RESEARCH REPORT

A Reference Guide to Lead Research in Canada

Canada

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A REFERENCE GUIDE TO LEAD RESEARCH IN CANADA.

A compilation of scientific publications, expertise and current legislation.

HILCON CONSULTANTS
Ottawa.

This overview of the current state of knowledge regarding lead in Canada was completed under Contract Number 6790-1-3 from CMHC to Hilcon Consultants.

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NOTE: Aussi disponible en français sous le titre: Guide de référence en matière de recherche sur le plomb au Canada

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LIST OF UNITS AND ABBREVIATIONS

2EL	diethyl lead
3EL	triethyl lead
ACGIH	American Conference of Government Industrial Hygienists
ALA-d	delta-aminolevulinic acid dehydratase
As-U	urinary arsenic
b.w.	body weight
CDC	Center for Disease Control (US)
cm	centimeter
CNS	central nervous system
d.	day
dL	deciliter
DPASV	differential-pulse anodic stripping voltammetry
DSC	Département de Santé Communautaire du Haut-Richelieu
DTT	dithiothreitol
F	fluoride
FEP	free erythrocyte protoporphyrin
FI	fixed interval
FR	fixed ratio
GFAAS	graphite furnace atomic absorption spectrophotometry
HSSB	Health and Safety Support Branch of the Ministry of Labour (Ontario)
IC_{50}	concentration at which 50% inhibition is observed
ICP-MS	Inductively coupled plasma-mass spectrometry
K	degrees kelvin
kg	kilogram
LDH	lactate dehydrogenase
L/kg	liters per kilogram
L/S	liquid to solid ratio
LTZ	lead titanate zirconate
MAC	maximum allowable concentration
μCi	microCuries (measure of radioactivity)
μg	micrograms
μg/dL	micrograms per deciliter
μg/g	micrograms per gram
μg/kg b.w./day	micrograms per kilogram body weight per day
μg/kg/day	micrograms per kilogram body weight per day
μg/L	micrograms per liter
μg/(100) ml	micrograms per (100) milliliters
μg/min	micrograms per minute
μmol/g	micromole per gram
μmol/L	micromole per liter
mg/L	milligrams per liter
mg/kg	milligrams per kilogram body weight
mg/kg b.w.	milligrams per kilogram body weight
mg/m^3	milligram per cubic meter
mg Pb/kg b.w./day	milligrams lead per kilogram body weight per day
ml	milliters
mm Hg	millimeter mercury
mM	millimole
MOE	Ontario Ministry of the Environment
min.	minute
M	molar

ng	nanogram
ng/g	nanogram per gram
ng/min.	nanograms per minute
OMT	Ontario Ministry of Transportation
NOAEL	no observed adverse effect level
NTD	neural tube defect
Pb	lead
Pb-B	blood lead
PbHOAC	lead acetate
pH	concentration of H^+ ions
ppb	parts per billion
ppm	parts per million
SD	standard deviation
sec.	seconds
STPF	stabilized temperature platform furnace
TEL	tetraethyl lead
TSP	total suspended particulate
wt.	weight
w/w	weight per weight
yrs.	years
ZPP	zinc protoporphyrin

INTRODUCTION.

This report was prepared by Hilcon Consultants under contract from the Canadian Mortgage and Housing Corporation, who requested an overview of Canadian research activities dealing with lead issues which had been published over the past five years. The contract was awarded in response to growing concerns that the presence of leaded-paint and other sources of lead, particularly in older Canadian homes, might represent an unnecessary health risk to their residents, especially during renovations.

The report summarizes most of the available literature concerning the health hazards associated with exposure to lead in Canada, the main focus being placed on studies dealing with exposure to lead in the home environment (drinking water, air, soil, building materials and consumer products), health effects on the Canadian population, and the measures being taken to decrease exposure to lead (lead abatement and remediation projects).

The report is divided into three sections, each of them addressing a particular aspect of lead research. The main part of the report consists of an annotated bibliography of Canadian studies published since 1985. All the publications concern some aspect of lead research, and in each case, the work was either undertaken at a Canadian centre or at least one of the authors was Canadian. This section has been sub-divided according to the subject matter (e.g. lead in the environment, analytical methods, etc.), and within each subsection the publications have been placed in chronological order, starting with those published most recently.

The second section of the report consists of a listing of Canadian experts and centres of expertise, together with a brief description of their field; here the listing has been organized geographically, province by province in alphabetical order.

The last section is a compilation of Canadian legislation and guidelines regarding the levels of lead in the environment and various consumer products. Federal legislation is summarized first, and then, as in the previous section, the listing has been arranged alphabetically province by province. A glossary of terms and abbreviations has been placed at the beginning of the report.

The preparation of this report was time-consuming, as designing a successful but complete search strategy restricted to Canadian studies proved difficult. For example, the majority of reports produced by federal, provincial and municipal authorities were not readily accessible from libraries (CISTI, HWC, National Archives, etc.), nor were they listed in the main database searches. Furthermore, many of the individuals listed in the second part of this report have only published a few scientific papers dealing with lead issues, making it difficult to recognize their expertise from print-outs of database searches. To overcome this problem, inquiries were made at the federal, provincial and municipal levels, and a list of individuals and organizations contacted is included in Appendix A.

ANNOTATED BIBLIOGRAPHY OF CANADIAN STUDIES DEALING WITH THE EXPOSURE OF THE CANADIAN POPULATION TO LEAD.

The following section contains the main body of this report, and summarizes recent or current Canadian studies related to lead in housing. The present literature survey is intended as an update to the 1986 Royal Society of Canada's report on lead.

The Royal Society of Canada's "Commission on Lead in the Environment" was created in 1984, and its mandate was to provide the Minister of the Environment with independent advice on the health risks and other areas of concern related to the presence of lead in the Canadian environment. Furthermore, the Commission was asked to suggest means by which the environmental and health risks associated with lead exposure could be reduced. The Commission's final Report: "*Lead in the Canadian Environment: Science and Regulation*" was released in 1986, together with three complementary volumes of scientific papers used by the Commission as a basis for its final report. These 4 publications provide one of the most comprehensive reviews of lead in the Canadian environment up to 1985; we have therefore only included a selection of the more relevant studies published prior to 1985.

Several aspects of lead research have been surveyed here, but emphasis has been placed on three types of studies, namely: **human exposure to lead in the home environment** (lead in drinking water, air, soil and dust, building materials, and consumer products), **health effects on the Canadian population** (epidemiological studies, blood-lead surveys, industrial and occupational exposure), and **measures being taken to eliminate sources of exposure** (soil replacement, lead abatement and remediation projects). However, reports dealing with the impact of lead emissions on the ecosystem, as well as experimental studies describing the toxic effects resulting from low level exposure to lead have also been included for the sake of completeness.

The information in this section was accessed by searching the following data bases:

- Science Citation Index (1988-1992)
- Toxline (1970-1992)
- Biological Abstracts (1985-1992)
- Codoc (1980-1989)
- Microlog (1979-1992)
- Nlcatbn (1973-1992)
- Canadiana (1977-1992)
- Canadian Studies (1980-1992)
- Dobis

In addition, a number of Governmental Institutions and individuals were contacted in order to obtain information on unpublished studies or reports relevant to this contract (See Appendix A).

The studies have been grouped according to the subject matter into one of 12 different sub-sections, within each of which the material has been placed chronologically. Studies addressing more than one topic have been placed in the section most relevant to its findings (e.g., studies of health effects following occupational exposure will be found in the "industrial exposure" rather than the "health effects" section).

GENERAL INTEREST BOOKS/ARTICLES ON LEAD.

Saturnine drugs and medicinal exposure to lead: An historical outline.

NRIAGU, J.O.
National Water Research Institute, Environment Canada, Burlington, Ontario.
In: Needleman, H.L., Ed. *Human Lead Exposure*. CRC Press, Boca Raton, Fla., pp. 3-21, 1992.

This paper looks at the pharmaceutical uses to which lead has been put in many ancient cultures, and notes that centuries ago many physicians warned that practitioners may be doing more harm than good by prescribing the metal.

Frozen in Time. Unlocking the Secrets of the Franklin Expedition.

BEATTIE, O. & GEIGER, J.
Western Producer Prairie Books, Saskatoon, Saskatchewan, 180 pp., 1987.

An account of the 1984 Canadian Arctic expedition which attempted to resolve the mystery behind the deaths of 129 men during the Franklin Expedition of 1848. Autopsies performed on three of those men nearly 140 years after their deaths revealed high levels of lead in their hair, bone and tissue samples. This observation led to the theory that lead poisoning, via food contained in soldered tins, was a major contributor to their demise.

The Citizen's Guide to Lead. Uncovering a Hidden Health Hazard.

WALLACE, B. & COOPER, K.
NC Press Ltd., Toronto, 196 pp., 1986.

A complete guide to the problems caused by environmental contamination with lead, which focuses mainly on the Canadian situation. This book was written for the general public, and clearly describes the different ways anyone (particularly young children) can be exposed to lead. The book includes chapters on what can be done to reduce personal health risks and avoid further environmental contamination.

GENERAL STUDIES/REPORTS ON LEAD IN THE ENVIRONMENT.

The Reduction of Lead in Steel Flue Dust Using a Batch Leaching Process.

TARSITANO, T.
Department of Chemical Engineering and Applied Chemistry, University of Toronto, Toronto, Ontario.
Report prepared for the Waste Management Branch, Ontario Ministry of the Environment, Queen's Printer for Ontario, 49 pp., 1991.

The effectiveness of various leaching procedures in removing lead from steel flue dust was examined and compared with the Ministry of the Environment (MOE) leachate requirements. Three sets of experiments were conducted, each using a batch leaching process that lasted for a 24 hour period. The first used varying concentrations of NaOH (deionized water, 0.47M, 0.96M and 3.47M), with a constant liquid to solid ratio (L/S) of 167:1. The amount of lead leached from the steel flue dust increased with increased alkalinity, as did the percent recovery of the total lead in the sample. In the

second set of experiments the L/S ratio ranged from 3.3:1 to 167:1 using a 0.47M KOH solution. As the L/S ratio decreased, the concentration of lead leached from the sample increased, but the percent recovery of the available lead from the sample decreased. In the third set of experiments the temperature ranged from 289°K to 353°K, with an L/S ratio of 167:1 and a leaching solution of 0.47M KOH. The small amount of variation in data from this experiments implies that temperature had negligible effects on the amount of lead leached from the steel flue dust at this concentration.

The MOE leach test was conducted on a treated sample from the 5:1 experiment. The average lead level in the leachate was about 41 ppm or 1.5% of the available lead. As the MOE limit is 5 ppm, the sample failed the test, although there was a substantial decrease in the lead content. Originally, 1325 ppm leached from an untreated sample or 49% of the available lead. It was suggested that any leaching process using L/S ratios greater than 100:1 would pass the MOE test.

Enhanced bioaccumulation of mercury, cadmium and lead in low-alkalinity waters: an emerging regional environmental problem. - Editorial.

WIENER, J.G. & STOKES, P.M.
U.S. Fish & Wildlife Service, National Fisheries Contaminant Research Center, Wisconsin, US & Institute for Environmental Studies, University of Toronto, Toronto, Ontario.
Environmental Toxicology and Chemistry 9: 821-823 (1990).

Editorial paper introducing the Proceedings of a Symposium on Metal Chemistry and Bioavailability in Acid Waters held in Arlington, Virginia on Nov. 16, 1988. The recent interest in the chemistry and biota of low alkalinity waters stems largely from concerns about acidic deposition and its effects on sensitive aquatic ecosystems. Thus, relatively high concentrations of mercury have been found in biota taken from low alkalinity waters in locations distant from both anthropogenic sources and mercury enriched deposits.

Contamination of Vegetation by Lead and Other Elements in the Vicinity of Toronto Refiners & Smelters Ltd., 28 Bathurst Street, Toronto, 1986, 1987.

RINNE, R.J.F. & DAY, D.
Ontario Ministry of the Environment, Phytotoxicology Section, Air Resources Branch, Toronto.
Report ARB-105-88-PHYTO, Toronto, Queen's Printer for Ontario, 1990.

Levels of Pb, As, Cd and Sb in unwashed *Ailanthus* foliage collected near Toronto Refiners & Smelters (TRS) in 1986 and 1987 were significantly elevated compared to corresponding control samples. Although average foliar lead levels were considerably lower than the levels recorded in 1985, there was no overall trend towards decreasing lead levels in TRS foliage samples between the late 1970's and 1987. Under the terms of an expropriation agreement with the City of Toronto, TRS vacated the property in February 1989, and a Steering Committee was formed to supervise the demolition of structures on the site and the actual decommissioning.

Lead in British Columbia and Yukon Environments: Summary of Industrial Data, 1979-1986.

KRAHN, P.K.
Conservation & Protection, Environment Canada, Vancouver, British Columbia, 1990.

(Report not available for abstracting).

Criteria for Managing Contaminated Sites in British Columbia.

B.C. MINISTRY OF THE ENVIRONMENT.

