr	489	43.9	43.3	249	52.9	124.0	0.266
Street Dust	Cu	220	118.9	210.6	106	75.8	92.0	0.010
Surface Soil	Cu	50	95.1	145.9	113	30.9	22.4	0.002
Over All	Cu	270	114.5	200.2	219	52.6	69.5	0.000
Street Dust	Fe	217	21155	11824	106	22726	16727	0.386
Surface Soil	Fe	50	21583	14660	113	13381	7628	0.000
Over All	Fe	267	21235	12375	219	17904	13659	0.005
Street Dust	Pb	407	157	156	132	140	148	0.264
Surface Soil	Pb	81	137	108	117	112	158	0.183
Over All	Pb	488	154	149	249	127	153	0.024
Street Dust	Mg	73	21487	6823	8	20092	4815	0.665
Surface Soil	Mg	8	22471	3763	1	34898	DNE	0.212
Over All	Mg	81	21584	6575	9	21737	6682	0.957
Street Dust	Mn	219	359	227	102	1158	2025	0.000
Surface Soil	Mn	50	655	1724	113	542	571	0.653
Over All	Mn	269	414	773	215	835	1483	0.000
Street Dust**	Hg	31	0.108	2.040	8	0.217	2.720	0.030
Surface Soil	Hg	20	0.177	0.167	26	0.090	0.154	0.004
Over All	Hg	51	0.157	0.163	34	0.148	0.229	0.834

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 45 (Continued)

COMPARISON OF MEAN ELEMENT CONCENTRATIONS IN STICKNEY AND CALUMET WATER RECLAMATION PLANT BASINS FOR STREET DUST AND SURFACE SOIL

		Stickney			Calumet			Sig.[1]
Sample Type	Parameter	Obs	Mean	Std	Obs	Mean	Std	P-Value
Street Dust	Mo	103	2.54	7.51	84	8.68	47.26	0.238
Surface Soil	Mo	34	1.85	3.57	113	0.62	0.92	0.047
Over All	Mo	137	2.37	6.74	197	4.06	31.02	0.459
Street Dust	Ni	408	15.39	15.18	132	16.57	15.47	0.446
Surface Soil	Ni	80	14.30	9.75	117	11.21	6.86	0.014
Over All	Ni	488	15.21	14.43	249	14.05	12.47	0.256
Street Dust	Se	103	0.19	1.03	84	0.00	0.00	0.056
Surface Soil	Se	34	0.00	0.00	113	0.00	0.00	0.000
Over All	Se	137	0.15	0.90	197	0.00	0.00	0.056
Street Dust	Ag	103	3.11	5.37	84	1.56	2.46	0.009
Surface Soil	Ag	34	1.57	2.38	113	0.43	0.32	0.005
Over All	Ag	137	2.73	4.84	197	0.91	1.71	0.000
Street Dust	Tl	103	2.06	1.05	84	2.20	1.29	0.436
Surface Soil	Tl	34	2.16	1.20	113	1.18	1.18	0.000
Over All	Tl	137	2.09	1.09	197	1.62	1.32	0.000
Street Dust	Zn	224	315	269	106	358	418	0.334
Surface Soil	Zn	48	266	142	113	249	266	0.607
Over All	Zn	272	306	252	219	302	351	0.874

[1]P-value <=0.05 indicates that means are unequal in two basins.

DNE = Does not Exist.

** = Calculated using log transformed concentration.

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