Waste Management Program, Ministry of the Environment, Victoria, British Columbia, 1989.

This document presents the Ministry of the Environment's criteria for contaminated sites in British Columbia. These criteria are intended to be used to develop site-specific objectives for contaminants in soil, water, sediments, and air, where spills and industrial discharges have resulted in chemicals contamination posing risks to human health and the environment. The criteria are based on an evolving body of knowledge relating to chemistry, toxicology, and other environmentally-related disciplines. They will be reviewed on a regular basis, and will be adjusted as new human health and environmental data become available.

Trace metal pollution from a municipal waste disposal site at Pangnirtung, Northwest Territories.

HAERTLING, J.W.
Department of Geography, Queen's University, Kingston, Ontario.

Arctic 42(1): 57-61 (1989).

Water and sediment samples collected from a municipal waste disposal site near the Hamlet of Pangnirtung, Baffin Island, were analyzed for classical parameters and trace metals (Cd, Cu, Fe, Pb and Zn). Although all trace metal concentrations showed a considerable increase below the dump, only Pb and Fe in water samples from the main collector ditch and below the dump exhibited excessive levels, at 6.1 and 53.3 ppm respectively. The ratios between easily exchangeable metals and total metals ranged between 0.02 (Fe) and 18.7 (Cu), in accordance with related studies. There was no significant accumulation of any trace metal in the sediments below the disposal site, indicating rapid removal from the intertidal flats and subsequent accumulation in the bottom sediments.

Summary of Emissions of Antimony, Arsenic, Cadmium, Copper, Lead, Manganese, Mercury and Nickel in Canada.

JACQUES, A.P.
Environmental Protection Service, Environment Canada, Ottawa, Ontario.

Prepared for the Environmental Analysis Branch, Conservation and Protection, Environment Canada, 1987.

(Report not available for abstracting).

Lead in the Canadian Environment: Science and Regulation. Final Report.

THE COMMISSION ON LEAD IN THE ENVIRONMENT.

The Commission on Lead in the Environment, The Royal Society of Canada, 374 pp., 1986.

This document is the final report of the Commission on Lead in the Environment which, under contract from the Federal Government, conducted an inquiry into all aspects of lead in the Canadian environment. The report begins with an analysis of the sources of environmental lead, e.g. the lead smelting industry. Next, the environmental pathways whereby lead can reach specific human targets is examined; it appears that inhalation is the main route of human exposure, although uptake of lead through soil and water may also occur. This is followed by a discussion of lead absorption in the body. The report concludes with a number of recommendations. Hot spots in Canada are also identified; these include the South Riverdale and Niagara districts of Toronto, the Bathurst-Belledune-Dalhousie area of

New Brunswick, and Trail and Kimberley, British Columbia. Other hot spots may exist around metal works, and it is recommended that secondary lead smelters should not be located near residential areas.

Pathways, Cycling and Transformation of Lead in the Environment.

STOKES, P.M., ED.
Institute for Environmental Studies, University of Toronto, Toronto, Ontario.
Report to the Commission on Lead in the Environment, The Royal Society of Canada, 415 pp., 1986.

This is one of three complementary volumes of scientific papers that the Royal Society of Canada's Commission on Lead in the Environment used extensively in preparing its final report. The present volume deals with the pathways by which lead moves through the environment. A workshop was convened by the Royal Society of Canada's Commission on Lead in the Environment in October 1985, in Edmonton Alberta, and the papers submitted by participants at the workshop have been published in this document. The topics include: The global lead cycle and Canada's contribution to it; a discussion of current analytical techniques for the determination of lead, emphasizing speciation in air; lead in the atmosphere: levels, size distributions and deposition; atmospheric deposition of lead in lake sediments and peat; inorganic lead in aquatic sediments: geochemical partitioning and bioavailability; speciation of organolead in the environment and the methylation of lead; the entry of lead into food webs in aquatic environments; the effects of exposure to lead on aquatic biota; terrestrial biological monitoring of lead using lower plants; lead contamination of the terrestrial environment as a result of long-range atmospheric transport; lead pathways through soil and household dusts; the potential for heavy metal exposure from urban gardens and soils; the fate of gasoline lead in the environment; a model of the relative contribution of atmospheric lead to total human lead exposure in the United States; the transfer of lead from the environment to man.

Submission to the Royal Society of Canada, Commission on Lead in the Environment.

BELLEDUNE ENVIRONMENTAL MONITORING COMMITTEE.
Belledune Environmental Monitoring Committee, Bathurst, 1986.

The Committee is a group composed of agencies involved in environmental monitoring of the Belledune area. The report outlines the monitoring data available on industrial effluents and emissions and identifies areas affected by elevated levels of heavy metals. No interpretation of the actual impacts of these emissions has been attempted.

Submission to the Royal Society of Canada, Commission on Lead in the Environment.

NEW BRUNSWICK DEPARTMENT OF MUNICIPAL AFFAIRS AND ENVIRONMENT.
Government of New Brunswick, Bathurst, 1986.

This report includes data from the lead monitoring surveys conducted by the New Brunswick Department of Municipal Affairs and Environment, and includes information regarding air quality, industrial effluents, sanitary wastes, drinking water, surface water quality and uptake by biota. The information included is mainly on levels, with little or no assessment of actual impact. The major sources of lead in the environment were identified as the Belledune lead smelter, Brunswick #12 Mine, Heath Steel Mine, combustion of leaded gasoline, sewage sludges, burning of waste oils, lead-rich dust escaping from railcars carrying ore from Brunswick Mines to Dalhousie, and spillage of ore and concentrate at the Dalhousie loading facility.

Lead in the New Brunswick Environment: Biomonitoring with lichens and mosses.
TIMS, J.S.
Water Classification Planning & Sciences Branch, N.B. Dept. Municipal Affairs & Environment, Fredericton, New Brunswick.
Departmental Submission to the Royal Society of Canada, Commission on Lead in the Environment, 1986.

Data on lead in lichens and mosses in New Brunswick are available from several studies which have used plants to monitor airborne pollutants. These include biomonitoring done by the New Brunswick Department of Municipal Affairs and Environment. Trace metal deposition rates to vegetation have been measured using various moss species to monitor air levels over specific time periods. This report summarizes data on lead levels in lichens and mosses from various rural and urban locations in New Brunswick, and discusses the sources such as thermal generating stations and the combustion of lead containing fuels.

Living Near an Urban Lead Smelter: A Neighbourhood Perspective. A submission to the Royal Society of Canada's Commission on Lead in the Environment.
WALLACE, B. & COOPER, K.
A report prepared for the Niagara Neighbourhood Association by Wallace Associates, Toronto, Ontario, 67 pp., 1986.

Presentation of information on lead issues in an urban "hotspot" from the perspective of the affected community.

A Medical Statement on Lead in the Environment.
THE CANADIAN MEDICAL ASSOCIATION.
Canadian Medical Association, 3 pp., 1985.

This document addresses a number of issues dealing with lead in the Canadian environment, including: the sources and relative contributions of lead releases; the pathways by which lead enters the Canadian environment, and the means and media by which lead is transported within the environment and to humans; the toxicity of lead; the potential or actual exposure of human and environmental targets in Canada. It also outlines practical remediative measures, and the economic, technical, social and labour implications of reductions in lead releases and exposure from all sources, including the implications of eliminating lead in gasoline.

Lead Contamination of the Canadian Environment. (Outline of presentation).
NRIAGU, J.O.
National Water Research Institute, Burlington, Ontario, 1985.

An overview is presented of the distribution of lead in the Canadian environment (air, water, and soils) from various sources.

Lead, People, and the Environment. The Niagara Neighbourhood Case Study.
WALLACE, B. & COOPER, K.
A report prepared for the Niagara Neighbourhood Association and funded by Canada Works Project No. 7406DK4, Toronto, Ontario, 239 pp., 1985.

(Report not available for abstracting).

Chemicals in the Environment, Lead (Summary Report), Vancouver, BC.
GARRETT, C.L.
Environmental Protection Service, Pacific and Yukon Region, Environment Canada.
EPS, May 1985.

(Report not available for abstracting).

National Inventory of Sources and Releases of Lead (1982).
JACQUES, A.P.
Environmental Protection Service, Environment Canada, Ottawa, Ontario.
Report EPS 5/HA/3, Ministry of Supply & Services Canada, 39 pp., 1985.

This report identifies anthropogenic sources of lead released to the Canadian environment through emissions, effluents and solid wastes during 1982. The data presented are estimates based on source testing data, process emission factors and production figures. Total emissions of lead in 1982 were estimated at 11,466 tonnes, with gasoline-powered motor vehicles accounting for 61% of the total.

Status Report on Compliance with Secondary Lead Smelter Regulations - 1984.
ENVIRONMENT CANADA.
Mining, Mineral and Metallurgical Division, Industrial Programs Branch, Environmental Protection Service, Environment Canada, Ottawa, Ontario.
Report EPS 1/MM/1, Ministry of Supply & Services Canada, 19 pp., 1985.
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Emissions of lead containing particulate matter from secondary lead smelters into the ambient air are regulated by the federal Clean Air Act of 1976. This report presents the state of compliance of the industry with the existing regulations in 1984, and provides a general discussion of the implementation program. In 1984, 51 facilities were identified as secondary lead smelters, encompassing lead recovery plants, battery manufacturing operations, lead compound manufacturing, brass and bronze foundries, and numerous metal fabricating industries.

LEAD IN AIR.

The use of stable lead 206/207 isotope ratios and elemental composition to discriminate the origins of lead in aerosols at a rural site in Eastern Canada.

STURGES, W.T. & BARRIE, L.A.
Atmospheric Environment Service, Environment Canada, Downsview, Ontario.
Atmosph. Environ. 23(8): 1645-1657 (1989).

Measurement of lead 206/207 ratios in atmospheric aerosols collected at Dorset, a rural location in central Ontario, during the fall of 1984 and spring of 1986 confirmed earlier results showing that there are significant differences in the isotopic composition of lead originating from Canadian automobile emissions, Canadian smelters and eastern American sources.

Analysis of ambient lead concentrations around three secondary lead smelters.

TSAI, E.C-E.
Environmental Quality Branch, Environmental Protection Service, Western and Northern Region, Environment Canada, Edmonton, Alberta.
Water Air Soil Pollut. 33(3-4): 321-329 (1987).

Ambient lead concentrations measured over a 30 month span around three secondary lead smelters in the City of Winnipeg, Manitoba are statistically analyzed. The results are compared with the provincial regulatory air quality guideline. The contribution of smelter emissions to high lead levels that exceed the provincial guideline is also demonstrated. It is concluded, by inference, that the Secondary Lead Smelter National Emission Standards Regulations were effectively implemented.

Total Suspended Particulate and Lead Concentrations in the Weston School Area of Winnipeg, January 1984 - April 1985.

SCHWARTZ, S.
Air Standards and Studies, Environmental Management Division, Department of Environment and Workplace Safety and Health, Winnipeg, Manitoba.
Air Standards and Studies Report 85-3, 36 pp., 1985.

Concentrations of lead and total suspended particulate in the vicinity of the Weston School were investigated between January 1984 and April 1985. Total suspended particulate (TSP) concentrations exceeded the Manitoba Air Quality Objectives on several occasions, whereas lead levels were below the criteria level. Ground level concentrations of lead and TSP were significantly higher than roof top levels, indicating that motorized vehicle emissions are most likely responsible for the contaminants being monitored. Results indicated that airborne lead levels are positively correlated to traffic flow.

Ambient Air Particulate Lead Concentrations in Canada 1975-1983.

ENVIRONMENT CANADA.
Environmental Protection Service, Environment Canada, Ottawa, Ontario.
Report EPS 7/AP/15, Ministry of Supply & Services Canada, 30 pp., 1985.

Data for airborne lead levels in Canada between 1975 and 1983 show that the average annual lead levels decreased by 55 percent over this period. A lower lead content in gasoline and a lower demand for gasoline accounted for this decrease in airborne lead levels.

LEAD IN DRINKING WATER.

Lead contamination of drinking water. - Metals leaching from soldered pipes may pose a health hazard.

SUBRAMANIAN, K.S. & CONNOR, J.W.
Environmental Health Centre, Health & Welfare Canada, Ottawa, Ontario.
J. Environmental Health 54(2): 29-32 (1991).

Studies were undertaken on the leaching of various metals from 50/50 tin/lead-soldered copper pipes into high-purity, tap and well water samples as a function of standing time in a static test on new plumbing. Significant amounts of lead, zinc and tin were leached into all three types of water samples.

[Lead in day care centre drinking water in the Quebec City area (Quebec, Canada).]

LAVOIE, M., LEVALLOIS, P., GUERRIER, P. & VIET, H.T.
Centre de Toxicologie du Québec/Centre Hospitalier de l'Université Laval, Ste-Foy, Québec/Hôpital du St-Sacrement, Québec/Ministère de l'Environnement du Québec.
Sciences et Techniques de l'Eau 24(1): 75-79 (1991) (in French).

A survey was undertaken to assess the degree of lead contamination in the drinking water of day care centres in the Quebec City area, and to correlate it with the water aggressivity and the age of the piping system. The median lead concentration in first-draw samples from day care centres using the Quebec City water supply system was 39 μg/L compared to 8 μg/L for day care centres using the Ste-Foy water supply system. 40% of day care centres served by the Quebec City water supply system had median lead concentrations higher than 50 μg/L, of which 71% were in locations where the age of the piping system was 5 years or less.

Health risks associated with lead contamination of first draw water in Quebec City day care centres.

LEVALLOIS, P., LAVOIE, M., GUERRIER, P. & GINGRAS, S.
Centre Hospitalier de l'Université Laval, Ste-Foy, Québec/Centre de Toxicologie du Québec/Hôpital du St-Sacrement, Québec/Dept. Community Health, Hôpital du Haut-Richelieu, St-Jean, Quebec.
Submitted for publication to Am. J. Public Health in October, 1991.

(Not available for abstracting.)

Analysis of the drinking water of mothers of neural tube defect infants and of normal infants for 14 selected trace elements by inductively coupled plasma-mass spectrometry (ICP-MS).

LONGERICH, H.P., FRIEL, J.K., FRASER, C., JACKSON, S.E. & FRYER, B.J.
Depts. of Earth Sciences and Biochemistry & Faculty of Medicine, Memorial University of Newfoundland, St. John's, Newfoundland.
Can. J. Appl. Spectrosc. 36(1): 15-21 (1991).

14 trace elements (Mg, Cu, Zn, Sr, Y, Mo, Cd, Sn, Sb, I, Ba, Ce, Pb and U) were determined by Inductively Coupled Plasma-Mass Spectrometry (ICP-MS) in the drinking water supplies of 28 women who had given birth to an infant with a neural tube defect (NTD), along with 28 matched controls. The results, although not significantly different at the 95% confidence level, suggest a relationship between the presence of trace elements in drinking water and NTD.

Flushing Taps to Reduce Lead Levels in Drinking Water.

MEDICAL HEALTH OFFICER, CITY OF TORONTO.
Report to the Board of Health, Department of Public Health, City of Toronto, 1991.

The primary source of the elevated lead levels observed at the consumer's tap is due to the leaching of lead from lead pipes and lead-based solders. Calculations made by the Board of Health have indicated that the level of lead in drinking water can be greatly reduced if the taps are run for 30 to 60 seconds before use when the tap has been unused for 5 hours. In homes with old plumbing or homes with water saving devices, the flow rate may be lower, thus requiring a longer flushing time, possibly 1 minute. A flushing time of 5 minutes is recommended for institutions and large buildings with greatly increased pipe lengths. This flushing policy is sufficient to reduce potential lead exposures while minimizing water waste.

Development of the Guidelines for Canadian Drinking Water Quality.

TOBIN, R.S. & WOOD, G.C.
Health Protection Branch, Health & Welfare Canada, Ottawa, Ontario.
13th International Symposium on Wastewater Treatment and 2nd Workshop on Drinking Water. November 14-16, 1990, Le Meridien Hotel, Montreal, Quebec. Environmental Protection, Environment Canada, Ottawa, Ontario, pp. 211-218, 1990.

The Guidelines for Canadian Drinking Water Quality prescribe the limits for microbiological, chemical and radiological contaminants in water. The limits prescribed in this document are applied by provincial and federal authorities within their respective jurisdictions. These guidelines are developed and updated on an ongoing basis, through the Federal-Provincial Subcommittee on Drinking Water reporting to the Federal-Provincial Advisory Committee on Environmental and Occupational Health. Some of the new guidelines and the basis for their development are discussed, including lead, arsenic and microbiological indicators.

Lead in Winnipeg Drinking Water.

LEE, P.S. & KJARTANSON, K.J.T.
Laboratory Services Division, Waterworks, Waste & Disposal Department, City of Winnipeg, Manitoba.
A Water Quality Study, the City of Winnipeg, 63 pp., 1990.

A research project was conducted to investigate lead in Winnipeg drinking water. The study objectives included determinations of lead levels in the Winnipeg drinking water distribution system, a review of conditions that may affect lead in drinking water, and a review of options to alleviate potential health concerns. The study included a literature review and the collection of samples from a variety of plumbing materials, water connections, and plumbing systems of various ages. Recommendations included the following: -lead use in plumbing systems should be restricted; -a public awareness program should be implemented to advise customers against drinking "first draw" water; -further research should be undertaken to determine the extent and effects of lead contamination from lead water connections and appropriate remediative measures.

Lead in Drinking Water. Public Awareness.
COMMISSIONER OF WORKS, METROPOLITAN WORKS DEPARTMENT, TORONTO.
Report to the Metropolitan Works Committee of the Metro Toronto Works Department, 1990.

The results of a preliminary survey of lead levels in the drinking water of City of Toronto schools and homes, as summarized in a report by the Acting Medical Officer of Health dated March, 1989, indicated that a number of first draw samples contained lead at levels exceeding the guideline value of 50 ppb. Lead levels in samples drawn after five minutes of free flow were substantially reduced. The Capital Works Programme has allotted a sum of money for the design and installation of a corrosion control system in order to reduce the water lead levels at the four water treatment plants. The notice also calls for a public awareness programme, an assessment of the costs involved and agreement by the area municipalities on an appropriate cost-sharing structure.

Lead in Drinking Water.
CANADIAN HOME BUILDERS' ASSOCIATION.
Builder's Note #14, M.O.M. Printing, Ottawa, 12 pp., 1989 (Pamphlet).

This pamphlet is designed to inform home builders of the potential health hazards of long term exposure to lead. The sources of lead in the home, such as household plumbing and lead-based paints, as well as alternative lead-free products are presented. The vulnerability of small children to an increased intake of lead and various means of decreasing lead intake in the home are also discussed.

Drinking Water Lead Survey. Final Report.
GORE & STORRIE LIMITED.
Gore & Storrie Limited, Toronto, Ontario, 7 pp., 1989.

An internal study was conducted to compare the amount of lead in drinking water at various office locations, before and after flushing pipes.

Metal mobilization in home well water systems in Nova Scotia, Canada.
MAESSEN, O., FREEDMAN, B. & MCCURDY, R.
Inst. Resource Environ. Studies, Dalhousie University, Halifax, Nova Scotia.
Am. Water Works Assoc. J. 77(6): 73-80 (1985).

A study of private wells in rural Nova Scotia found that the levels of metals such as cadmium, zinc, copper, and lead increased in water that remained in the distribution system overnight. Some 50% of the homes studied exceeded Canada's recommended 1.0 mg/L maximum permissible limit for copper while a further 20% exceeded the 0.05 mg/L limit for lead. Metal mobilization was observed in all four of the communities studied, regardless of differences in well water chemistry. Significant leaching was observed in water of high pH and hardness. Four indices commonly used to assess the corrosive tendency of a water did not accurately predict the metal leaching that could occur in a given water sample.

LEAD IN SOIL AND DUST.

Cadmium, copper and lead in soils and garden produce near a metal smelter at Flin-Flon, Manitoba.

PIP, E.
Department of Biology, University of Winnipeg, Manitoba.
Bull. Environ. Contam. Toxicol. 46(5): 790-796 (1991).

Concentrations of cadmium, copper and lead in soils and garden produce from the vicinity of the Flin Flon smelter were determined on samples collected at the end of the 1989 growing season. Samples were obtained from 12 locations ranging from 0.29-12.8 km northeast to southwest of the smelter. Lead levels in soil decreased significantly with increasing distance from the smelter ($r=-0.78$, $p=0.006$), while produce samples showed substantial variation in metal concentrations.

Lead in boreal soils and food plants.

SHEPPARD, S.C. & SHEPPARD, M.I.
Environmental Research Branch, AECL Res., Whiteshell Labs, Pinawa, Manitoba.
Water Air Soil Pollution 57/58: 79-91 (1991).

The soils of the boreal zone, characterized by acidic, low organic matter sands in uplands and organic deposits in lowlands, represent unique environments for heavy metals. The mobility and plant uptake of Pb can be substantially different than in other soils. A survey of the natural levels of Pb in northern Ontario revealed concentrations of 26 mg/kg dry soil and 1.3 mg/kg dry blueberry leaf, with an apparent plant/soil concentration ratio of 0.051. In outdoor lysimeters with an acidic sand profile (pH 4.9) and under a boreal climate, 67% of a pulse of Pb applied as $Pb(NO_3)_2$, was essentially immobile over 4 yrs. The 33% that leached may have been mobilized by soluble organic ligands or the NO_3^- counterion. The solid/liquid partition coefficient for this soil was very low (20 L/kg), as compared to 9,000 to 30,000 L/kg for acidic organic deposits. The plant/soil concentration ratio was most closely related to the soil cation exchange capacity, although organic matter content and pH were undoubtedly important related factors. In combination, the acidic sand and organic soils of boreal settings represent extremes for the mobility of Pb.

Soil Lead Concentrations in Residential Area of Concern in the Vicinity of Tonolli Canada Ltd. and the Former Exide Plant, Mississauga, 1987-89.

EMERSON, R. & RINNE, R.
Phytotoxicology Section, Air Resources Branch, Ontario Ministry of the Environment.
Report ARB-159-89-PHYTO. Queen's Printer for Ontario, 19 pp., 1991.

Historical lead emissions from both the Tonolli Company of Canada Ltd. and the nearby former battery manufacturing plant Exide have contributed to elevated levels of lead in the soil surrounding neighbouring commercial-industrial and residential properties in the Dixie Road/Queensway area of Mississauga. Between 1987 and 1989, the Ontario Ministry of the Environment (MOE) conducted extensive soil sampling in the area, and was able to identify areas in which numerous properties and/or sites were affected by soil lead levels of 500 ppm or higher. Of the 135 residential properties sampled, 97 had a surface soil lead level of 500 ppm or higher. Soil lead levels of 1000 ppm or higher were found on 38 properties, only at the boulevard site on another 23 properties and in 9 out of 13 publicly accessible sites. At residential sites where lead was elevated and subsoil was subsequently sampled, only the surface soil (0-5 cm) was found to have a lead level equal to or above 500 ppm. The highest lead levels (2750 and 2800 ppm) were found at boulevard sites fronting residential properties in the general vicinity of the Dixie Road/Queensway Avenue intersection.

Element Analysis of 198 Soil Samples Collected in Trail, B.C.

KELLY, S.J. ET AL.
Department of Health Care and Epidemiology, University of British Columbia.
Report prepared for the B.C. Ministry of Environment, 1991.

(Report not available for abstracting).

Soil lead concentrations and prevalence of hyperactive behavior among school children in Ottawa, Canada.

ERICSON, J.E. & MISHRA, S.I.
Program in Social Ecology, University of California, Irvine, California, US.
Environmental International 16: 247-256 (1990).

This pilot study attempts to correlate the prevalence of hyperactive behavior among school children with the soil lead levels in the urban environment of Ottawa, Ontario. Pre-existing data on the prevalence of hyperactivity were correlated with soil lead concentrations from samples collected in 1981. The distribution patterns of both parameters are described as topographical "ridges" extending northeast-southwest in the central part of the city, and running parallel to major thoroughfares and highways in Ottawa. However, the study does not consider confounding factors, and caution should be used when assessing the findings.

Trace elements in agricultural soils of northwestern Alberta.

SOON, Y.K. & ABBOUD, S.
Research Station, Agriculture Canada, Beaverlodge, Alberta/Alberta Research Council, Edmonton, Alberta.
Canadian Journal of Soil Science 70: 277-288 (1990).

Fifty-two surface soils and 11 subsoils collected from agricultural soils in the Peace River region of northwestern Alberta were analyzed for total and extractable Cd, Cr, Cu, Mn, Ni, Pb and Zn. The purpose of the survey was to build up a database on the soil levels of those trace elements which are of agricultural and environmental concern. Extractable amounts were determined by DTPA-ammonium bicarbonate, 0.05 M EDTA, 0.1 M HCl and saturation extractions. Total Pb levels were similar to the mean levels reported for "world" soils, but lower than average values for Canadian soils. Total lead was similar in surface and subsurface soils but extractable lead was higher in the clay-enriched subsoils.

Among the surface soils, soils with higher amounts of organic matter generally contained greater amounts of total and extractable metals. Data on Cd, Cr, Cu, Mn, Ni, and Zn soil levels are also presented.

Limited downward migration of pollutant metals (copper, zinc, nickel and lead) in acidic virgin peat soils near a smelter.

DUMONTET, S., LEVESQUE, M. & MATHUR, S.P.
Istitudo di Chimica Agraria e Forestale, Universita Degli Studi di Basilicata, Potenza, Italia & Land Resource Research Centre, Research Branch, Agriculture Canada, Ottawa, Canada.
Water Air Soil Pollut. 49(3-4): 329-342 (1990).

The distribution of Cu, Zn, Ni, Cd and Pb was determined in 11 acidic virgin peat profiles located in the Rouyn-Noranda area in Quebec along two transects originating at the Noranda smelting plant. The levels of all five metals were highest in the top 0-15 cm layer at the site nearest the smelter, and decreased progressively up to a distance of 42 km from the smelter. The amounts of heavy metals moving down through the peat profile and accumulating in the anaerobic zone were limited. Cu, Zn and Cd were relatively more mobile than Pb.

[The Environmental Contamination by Lead of a Residential Neighbourhood in the Vicinity of the Balmet Company in Saint-Jean-sur-Richelieu.]

MESSIER, A. ET AL.
Hôpital du Haut-Richelieu, Département de Santé Communautaire, St-Jean-sur-Richelieu, Québec.
Vol. I & II, 1990 (in French).

This report summarizes the activities coordinated by the Department of Community Health of Haut-Richelieu (DSC) with respect to lead contamination of a residential neighbourhood situated in the vicinity of Balmet Canada Inc. located in Saint-Jean-sur Richelieu, a battery recycling plant. The report covers the period between August 1989 and August 1990, and discusses the measures taken by the DSC to identify the extent of exposure of the population to lead in the contaminated area, and to bring about a solution to the problem.

[Report on the Contamination with Lead Dust of the Felix Leclerc Pavillon, at the Rochebelle High School.]

RHAINDS, M., ROY, R. & ALLAIRE, S.
Service Santé et Environnement, Département de Santé Communautaire, Centre Hospitalier de l'Université Laval, Ste-Foy, Québec.
Report presented to the Directors of the "Commission Scolaire des Découvreurs et du Pavillon Félix Leclerc", 1989 (in French).

Samples of dust collected from different locations in the school contained lead levels ranging from 180 to 537,400 $\mu g/g$, the highest level being found in the audio-visual room, a room which had been closed down. The source of the contamination was traced to the ventilation system in the indoor shooting range, due to the expulsion of lead dust from the room to the exterior of the building. The window of the unused audio-visual room was located directly below the exhaust of the range's ventilation system. The Department of Community Health recommended that the indoor range be closed down, in order to eliminate an unnecessary source of lead contamination.

Lead Concentrations in Soil on Residential, Public, and Publicly Accessible Commercial Properties in the Vicinity of Tonolli Company of Canada Ltd., Mississauga, 1987.
DAY, D., BELLEMARE, P. & RINNE, R.J.K.
Phytotoxicology Section, Air Resources Branch, Ontario Ministry of the Environment.
1988.

(Report not available for abstracting.)

Phytotoxicology Assessment Survey of Lead and Other Metals in Soil and Vegetation in the Vicinity of Westmount Avenue and the Queensway Highway (Hwy 417), Ottawa, July 1987.
EMERSON, R.
Phytotoxicology Section, Air Resources Branch, Ontario Ministry of the Environment.
Environment Ontario, 1988.

(Report not available for abstracting.)

Lead Concentrations in Soil on Residential, Public and Publicly Accessible Commercial Properties in the Vicinity of Toronto Refiners and Smelters Limited, Toronto - 1985-1987.
DAY, D., BELLEMARE, P. & RINNE, R.
Phytotoxicology Section, Air Resources Branch, Ontario Ministry of the Environment.
Report ARB-094-88-PHYTO, Toronto, Queen's Printer for Ontario, 27 pp., 1988.

(Report not available for abstracting.)

Lead in soils: Canadian case studies and perspectives.
STOKES, P.
Department of Botany, Institute for Environmental Studies, University of Toronto, Toronto, Ontario.
In: Davies, B.E. & B.G. Wixson, Eds. *Lead in Soil: Issues and Guidelines.* Northwood, Science Reviews Limited, pp. 7-25, 1988.

Lead levels in Canadian soils range from less than 5 $\mu g/g$ to tens of thousands of $\mu g/g$. Major sources include automobile emissions, primary and secondary smelters, power plants and waste incinerators as well as agricultural lead-containing pesticides. Most of the major anthropogenic sources of lead in soil are delivered via wet and dry deposition over a wide area. On a local scale however, apparently minor sources of lead can be of major significance, as exemplified by the presence of so called "urban hotspots" of lead. This paper discusses a number of such cases, each selected to illustrate specific points of concern. The paper concludes by recommending that each new situation be considered on a case by case basis, rather than on a fixed model or a uniform set of regulations, and that alternatives to soil removal and replacement be considered first.

Lead in soil: the Ontario situation.
JENKINS, G., MURRAY, C., THORPE, B.H. & BOYD, R.
Ontario Ministry of the Environment, Toronto, Ontario.
In: Davies, B.E. & B.G. Wixson, Eds. *Lead in Soil: Issues and Guidelines.* Northwood, Science Reviews Limited, pp. 235-245, 1988.

In 1987, the Ontario Ministry of the Environment established a lead in soil guideline of 500 mg/kg, and initiated a soil replacement programme in the vicinity of a secondary smelter in Toronto. This paper outlines the steps leading to the establishment of the guideline, the current soil removal programme and current initiatives to understand and solve the lead pollution problem in Ontario.

Get the Lead Out. A submission to the Ontario Minister of the Environment, the Hon. James Bradley.
RACHLIS, M.
South Riverdale Community Health Centre-Environmental Health Committee, Toronto, Ontario, 65 pp., 1987.

This report outlines the lead-in-soil and housedust problem in the South Riverdale neighbourhood in the southest area of Toronto. The report was submitted to the Ontario Ministry of the Environment by the South Riverdale Community Health Centre, with a request that the lead-contaminated soil and housedust in the area be remediated.

Phytotoxicology Complaint Investigations of Lead Concentrations in Surface Soil Collected from Residential and other Properties in the Vicinity of Tonolli Canada Ltd., Mississauga, 1987.
EMERSON, R. & RINNE, R.
Phytotoxicology Section, Air Resources Branch, Ontario Ministry of the Environment.
Report ARB-171-87-PHYTO. Queen's Printer for Ontario, 1987.

(Report not available for abstracting).

Review and Recommendations on a Lead in Soil Guideline: Report to the Minister of the Environment.
THORPE, B.
Lead in Soil Committee, Hazardous Contaminants Coordination Branch, Ontario Ministry of the Environment, Toronto, Ontario.
[Toronto]: The Committee, 1987.

(Report not available for abstracting).

Contamination of Vegetation and Soil by Lead and Other Elements in the Vicinity of the Tonolli Company of Canada Ltd. and Exide Canada Inc., Dixie Road, Mississauga, 1983, 1984, 1985.
RINNE, R.
Phytotoxicology Section, Air Resources Branch, Ontario Ministry of the Environment.
Report ARB-063-86-PHYTO, 1986.

Levels of Pb, As, Cd and Sb in unwashed tree foliage collected in the vicinity of Tonolli and Exide, Mississauga in 1983, 1984 and 1985 were elevated with respect to the control area, and implicated Tonolli as the major source. Average concentrations of lead in surface soil near Tonolli and Exide increased by 14% from 1980 to 1985. For the years 1980 and 1983 it was estimated that 10% of the foliar lead in trees growing in the vicinity of the Tonolli and Exide plant sites was attributable to soil re-entrainment.

Contamination of Vegetation and Soil by Lead and Other Elements in the Vicinity of the Canada Metal Company, Eastern Avenue, Toronto, 1983, 1984, 1985.
RINNE, R.J.K.
Phytotoxicology Section, Air Resources Branch, Ontario Ministry of the Environment.
1986.

(Report not available for abstracting.)

A Survey of Lead-in-Soil Concentrations from Seven Rural Communities in Manitoba, 1984.
JONES, D.C.
Terrestrial Standards and Studies Section, Environmental Management Services Branch, Department of Environment and Workplace Safety and Health, Winnipeg, Manitoba.
Winnipeg, Terrestrial Standards and Studies Report 86-2, 1986.

Soil lead levels in samples collected from seven rural communities in Manitoba were determined during the summer of 1984. All samples had lead levels well below the Environmental Management guideline of 2,600 μg Pb/g, with a trend towards slightly higher lead levels in locations adjacent to main thoroughfares.

A Survey of Lead-in-Soil Concentrations at Seven Tot Lots in the City of Winnipeg.
JONES, D.C.
Terrestrial Standards and Studies Section, Environmental Management Services Branch, Manitoba Department of Environment and Workplace Safety and Health, Winnipeg, Manitoba.
Terrestrial Standards and Studies Report 86-3, 17 pp., 1986.

Sod and soil samples were collected during the summer of 1984 from seven tot lots located adjacent to major traffic thoroughfares in Winnipeg. Lead concentrations in all samples were well below the Environmental Management guideline of 2,600 μg/g, and ranged from 15 to 740 μg Pb/g.

A Survey of Lead in Soil from Seven Schools and Three Residential Areas of Winnipeg, 1983.
JONES, D.C. & WOTTON, D.L.
Terrestrial Standards and Studies Section, Manitoba Environment & Workplace Safety and Health, Winnipeg, Manitoba.
Terrestrial Standards and Studies Report 83-15, 25 pp., 1984.

Lead levels were determined in soil and particulate debris from paved playground surfaces at seven schools in Winnipeg during the summer of 1983. Lead levels of boulevard sod and soil from three residential areas were also determined.

Lead levels at the school playgrounds were acceptable, with higher levels of lead found in samples suspected of containing paint chips.

The elemental composition of street dust from large and small urban areas related to city type, source and particle size.

FERGUSSON, J.E. & RYAN, D.E.
Department of Chemistry, University of Canterbury, Christchurch, New Zealand.
Sci. Total Environ. 34(1-2): 101-116 (1984).

26 elements were determined in street dust from London (UK), New York (USA), Halifax (Canada), Christchurch (New Zealand) and Kingston (Jamaica). The cities were divided into 2 groups: Large urban centres (London and New York), and small urban centres (Halifax, Christchurch and Kingston). The elements analysed either originated mainly from soil (e.g., Al, K, Na, Th, Ce, La, Sm and Ti) or from anthropomorphic sources such as cement, tire wear and car emissions (e.g., Ca, Cd, Pb, Cr, Zn, Cu and Au). The first group of elements were in lower concentrations in the large urban centres as compared to the small urban centres, while the reverse held for the second group of elements. The concentration of most elements increased with decreasing dust particle size.

A Status Report on the Lead Concentration in Sod and Soil for Flin Flon-Channing, Manitoba, 1982.

JONES, D.C.
Terrestrial Standards and Studies Section, Manitoba Environmental Management Division.
Manitoba Terrestrial Standards and Studies Report 83-1, 1983.

A survey of surface sod and soil in the Flin Flon-Channing residential area was conducted on June 3, 1982. Lead was analysed in sod and soil samples from 24 sites and was found to range from 90-750 $\mu g/g$ in sod (mean=356 $\mu g/g$), and from 20-690 $\mu g/g$ in the soil (mean=171 $\mu g/g$). The highest lead level (750 $\mu g/g$) was found in the sod adjacent to a major traffic artery. Smelter emissions did not appear to be contributing significantly to lead accumulation in the surface soils of the community.

A Status Report on the Lead Concentration in Sod and Soil for Thompson, Manitoba, 1982.

JONES, D.C.
Terrestrial Standards and Studies Section, Manitoba Environmental Management Division.
Manitoba Terrestrial Standards and Studies Report 83-2, 1983.

A survey of surface sod and soil in the Thompson residential area was conducted on June 1, 1982. Lead was analysed in sod and soil samples from 21 sites and found to range from 40-430 $\mu g/g$ in sod (mean=166 $\mu g/g$), and from 20-270 $\mu g/g$ in the soil (mean=82 $\mu g/g$). The highest lead level (430 $\mu g/g$) was found in the sod near a major thoroughfare. Smelter emissions did not appear to be contributing significantly to lead accumulation in sod and soil.

Lead Particulate Analysis in Air and Soil of the City of Winnipeg, 1982.
WOTTON, D.L. & DOERN, F.E.
Manitoba Terrestrial Standards and Studies, Environmental Management Division.
Winnipeg, Terrestrial Standards and Studies Report 83-3, 64 pp., 1983.

A procedure capable of distinguishing between the forms of lead emissions originating from various sources was developed by Atomic Energy of Canada (Pinawa) using scanning electron microscopy/energy dispersive X-ray spectrometry. Smelter and motor vehicle emissions were found to have unique physical and chemical characteristics. Elevated levels of lead found in the Weston school yard one year after clean-up are believed to derive mainly from the exhaust of motor vehicle traffic, and not from the secondary smelter located nearby.

Transfer of ^{226}Ra, ^{210}Pb and uranium from soil to garden produce: assessment of risk.
TRACY, B.L, PRANTL, F.A. & QUINN, J.M.
Radiation Protection Bureau, Health & Welfare Canada, Ottawa, Ontario.
Health Physics 44(5): 469-477 (1983).

A study of gardens contaminated by uranium processing wastes was carried out in the town of Port Hope, Ontario during the summer of 1976. Levels of ^{226}Ra, ^{210}Pb and total U were measured in soil and garden produce, and found to be highest in root and stem vegetables, while fruit generally showed the lowest values. The implications of these findings for other communities affected by nuclear fuel-cycle operations are discussed.

Background levels of minor elements in some Canadian soils.
MCKEAGUE, J.A. & WOLYNETZ, M.S.
Land Resource Research Institute/Engineering and Statistical Research Institute, Agriculture Canada, Ottawa, Ontario.
Geoderma 24: 299-307 (1980).

The background levels of several minor elements (Cr, Mn, Co, Ni, Cu, Zn, Se, Sr, Hg and Pb) in Canadian mineral soils, and the relationships between soil genesis and the levels of elements in the various horizons of uncultivated soils are presented. Lead was analyzed by atomic absorption in 173 samples of 53 uncontaminated soils widely dispersed throughout Canada, and a mean value of 20 ppm (range = 5-50 ppm Pb) was reported. Data on background levels are essential to an assessment of the degree of soil contamination with minor elements from industrial and urban wastes.

A survey of Soil Lead Levels in the City of Winnipeg.
KRAWCHUK, B.P.
M.Sc. Thesis presented to the University of Manitoba, 1980.

(Thesis not available for abstracting).

LEAD IN FOOD AND CONSUMER PRODUCTS.

Organic and total lead in selected fresh and canned seafood products.

FORSYTH, D.S., DABEKA, R.W. & CLEROUX, C.
Food Research Division, Bureau of Chemical Safety, Food Directorate, Health Protection Branch, Health & Welfare Canada, Ottawa, Ontario.
Food Additives & Contaminants 8(4): 477-484 (1991).

Various fresh and canned seafood products collected from local food markets were analyzed for ionic alkyl lead, tetraalkyl lead and total lead by gas chromatography-atomic absorption spectrometry. Dimethyl lead, diethyl lead, trimethyl lead and triethyl lead were extracted with diphenylthiocarbazone from enzymically hydrolysed samples, while tetraalkyl lead was extracted from the hydrolysates with hexane. Total lead was determined by reductive coprecipitation with palladium in the presence of ascorbic acid after nitric-perchloric digestion. Many of the samples contained low (<0.09-0.7 ng/g) levels of trimethyl- and dimethyl lead. Triethyl lead was found at similar levels in several samples. Total lead levels were higher with values ranging from <5 ng/g to 2.9 μg/g. Detection limits for the organolead and total lead methods were 0.07-0.2 and 3-19 ng Pb/g respectively.

Seizures in a 10-week-old infant: lead poisoning from an unexpected source.

LOCKITCH, G., BERRY, B., ROLAND, E., WADSWORTH, L., KAIKOV, Y. & MIRHADY, F.
Depts. of Pathology and Pediatrics, University of British Columbia and B.C. Children's Hospital, Vancouver, B.C.
Can. Med. Assoc. J. 145(11): 1465-1468 (1991).

This case report describes an incidence of lead poisoning traced to the use of water boiled in an electric urn of Iranian origin in the preparation of infant formula. A 10-week-old girl was admitted to hospital because of a sudden onset of repeated seizures consisting of stiffening of the body, clonic movements of the left limbs and deviation of the eyes and head to the left. The seizures lasted approximately ten minutes, and were controlled with phenobarbital. The infant had been breast-fed for 4 weeks and had subsequently received only commercial infant formula. The infant showed an initial blood lead level (5 days after admission) of 7.45 μmol/L, as compared to less than 0.72 μmol/L in normal infants. Analysis of previously boiled tap water from the urn showed that the water used to prepare the infant formula contained around 84.94 μmol/L of lead. Although Canadian legislation prohibits the sale in Canada of electric kettles releasing more than 0.050 ppm of lead into the water, the importation of small amounts of such kettles by ethnic communities is difficult to control. The report also mentions a further case of lead poisoning in a 7-month-old boy, from water boiled in an Iranian stove-top kettle.

Migration of Lead into Alcoholic Beverages During Storage in Lead Crystal Decanters.

FALCONE, F.
Liquor Control Board of Ontario, Quality Assurance Laboratory, Toronto, Ontario.
Draft report, 10 pp., 1991.

The lead content of various alcoholic beverages stored in lead crystal decanters was determined over a period of 60 weeks using graphite furnace atomic absorption spectroscopy. After 60 weeks, the levels of lead ranged from 116 to 2576 ppb, with seven of the nine samples containing lead levels above the maximum allowable level of 200 ppb. It is concluded that the use of lead crystal decanters for storage of alcoholic beverages poses a potential health hazard, and can lead to an increase in the incidence of lead poisoning from this source.

The Potential Health Hazards Associated with the Use of Common Cookware Articles.

HILL, R.J., BRUNHUBER, B. & HILL, M.
Hilcon Consultants, Ottawa, Ontario.

A critical review of the literature prepared by Hilcon Consultants, Ottawa under contract for the Industrial Chemicals & Product Safety Section, Health Protection Branch, Department of Health & Welfare Canada, 88 pp., 1989.

This report summarizes much of the available literature concerning the potential health hazards associated with the use of various common cookware articles as well as other materials such as plastic film, which are commonly used in food preparation and storage. The report is divided into seven main sections, dealing with metal articles, glass articles, ceramic articles, plastic articles, the protection of the consumer, a brief review of the toxicology of many of the substances known to migrate from cookware into foodstuffs, and finally an exposure assessment. The main source of exposure to lead from cookware lies in the use of faultily-fired ceramics with lead glazes, followed by the extensive use of tinned copperware, where the lead impurities in the tin could leach out slowly, especially when acid foods are cooked.

Survey of lead, cadmium, cobalt and nickel in infant formulas and evaporated milks and estimation of dietary intakes of the elements by infants 0-12 months old.

DABEKA, R.W.
Food Research Division, Bureau of Chemical Safety, Food Directorate, Health Protection Branch, Health & Welfare Canada, Ottawa, Ontario.

Sci. Total Environ. 89: 279-289 (1989).

Lead, cadmium, cobalt and nickel were determined in 282 infant formulas and evaporated milks using a graphite furnace atomic absorption coprecipitation method capable of determining background levels in all samples. Average lead levels in ready-to-use, concentrated liquid and powder formulas were 1.6, 3.7 and 12.6 ng/g respectively, while evaporated milks in lead-free and lead-soldered cans contained 2.8 and 95 ng/g respectively. Lead dietary intakes by 0-12 month-old infants averaged 1.81 μg/kg b.w./day, while infants fed evaporated milk stored in lead-soldered cans had an intake of 6 μg/kg/day.

Lead and cadmium levels in commercial infant foods and dietary intake by infants 0-1 year old.

DABEKA, R.W. & MCKENZIE, A.D.
Food Research Division, Bureau of Chemical Safety, Food Directorate, Health Protection Branch, Health & Welfare Canada, Ottawa, Ontario.

Food Additives & Contaminants 5(3): 333-342 (1988).

Lead and cadmium levels were determined in 131 infant foods. Mean lead and cadmium levels were 19.3 and 3.3 ng/g for meats, 8.4 and 4.1 ng/g for vegetables, 14.9 and 0.58 ng/g for fruits and desserts, 9.6 and 0.53 ng/g for juices and drinks, and 32.8 and 33.6 ng/g for dry infant cereals. These data, combined with other recent surveys, yielded average dietary (food and water) intakes of lead and cadmium by infants 0-1 year old of 2.4 and 0.37 μg/kg/day, respectively. Lead intakes were most strongly influenced by storage of infant formulas in lead-soldered cans. For infants 0-1 month old, they ranged from 0.5 μg/kg/day when human or cow milk was fed to infants, to 5.3 μg/kg/day when feeding ready-to-use formula stored in lead-soldered cans. Cadmium intakes were most strongly affected by soya based formulas, and ranged from 0.16 μg/kg/day for 0-1 month old infants fed human or cow milk, to 0.50 μg/kg/day for infants fed soya-based concentrated liquid formula.

Lead in 1988: More Urgent Than Ever. A brief presented to the Honourable Tom McMillan, Minister of the Environment and The Honourable Jake Epp, Minister of National Health & Welfare.

THE CANADIAN COALITION FOR LEAD-FREE GASOLINE.

Canadian Coalition for Lead-free Gasoline, Toronto, 1988.

In light of the fact that numerous studies published between 1986 and 1988 have shown that lead causes health problems at much lower levels than previously thought, the Canadian Coalition for Lead-free Gasoline urgently recommended that the Government of Canada accelerate the schedule for phasing-down lead in gasoline to achieve 26 μg/L by January 1990.

Dietary intakes of lead, cadmium, arsenic and fluoride by Canadian adults. A 24-hour duplicate diet study.

DABEKA, R.W., MCKENZIE, A.D. & LACROIX, G.M.A.
Food Research Division, Bureau of Chemical Safety, Food Directorate, Health Protection Branch, Health & Welfare Canada, Ottawa, Ontario.

Food Additives & Contaminants 4(1): 89-102 (1987).

24-hour duplicate diets (including drinking water and snacks), were collected from 24 adults living in 5 Canadian cities. Each diet was separated by the participants into 10 food categories, and each of the samples was analyzed in duplicate for lead, cadmium, arsenic and fluoride. Mean dietary intakes were: 0.80, 0.21 and 0.26 μg/kg/day for lead, cadmium and arsenic respectively, while fluoride intakes were influenced by the level of fluoridation of the drinking water. The fluoride dietary intake for participants living in communities with fluoridated water (1 μg/g F in the drinking water) was 39.7 μg/kg/day, as compared to 8.5 μg/kg/day for participants living in non-fluoridated communities (<0.2 μg/g F in the drinking water). The contribution of individual foods and food categories to the dietary intakes is discussed.

Survey of lead, cadmium and fluoride in human milk and correlation of levels with environmental and food factors.

DABEKA, R.W., KARPINSKI, K.F., MCKENZIE, A.D. & BAJDIK, C.D.
Food Research Division, Bureau of Chemical Safety and Food Statistics and Operational Planning Division, Food Directorate, Health Protection Branch, Health & Welfare Canada, Ottawa, Ontario.

Food Chem. Toxicol. 24(9): 913-921 (1986).

A survey of chemical residues in the milk of 210 mothers was carried out in 1981. Milk samples were analysed for lead, cadmium and fluoride content, and possible correlations between the levels found and environmental and dietary factors were investigated. Mean levels and ranges were 1.04 (<0.05-15.8), 0.08 (<0.002-4.05) and 7.08 (<2-97) ng/g for lead, cadmium and fluoride respectively. For mothers taking no fluoride supplements and living in communities with fluoride in the drinking water (1 μg/g), the mean fluoride level was 9.8 ng/g, as compared to mean levels of 4.4 ng/g when no fluoride was present in the drinking water. Lead levels were most strongly correlated with the age of the house ($p<0.001$), with maternal exposure to heavy traffic for more than 5 years ($p=0.011$), and with coffee consumption ($p=0.034$). Fluoride levels correlated strongly ($p=0.007$) with the presence of fluoride in the drinking water. Cadmium levels correlated strongly with exposure to cigarette smoke ($p=0.005$ if the mother smoked, and $p=0.003$ if the father smoked but not the mother).

Alternatives to Lead in Gasoline.
HOTZ, M.C.B.
Report from the Commission on Lead in the Environment, The Royal Society of Canada, 48 pp., 1986.

This is one of three complementary volumes of scientific papers that the Royal Society of Canada's Commission on Lead in the Environment used in preparing its final report, Lead in the Canadian Environment: Science and Regulation. This volume is a technical appraisal of the health effects and industrial and engineering problems inherent in the alternative lead-free ways of matching fuels to engines.

Lead in Gasoline. A Review of the Canadian Policy Issue. (Interim report).
THE ROYAL SOCIETY OF CANADA.
Committee on Lead in the Environment, 56 pp., 1985.

The purpose of the report was to provide the Federal Minister of the Environment with independent advice on the current and future risks and areas of concern resulting from lead in the Canadian Environment, as well as proposing corrective measures.

Electric kettles as a source of human lead exposure.
WIGLE, D.T. & CHARLEBOIS, E.J.
Laboratory Centre for Disease Control, Health & Welfare Canada, Ottawa, Ontario.
Arch. Environ. Health 33(2): 72-78 (1978).

574 households in Ottawa were surveyed to evaluate water boiled in electric kettles as a source of lead exposure. Excessive lead concentrations were observed in 62.8% of water samples from kettles more than 5 years old, the source of lead being traced to the solder used to seal the heating element into the kettle base. (The Department of Consumer and Corporate Affairs of Canada has since introduced regulations banning the advertising, sale and importation of such kettles).

LEAD IN HOME PRODUCTS AND BUILDING MATERIALS.

Lead: New Worries About Old Paint.
STEVENSON, D.
On behalf of the Institute for Research in Construction, National Research Council of Canada, Ottawa, Ontario.
The Royal Architectural Institute of Canada Update 15(3): 5 (1992).

Lead-based paint that is disturbed during renovation of older homes can pose a significant long-term health hazard to children living in or visiting the building. The dust left behind may contain high levels of lead which may be picked up on children's hands or toys, and hence ingested when they put their fingers or other objects in their mouths. For these reasons, it is crucial to determine whether lead-based paint is present before beginning renovation work on an older building. Spot test kits are available to detect the presence of lead-based paints. If the lead-based paint is covered and in good condition, it can be left on the walls; if not, there are three possible strategies: encapsulation, replacement, and

removal. Not all paint removal strategies are suitable for removing lead-based paints, and most experts recommend the use of chemical strippers.

Home Renovations. - Removing Lead-Based Paint.
HEALTH AND WELFARE CANADA.
A fact-sheet on the series of *Issues* produced by the Health Protection Branch of Health & Welfare Canada for the public, media and special interest groups, 5 pp., 1991.

This pamphlet is designed to inform home owners of the potential health hazards associated with the exposure to lead dust during renovations of older homes where lead-based paint is being stripped. It advises the consumer on issues such as how to find out whether the home contains lead-based paint, when and how it is recommended to remove it, safe practices to follow during renovations, and how to get help if exposure to lead is suspected.

Health Hazard Associated with the Stripping of Lead-Containing Paint. A Background Document.
HILL, R.J.
Hilcon Consultants, Ottawa, Ontario.
A Report prepared by Hilcon Consultants, Ottawa under contract for the Consumer Product Section, Environmental Health Directorate, Health Protection Branch, Department of Health & Welfare Canada, 22 pp., 1991.

This report reviews the scientific literature dealing with paint stripping. It not only adresses the health hazards associated with exposure to leaded-paint during home renovations, but also discusses the chemical composition and toxic properties of commercially available chemical paint strippers, as well as the use of mechanical stripping methods (burning, sanding or blasting). The merits or disadvantages of each method are discussed.

Evaluation of the Regulations for Lead and Mercury Content in Paints.
VODDEN, K. & SMITH, D.
Abt Associates of Canada, Social Research Consultants, Ottawa.
Project Report prepared for Product Safety Branch, Consumer & Corporate Affairs, 72 pp., 1991.

In this report the question of whether current regulations regarding lead are adequate to ensure the health and safety of consumers, especially children, is discussed. The report provides an assessment of the costs and benefits of potential regulatory changes and other measures intended to limit exposure to lead and mercury from liquid coatings. Recommendations are preceeded by a discussion of the various routes of exposure to lead and lead-containing substances, and a discussion of the benefits of the proposed regulations. The new regulation, which would limit the lead in liquid coatings to 0.06% w/w (dry solids), is deemed necessary, despite the fact that it will affect only a few products available in the marketplace.

Leaching of antimony, cadmium, copper, lead, silver, tin and zinc from copper piping with non-lead-based soldered joints.

SUBRAMANIAN, K.S., CONNOR, J.W. & MERANGER, J.C.
Environmental Health Centre, Health & Welfare Canada, Ottawa, Ontario.
J. Environ. Sci. Health Part A-Environmental Science and Engineering 26(6): 911-929 (1991).

Studies were undertaken on the leaching of Ag, Cd, Cu, Pb, Sb, Sn and Zn from a variety of copper pipes with non-lead-based soldered joints into high-purity, tap, and well water samples as a function of standing time in a static test on new plumbing. There was no significant leaching of Ag, Cd, Pb, Sb or Sn from the solders into any of the three types of water samples studied. It is recommended that these lead-free solders be used in plumbing systems in order to avoid contamination of the drinking water with lead leached from lead-based solders.

Acute lead intoxication in a group of demolition workers.

HOLNESS, D.L. & NETHERCOTT, J.R.
Dept. Occupational & Environmental Health, University of Toronto.
Appl. Ind. Hyg. 3: 338-341 (1988).

This article reports the acute health effects of lead exposure experienced by a group of metal cutters and their assistants while dismantling a water filtration plant in Toronto between October, 1982 and August, 1984. The metal filtration tanks had received numerous coats of lead-based paint over the years, and leaded joints had been used to connect the plant's extensive pipe network. Torch cutting was the method initially employed for dismantling the tanks. Blood lead levels ranging from 15 to 99 μg/100 ml (mean = 59 μg/100 ml) were recorded in the initial phase of the demolition project. Sandblasting the metal structure prior to the actual cutting and the use of adequate respirators reduced the workers' exposure to lead dust/fumes so that during the final phases of this project the workers' blood lead levels ranged between 13-30 μg/100 ml. Recommendations for changes in work practices and control measures for reducing exposure to lead are outlined.

Lead based paint in dwellings: The potential for contamination of the home environment during renovation.

INSKIP, M.J. & HUTTON, M.
Environmental & Occupational Toxicology, Health & Welfare Canada, Ottawa, Ontario/Monitoring & Assessment Research Centre, Kings College, University of London, London, U.K.
Environmental Geochemistry and Health 9(3-4): 86-92 (1987).

The quantity and particle size characteristics of lead in dust released during three different paint removal techniques was determined under controlled conditions and in situ in a dwelling. Air-lead and deposited dust-lead levels were highest after sanding but "burning off" and "hot air" removal methods also produced significant contamination. The importance of dust particle size and lead is discussed in relation to the potential hazard to home renovators via inhalation and to children via the "hand-to-mouth" route.

LEAD ABATEMENT/SOIL REMEDIATION PROJECTS.

The Lead Abatement Evaluation Project: Analysis of Data to 1988.

Occupational Health Centre at Queen's University, Kingston, Ontario.
70 pp., 1991.

This report provides a summary of data on the lead abatement program in South Riverdale from 1984 until the fall of 1988. The study was undertaken mainly to determine whether the lead abatement program in South Riverdale had resulted in lower blood lead levels in the children living in this district, and to determine which factors explain any decrease. The data from six cross-sectional surveys were examined, and time trends in blood lead levels were compared in two areas for which data existed for both 1984 and 1988: the South Riverdale area and the Ontario Blood Lead Study schools. The 1988 South Riverdale data were then compared to the 1987 data, and to the results from a non-contaminated region with similar socioeconomic and demographic characteristics. The results of the study failed to show a clear correlation between the abatement activities (soil replacement and dust cleaning), and a decreased blood lead level in the children. Some (statistically not significant) decrease was shown following the dust cleaning program. It was concluded that since the program was still in its final stages during the fall of 1988, the study was too premature to reveal any true post-intervention changes in blood lead levels.

[Professional Clean-up of 96 Lead Contaminated Homes Inhabited by Children 6 Years Old or Younger or by Children 7-10 Years Old Whose Blood Lead Level was ≥ 150 μg/L in September 1989.]

MESSIER, A., TREMBLAY, Y., LANGLOIS, Y., COACHE, S., LEWIS, L., MONETTE, Y., DION, P. & BEAUDOIN, L.
Département de Santé Communautaire, Hôpital du Haut-Richelieu, St-Jean-sur-Richelieu, Québec.
Report presented to the Ministry of Health and Social Services, 1990 (in French).

The professional clean-up of 96 homes in a residential sector contaminated by lead took place between December 1989 and March 1990. This report is an assessment of the clean-up operations, and includes details on the homes involved, the effectiveness of the cleaning operation, the cost of the programme and the problems encountered during its implementation.

Lead Reduction Program - Housedust Cleaning. Final Report and Appendices.

CITY OF TORONTO, DEPARTMENT OF PUBLIC HEALTH, IN CONJUNCTION WITH THE ONTARIO MINISTRY OF THE ENVIRONMENT.
A report prepared by Concord Scientific Corporation and Gore & Storrie Limited, in association with the South Riverdale Community Health Centre, 1990.

The report provides details of the full-scale lead reduction housecleaning activities undertaken by Toronto Department of Public Health. Details of the procedures used are provided as guidance to other communities which may be faced with the need to undertake similar work.

Housedust Lead Reduction Programme. Post Demonstration Review (1988).

CITY OF TORONTO, DEPARTMENT OF PUBLIC HEALTH.
Department of Public Health, City of Toronto, Ontario, 50 pp., 1990.

This document provides a background discussion and rationale paper for the full-scale housedust cleaning programme, implemented and completed in 1989 in South Riverdale and Niagara blood test areas in the City of Toronto.

South Riverdale Lead Reduction Program. Housedust Cleaning Demonstration.
CITY OF TORONTO, DEPARTMENT OF PUBLIC HEALTH.
Final Report prepared by Concord Scientific Corporation and Gore & Storrie Ltd. in association with South Riverdale Community Health Centre, for the City of Toronto, Department of Public Health, 1989.

The principal objective of this project was to design, carry out and evaluate the effectiveness of two alternative cleaning protocols, each of which was intended to reduce the lead content of housedust, prior to undertaking full-scale cleaning of the interiors of the 1,000 houses involved in the South Riverdale Lead Reduction Program. This report evaluates the clean-up of 8 houses in the area by 4 commercial cleaning contractors hired by the City of Toronto, and presents the conclusions and recommendations for the implementation of the full-scale clean-up program.

Protecting the environment during coating rehabilitation in Ontario.
BATTEN, M. & LEECH, F.R.
Contract Management Officer, Provincial Highways/Senior Environmental Planner, Ontario Ministry of Transportation, Downsview, Ontario.
In: Appleman, B.R., L.M. Smith & J.A. Zappa, eds. *Lead Paint Removal from Steel Structures.* Proceedings of the SSPC Symposium February 29-March 1, the Sheraton National Hotel in Arlington, Virginia, pp. 148-174, 1988.

The Ontario Ministry of Transportation (OMT) has 618 mild steel structures in their highway system, most of which have been coated with alkyd intermediate and finish coats over a shop-applied red lead primer. On many of these structures the surface coatings are in such a state of deterioration that new coatings need to be applied in order to control corrosion. This paper outlines a cooperative approach by the OMT which involves containment of spent abrasive, old paint and corrosion residues resulting from the surface preparation of Ontario's numerous steel structures. Standards of containment are specified for various environmental situations, and sample laboratory test evaluations of the old paint, rust and spent abrasive residues from these projects are discussed.

Lead in Toronto's Niagara Neighbourhood. A Brief to the Minister of the Environment, Province of Ontario on the Establishment of a New Lead Soil-Removal Criterion.
WALLACE, B. & QUANCE, E.
Niagara Neighbourhood Association, Toronto, Ontario, 33 pp., 1987.

As a result of concern regarding levels of lead in soil, a formal request was made for the lowering of the lead-in-soil guideline to 500 ppm, as well as for soil replacement in the Niagara Neighbourhood.

Lead Program Report. Boulevard Sod/Soil Removal and Replacement in the Weston Area of Winnipeg, 1983.
JONES, D.C. & WOTTON, D.L.
Terrestrial Standards and Studies Section, Manitoba Environment and Workplace Safety and Health, Winnipeg, Manitoba.
Winnipeg, Manitoba Environment & Workplace Safety & Health, Report # 83-16, 15 pp., 1984.

Lead-in-soil surveys conducted in 1981 in the city of Winnipeg identified 27 15-meter sections of boulevard in the Weston area which had lead levels in sod and/or soil in excess of 2600 μg/g. The Environmental Management Division

recommended removal of the sod and soil of the designated boulevards to a minimum depth of 15 cm, and replacement with soil containing no more than 200 $\mu g/g$ lead.. Details of the awarded contract are given.

Lead Program Report Soil/Sod Removal and Replacement in the Weston Area of Winnipeg, 1982.

JONES, D.C. & WOTTON, D.L.
Terrestrial Standards and Studies Section, Manitoba Environmental Management Division, Winnipeg.
Manitoba Terrestrial Standards and Studies Report # 82-3, 1982.

In 1981, an intensive lead-in-soil survey was conducted in the vicinity of the Canadian Bronze Co. Ltd. (a secondary lead smelter specializing in the manufacture of bearings and castings), located in the residential area of Weston, in the City of Winnipeg. This survey identified 31 residences, in addition to the Canadian Bronze picnic site located on company property, which had elevated sod and soil lead levels. It was recommended that a sod and soil removal/replacement program be undertaken in all residential areas found to have lead levels of 2600 $\mu g/g$ or greater in the surface soil. Details of the awarded contract are given.

ANIMAL EXPOSURE/TOXICITY STUDIES.

Neurobiological Mechanism of Lead Toxicity.

PETIT, T.L. ET AL.
Department of Psychology, Division of Life Seciences, University of Toronto, Toronto, Ontario.
Ongoing study, unpublished results.

Environmental lead (Pb) exposure in developing humans results in deficits in learning and memory processes proportional to the degree of exposure; low level exposure results in mild to moderate learning disabilities while higher levels of exposure results in mental retardation. Previous research has shown that Pb causes a marked reduction in central nervous system (CNS) synaptic plasticity, a frequently used cellular model of learning and memory processes. There is also preliminary evidence that Pb interferes with the functioning of the NMDA receptor, which is known to be critical for memory processes and neural plasticity. The proposed studies will conduct an in-depth analysis of Pb's interaction with the NMDA receptor using behavioural and autoradiographic receptor binding techniques. It will be determined if early Pb exposed animals are super-sensitive to NMDA and whether Pb alters the levels of NMDA receptors in animals at different ages and in different Pb exposure groups. Finally, it will be determined if the cognitive deficits observed in Pb exposed animals are related to alterations in NMDA receptor levels. This research, therefore, is aimed at elucidating the mechanism of Pb induced plasticity inhibition, which represents a long-term, dynamic process observed in the adult long after the initial period of Pb exposure, and which may well underlie the long-term intellectual effects of lead exposure.

Maternal-Fetal Transfer of Lead in a Non-Human Primate Macaca fascicularis: Preliminary Studies Using Stable Isotope Tracers.

INSKIP, M.J., YAGMINAS, A., FRANKLIN, C.A., FOSTER, W., WANDELMAIER, F., HAINES, D. & BLENKINSOP, J.
Environmental & Occupational Toxicology, Health & Welfare Canada, Ottawa, Ontario.

Proceedings International Conference Trace Metals in the Environment, CEP Consultants, Edinburgh, 294-297, 1991.

(Report not available for abstracting).

The effects of thiamin on lead metabolism: Whole-body retention of lead-203.

KIM, J.S., HAMILTON, D.L., BLAKLEY, B.R. & ROUSSEAUX, C.G.
Depts. Veterinary Physiological Sciences & Veterinary Pathology, University of Saskatchewan, Saskatoon, Sakatchewan.
Toxicology Letters 56(1-2): 43-52 (1991).

The effects of thiamine on the whole body retention of lead were studied in CD-1 mice exposed intragastrically or intraperitoneally to a single dose of 100 μg lead acetate containing 100 μCi ^{203}Pb. Thiamine (25 or 50 mg/kg b.w.), CaEDTA (50 mg/kg b.w.) or their combination were administered to mice in pre-treatment or post-treatment regimes for 13 days. Both pre- and post-treatment with thiamine reduced the lead retention compared to the untreated lead-exposed mice. The reduced absorption and enhanced excretion of lead associated with thiamine administration may have therapeutic application for the treatment of lead poisoning.

Actions of lead on transmitter release at mouse motor nerve terminals.

WANG, Y.X. & QUASTEL, D.M.J.
Dept. Pharmacology & Therapeutics, Medical Faculty, University of British Columbia, Vancouver, B.C.
Pflugers Archiv-European J. Physiology 419 (3-4): 274-280 (1991).

The actions of lead on transmitter release were studied at neuromuscular junctions in mouse diaphragm *in vitro*. The results suggest that lead (Pb^{2+}) acts by blocking the entry of Ca^{2+} and Ba^{2+} into the terminal by acting on voltage-gated Ca^{2+} channels. At higher concentrations, Pb^{2+} also penetrates the channel and subsequently acts as an agonist at intracellular sites that govern transmitter release.

Evaluation of edetate and thiamine for treatment of experimentally induced environmental lead poisoning in cattle.

COPPOCK, R.W., WAGNER, W.C., REYNOLDS, J.D., VOGEL, R.S., GELBERG, H.B., FLORENCE, L.Z. & WOLFF, W.A.
Depts. Veterinary Biosciences, Pathobiology and Clinical Medicine, College of Veterinary Medicine, University of Illinois, Urbana, IL., US/State of Illinois Veterinary Diagnostic Laboratory, Centralia, IL.,US/Animal Sciences Division, Alberta Environmental Centre, Alberta.
Am. J. Veterinary Research 52(11): 1860-1865 (1991).

20 mature Holstein cows were randomly alloted to five treatment groups, and were administered either 0 (controls) or 2 mg Pb/kg b.w./day for 28 days. Clinical signs of plumbism were scored, and blood was collected weekly for Pb, progesterone and hematologic analyses. Cows were also examined weekly for anomalous ovarian cycles. Starting on study day 28, cows were exposed to one of the following treatment regimens: once daily with 2 mg of thiamine HCl/kg for 13 days (group 3); twice daily with 62 mg of disodium, calcium-ethylenediaminetetraacetate (Na_2,Ca-EDTA)/kg for 4 days (group 4); or, once daily with 2 mg thiamine HCl/kg plus twice daily with 62 mg of Na_2,Ca-EDTA/kg (group 5). On study days 96 through 139, cows were slaughtered and samples of blood, skeletal muscles, bones, liver, and kidneys

were collected for Pb analysis. Thiamine was not effective in reducing blood lead levels but was most effective in inducing remission of clinical signs of plumbism, while treatments with Na_2,Ca-EDTA and thiamine plus Na_2,Ca-EDTA were effective in reducing the concentration of lead in blood. Blood lead levels were significantly correlated ($p<0.05$) to the concentration of lead in liver, kidneys, skeletal muscles and bones. A significant relationship ($p<0.05$) existed between the number of days from Pb exposure to slaughter and lead levels in blood, liver and skeletal muscles. Progesterone analysis and ovarian examination suggested that exposure to lead and treatment of plumbism did not induce changes in the ovarian cycle.

The effects of thiamin on lead metabolism - whole-body retention of Pb-203.

KIM, J.S., HAMILTON, D.L., BLAKLEY, B.R. & ROUSSEAUX*, C.G.
Department of Veterinary Physiological Sciences/Department of Veterinary Pathology*, Western College of Veterinary Medicine, University of Saskatchewan, Saskatoon, Saskatchewan.
Toxicology Letters 56(1-2): 43-52 (1991).

(Paper not available for abstracting).

Subchronic oral toxicity of triethyl lead in the male weanling rat. Clinical, biochemical, hematological, and histopathological effects.

YAGMINAS, A.P., FRANKLIN, C.A., VILLENEUVE, D.C., GILMAN, A.P., LITTLE, P.B. & VALLI, V.E.O.
Fundamental and Applied Toxicology 15(3): 580-596 (1990).

Groups of 20 animals were administered triethyl lead (3EL) by gavage at 0.05, 0.10, 0.20, 0.50, 1.00 mg/kg body wt/day for 91 days, 5 days/week. Lead acetate (PbHOAC) was given as a positive control at 200 mg/kg body wt/day. Dose-dependent accumulation of the residues of 3EL, and its metabolites diethyl lead (2EL) and lead (Pb) were observed in blood, liver, kidney and brain, with preferential accumulation of 3EL occurring in the liver, while inorganic lead accumulated in the kidney. Dose-dependent decreases in serum calcium were observed, while elevations in phosphorous were observed in all groups. Serum cholesterol and alkaline phosphatase were also elevated in the three highest 3EL groups. Decreased levels of LDH, increased levels of microsomal aniline hydroxylase, and decreased mean corpuscular hemoglobin content were observed in the PbHOAC-treated group. Other observed effects included elevated platelet counts and reduced weight gain in the 1.0 3EL-treated group, elevated spleen and kidney weights in the PbHOAC-treated group, and histopathological changes in the thyroid, liver, kidney and bone marrow. A no observed adverse effect level (NOAEL) for 3EL was set at 0.10 mg/kg body wt.

Effects of lead and pesticides on [Kronecker delta]-aminolevulinic acid dehydratase of ring doves *(Streptopelia risoria)*.

SCHEUHAMMER, A.M. & WILSON, L.K.
Canadian Wildlife Service, Environment Canada, Ottawa, Ontario.
Environmental Toxicology and Chemistry 9(11): 1379-1386 (1990).

The effects of lead (Pb^{2+}) and various pesticides on delta-aminolevulinic acid dehydratase (ALA-d) in avian blood, liver and kidney were studied. In avian blood, virtually all of the ALA-d activity was localized in the cellular fraction. Complete inhibition of RBC ALA-d occurred at an in vitro Pb^{2+} concentration of approximately 10 μmol/g protein, with an IC_{50} of approximately 0.9 μmol/g protein. Recovery of Pb-inactivated RBC ALA-d activity was accomplished by treatment of blood hemolysates with Zn^{2+} and an SH-reducing agent such as dithiothreitol (DTT). A combination of Zn^{2+} (4mM) and DTT (120mM) was required to achieve complete recovery of Pb-inhibited enzyme activity. Normal

avian ALA-d activity was greatest in blood, followed by liver, and then kidney. Unlike blood hemolysates, liver and kidney homogenates contained a fraction of ALA-d activity which was very resistant to inhibition by Pb^{2+} *in vitro*. *In vivo*, hepatic ALA-d was unaffected by Pb exposure (2.5 μg Pb^{2+}/g body wt. injected intraperitoneally), but renal ALA-d was decreased as a result of greater deposition of Pb in the kidney than in the liver. Inhibition of ALA-d in avian blood, particularly when expressed as the ratio of fully restored:nonrestored activity (activity ratio), is a highly specific and sensitive indicator of Pb exposure and deposition, as well as being a reliable predictor of enzyme inhibition in other target organs (kidney).

Lead-induced behavioral impairment on a spatial discrimination reversal task in monkeys exposed during different periods of development.

RICE, D.C.
Foods Directorate, Toxicology Research Division, Health Protection Branch, Health & Welfare Canada, Ottawa, Ontario.
Toxicol. Appl. Pharmacol. 106(2): 327-333 (1990).

A total of 52 monkeys were dosed orally with vehicle (glycerine) or with lead at a dose of 1.5 mg Pb/kg/day in one of the following four dosing regimens: 1.-vehicle only; 2.-lead from birth onward; 3.-lead from birth to 400 days of age and vehicle thereafter; and 4.-vehicle from birth to 300 days of age and lead thereafter. When 7-8 years old, the monkeys were tested on three spatial discrimination reversal tasks: no irrelevant cues, irrelevant form cues, and irrelevant form and color cues. Only group 2 was impaired in the absence of irrelevant cues, while all 3 treated groups were impaired in the presence of irrelevant cues.

Lack of sensitive period for lead-induced behavioral impairment on a spatial delayed alternation task in monkeys.

RICE, D.C. & GILBERT, S.G.
Foods Directorate, Toxicology Research Division, Health Protection Branch, Health & Welfare Canada, Ottawa, Ontario
Toxicology and Applied Pharmacology 103(2): 364-373 (1990).

A total of 52 monkeys (*Macaca fasciculairs*) were dosed orally with vehicle (glycerine) or 1.5 mg lead/kg/day using one of four dosing regimens (13 monkeys/group). Blood lead levels averaged 3-6 μg/dL when monkeys were not being dosed with lead, as compared to 32-36 μg/dL when being dosed with lead and having access to infant formula, and 19-26 μg/dL when being dosed with lead after weaning from infant formula. At 6-7 years old, the monkeys were tested on a spatial delayed alternation task. The task required the monkey to alternate responses between two push buttons. The initial delay was 0.1 sec and was increased in steps to 15 sec by the end of the experiment. All three treated groups were impaired to approximately an equal degree. Deficits were observed in the initial training procedure, and at the longer delay values. These results suggest that there is not an early critical period for lead-induced impairment on this task and that exposure only during infancy results in a degree of impairment comparable to ongoing exposure beginning at birth. These results are in contrast to previous findings on a series of nonspatial discrimination reversal tasks, in which only the group exposed early in life was unimpaired, while the group whose exposure began after infancy was less impaired than the group exposed continuously from birth.

Sensitive periods for lead-induced behavioral impairment (nonspatial discrimination reversal) in monkeys.

RICE, D.C. & GILBERT, S.G.
Foods Directorate, Toxicology Research Division, Health Protection Branch, Health & Welfare Canada, Ottawa, Ontario
Toxicology and Applied Pharmacology 102(1): 101-109 (1990).

A total of 52 nursery-reared monkeys (*Macaca fascicularic*) were dosed with 1.5 mg lead/kg/day on one of four dosing regimens (13 monkeys/group): Group 1, vehicle only; Group 2, continuous dosing from birth; Group 3, dosing from birth to 400 days; and Group 4, dosing with vehicle from birth to 300 days, followed by lead. The dosing regimen allowed the evaluation of differential infant vulnerability as well as reversibility of the behavioural toxicity of lead. Blood lead concentrations averaged 3-6 μg/dL when monkeys were not being dosed with lead, 32-36 μg/dL when being dosed with lead and having access to infant formula, and 19-26 μg/dL during lead exposure after weaning from infant formula. At 5-6 years old, the monkeys were tested on a series of nonspatial discrimination reversal tasks: form, form with irrelevant colour cues, colour with irrelevant form cues, and alternating form and colour. Group 2 exhibited the greatest degree of impairment compared to controls. Group 4 also exhibited impaired performance, although less marked than that of Group 2. Group 3 was not impaired on this series of tasks. These results confirm findings observed in other monkeys exposed continuously to lead and suggest that while exposure beginning after infancy produces impairment, exposure from early infancy exacerbates the effect.

Effects of chronic developmental lead exposure on monkey neuroanatomy: Visual system.

REUHL, K.R., RICE, D.C., GILBERT, S.G. & MALLETT, J.
Foods Directorate, Toxicology Research Division, Health Protection Branch, Health & Welfare Canada, Ottawa, Ontario/Dept. Biological Sciences, Carleton University, Ottawa, Ontario.
Toxicol. Applied Pharmacol. 99: 501-509 (1989).

The effects of lead on specific areas of the primate's visual system were examined in two groups of monkeys receiving 2000 μg Pb/kg/day from infancy onward (n=3), and 25 μg Pb/kg/day from birth onward (n=4), respectively. The monkeys (*Macaca fascicularis*) were killed at approximately 6 years of age, and areas of the visual system, including optic nerve, lateral geniculate nucleus, primary area V1 and one visual projection area V2, were examined by a combination of light and electron microscopy and Golgi impregnation. Although no effect of lead was observed on the optic nerve or the lateral geniculate nucleus, the neuronal volume density within areas V1 and V2 was significantly reduced in the high dose group. The authors concluded that lead exposure beginning during the early postnatal period may result in changes in cytoarchitecture in visual areas V1 and V2.

Bovine lead poisoning in Alberta: A management disease.

YONGE, K.S. & MORDEN, B.B.
Western College of Veterinary Medicine, University of Saskatchewan, Saskatoon, Saskatchewan/Alberta Agriculture, Animal Health Division, Edmonton, Alberta.
Can. Vet. J. 30: 42-45 (1989).

Lead poisoning was the most common toxicosis diagnosed in cattle by Alberta Animal Health Laboratories between 1964 and 1985, with 738 reported cases (mean, 33.5 cases/year). Discarded batteries or used crankcase oil were implicated in more than 80% of cases for which the source of lead was determined. 86% of poisoning cases were confirmed by elevated lead tissue levels.

Lead distribution in rats repeatedly treated with low doses of lead acetate.

P'AN, A.Y.S. & KENNEDY, C.
Dépt. Méd. Travail & Hyg. Milieu, Fac. Méd., Université de Montréal, Montréal, Québec.
Environmental Research 48(2): 238-247 (1989).

Male Sprague-Dawley rats were repeatedly treated intraperitoneally with 10 or 20 mg/kg lead acetate at intervals of 1, 2, 4, 8, 12, 16, 20 or 24 weeks, and sacrificed 48 hr. after the end of each treatment. Lead was determined in whole blood, plasma, plasma filtrate, saliva, urine, feces, brain, salivary glands, liver, kidney, testes, femur and fur. Correlations between kidney-lead and blood, urine and fur-lead, as well as between fur-lead and brain-lead are discussed.

Maternal and fetal chromosomal aberrations in mice following prenatal exposure to subembryotoxic doses of lead nitrate.

NAYAK, B.N., RAY, M. & PERSAUD, T.V.N.
Depts. of Anatomy and Pediatrics & Child Health, University of Manitoba, Winnipeg, Manitoba.
Acta Anatomica 135(2): 185-188 (1989).

Maternal exposure to low levels of lead nitrate (12.5, 25 or 50 mg $Pb(NO_3)_2$/kg b.w.) administered intravenously to mice on day 9 of gestation did not cause embryonic resorption or fetal lethality, but induced chromosomal deletions and other forms of aberrations in fetal liver and maternal bone marrow cells.

In vivo evaluation of cytogenetic changes and fetal development following maternal exposure to heavy metals (methylmercury, lead and cadmium).

PERSAUD, T.V.N. & RAY, M.
Depts. of Anatomy and Pediatrics & Child Health, University of Manitoba, Winnipeg, Manitoba.

The purpose of the study is to employ heavy metals (mercury, lead, cadmium), which are major environmental pollutants, to determine whether any relationship exists between chromosomal alterations, level of sister chromatid exchanges, and nucleolus organizing regions in somatic cells, and the dose level of the substances in the same animal model. Unlike previous studies, the experiments will be carried out using an *in vivo* system in pre-implantation and post-implantation embryos, and in chorionic villi cells. The results of this investigation will not only provide some insight as to the mechanisms of teratogenesis with respect to heavy metals, but, more importantly, if a correlation is shown to exist between the degree of cytogenetic changes and dose levels, then it might be possible to use this test system for the screening of suspected teratogenic agents.

Monitoring wild bird populations for lead exposure.

SCHEUHAMMER, A.M.
Canadian Wildlife Service, Environment Canada, Ottawa, Ontario.
J. Wildlife Management 53(3): 759-765 (1989).

Delta-aminolevulinic acid dehydratase (ALA-d), an enzyme in the heme biosynthetic pathway, is extremely sensitive to inhibition by lead. The erythrocyte ALA-d activity ratio (defined as the ratio between the fully restored enzyme activity and that measured without removing any inhibitory influence that might be present), was evaluated in free-living birds as an indicator of lead exposure. In the absence of elevated Pb exposure, birds had comparable ALA-d activity ratios regardless of species, geographical location or time of year sampled. In blood collected from free-living mallards, ALA-d activity ratios were better correlated with blood-lead than with blood-protoporphyrin concentrations. At least 9.5% of

mallards with blood-lead >80μg/dL did not have elevated protoporphyrin levels. The ALA-d activity ratio was as accurate as blood-lead measurements for monitoring the relative degree of recent Pb exposure in the wild bird populations studied. Unlike blood-lead analyses, ALA-d determinations do not require sophisticated and expensive instrumentation, and assays can be performed efficiently with minimal training.

Effects of lead on luteal function in Rhesus monkeys.

FRANKS, P.A., LAUGHLIN, N.K., DIERSCHKE, D.J., BOWMAN, R.E. & MELLER, P.A.
Dept. Psychology, University of Toronto, Mississauga, Ontario/Harlow Primate Laboratory, Environmental Toxicology Center & Wisconsin Regional Primate Research Center, University of Wisconsin, Madison, Wisconsin, US.
Biol. Reprod. 41(6): 1055-1062 (1989).

Female rhesus monkeys were exposed to lead acetate in their drinking water for 33 months at levels between 2 and 8 mg Pb/kg/day. During the final 7 months of treatment, circulating amounts of progesterone were determined to evaluate luteal function. Female monkeys receiving lead exhibited longer and more variable menstrual cycles and shorter menstrual flow. Although chronic exposure to lead did not prevent ovulation, luteal function was suppressed.

Lifetime low-level lead exposure produces deficits in delayed alternation in adult monkeys.

RICE, D.C. & KARPINSKI, K.F.
Foods Directorate, Toxicology Research Division, Health Protection Branch, Health & Welfare Canada, Ottawa, Ontario.
Neurotoxicology and Teratology 10(3): 207-214 (1988).

Monkeys dosed from birth with 0, 50 or 100 μg Pb/kg/day were tested on a delayed alternation task at age 7-8 years. Treated monkeys were impaired in their ability to learn the alternation task, but were not different from controls at short delay values (1 and 3 sec). At longer delay values (5 and 15 sec), treated monkeys again exhibited impairment. The data are interpreted as indicative of spatial learning and short-term memory deficits in the lead-exposed monkeys.

Chronic low-level lead-exposure in monkeys does not affect simple reaction time.

RICE, D.C.
Foods Directorate, Toxicology Research Division, Health Protection Branch, Health & Welfare Canada, Ottawa, Ontario.
Neurotoxicology 9(1): 105-108 (1988).

Simple visual reaction time was measured in adult monkeys orally exposed to 500 μg Pb/kg/day from birth onward, as well as in matched controls. Blood lead levels had remained at 33 μg/dL for 6 years prior to the testing. The results showed no consistent differences in performance between treated and control monkeys.

Schedule-controlled behavior in infant and juvenile monkeys exposed to lead from birth.

RICE, D.C.
Foods Directorate, Toxicology Research Division, Health Protection Branch, Health & Welfare Canada, Ottawa, Ontario.
Neurotoxicology 9(1): 75-88 (1988).

Monkeys exposed orally from birth to 0 or 2000 μg Pb/kg/day as lead acetate were tested on a fixed ratio (FR) schedule of reinforcement followed by a fixed interval (FI) schedule beginning at 60 days of age. When the monkeys reached 3 years of age, performance on a multiple fixed interval-fixed ratio schedule was evaluated. Performance was characterized by increased FR pause and decreased FI pause in infant-treated monkeys, and increased FI run rate, pause time, and index of curvature in juvenile-treated monkeys.

Effect of prenatal and neonatal exposure to lead on the affinity and number of estradiol receptors in the uterus.

WIEBE, J.P. & BARR, K.J.
Hormonal Regulatory Mechanisms Laboratory, Department of Zoology, University of Western Ontario, London, Ontario.
J. Toxicol. Environ. Health 24(4): 451-460 (1988).

Female Sprague-Dawley rats were exposed to 20 or 200 ppm lead chloride or sodium chloride in their drinking water either prior to mating or during pregnancy and lactation, and female offspring were similarly exposed from days 21-35 or 21-150. The uteri were subsequently removed from 21, 35 and 150 d. old female offsprings and analyzed for estradiol-receptor binding and affinity. The results of this study demonstrate that prenatal and/or postnatal exposure to lead alters the number and affinity of estradiol receptors in the prepubertal and adult rat uterus.

Effect of prenatal and neonatal exposure to lead on gonadotropin receptors and steroidogenesis in rat ovaries.

WIEBE, J.P., BARR, K.J. & BUCKINGHAM, K.D.
Hormonal Regulatory Mechanisms Laboratory, Department of Zoology, University of Western Ontario, London, Ontario.
J. Toxicol. Environ. Health 24(4): 461-476 (1988).

Sprague-Dawley rats were exposed to 20 or 200 ppm lead chloride or sodium chloride in their drinking water either prior to or during pregnancy and lactation, and female offspring were examined at weaning (21 d) or at 150 d. Other female rats were treated from day 21 to 35. The results demonstrate that lead exposure prior to mating may affect gonadotropin-receptor binding in the offspring, and that lead exposure (in utero, via mother's milk or post weaning) may significantly alter steroid production and gonadotropin binding in the ovaries of the prepubertal, pubertal and adult female.

Effect of diet on the response in rats to lead acetate given orally or in the drinking water.

KORSRUD, G.O. & MELDRUM, J.B.
Health of Animals Laboratory, Agriculture Canada, Saskatoon, Saskatchewan.
Biological Trace Element Research 17: 167-173 (1988).

Male Sprague-Dawley rats were treated with lead acetate orally or in their drinking water and fed either a pelleted or a semipurified diet. Rats dosed with lead orally or in their drinking water and fed the semipurified diet were more sensitive to lead treatment than those fed the pelleted diet.

Effect on blood, liver, and kidney variables of age and of dosing rats with lead acetate orally or via the drinking water.

KORSRUD, G.O. & MELDRUM, J.B.
Health of Animals Laboratory, Agriculture Canada, Saskatoon, Sakatchewan.
Biological Trace Element Research 17: 151-166. (1988).

Male Sprague-Dawley rats were exposed to lead acetate either orally or in their drinking water, and the levels of lead in the liver and kidneys were measured. A positive linear dose response was observed in both liver and kidney lead levels, while δ-amino levulinic acid dehydrogenase activities decreased in blood and liver when rats were treated with lead either orally or in their drinking water.

Low-level lifetime lead-exposure produces behavioral toxicity (spatial discrimination reversal) in adult monkeys.

GILBERT, S.G. & RICE, D.C.
Foods Directorate, Toxicology Research Division, Health Protection Branch, Health & Welfare Canada, Ottawa, Ontario.
Toxicol. Applied Pharmacol. 91(3): 484-490 (1987).

Monkeys dosed from birth with 0, 50 or 100 μg Pb/kg/day were tested on a series of spatial discrimination reversal problems at age 9-10 years. Treated monkeys were impaired relative to controls in the presence, but not in the absence of irrelevant cues. Moreover, the lower dose group was impaired only during the first task after the introduction of irrelevant stimuli, but not after irrelevant stimuli were familiar. These findings represent behavioral impairment in adult monkeys as a result of lifetime lead exposure resulting in blood lead levels that are in the same range as seen in industrially exposed humans (11-13 μg Pb/dL).

Evidence of differential hematopoietic compensation to lead intoxication in blood, liver and kidney.

HOLLEBONE, B.R., JOHNSON, P.M., CHAKRABARTI, C.L. & KARWOWSKA, R.
Department of Chemistry, Carleton University, Ottawa, Ontario.
Journal of Applied Toxicology 6(6): 419-424 (1986).

The dependence of fluorescent porphyrin levels on the levels of lead in blood, liver, and kidney has been examined as functions of both the level and duration of dosing. Individually housed 200 g male Wistar COBS rats were randomly selected for 3, 7, 21, and 35 day dosing periods in groups of control, 50, 100 or 1000 ppm lead in drinking water. The plot of all data points for porphyrin concentration against measured lead burden covers the same range of levels and closely resembles the scatter of data observed in humans. However, subsets of this plot defined by individual dose levels and durations yield well-defined linear relationships. At all dose levels, at 7 days, the correlation of porphyrin concentration to lead tissue burden is negative in all tissues, showing a direct inhibition of hemopoiesis with lead burden. Depending on the tissue, the slope becomes less negative, or, as in blood, positive at 21 and 35 days at all doses. This compensation is more rapid in blood, then in liver and is least evident in kidney. The time at which compensation is observed is the same for all doses in each tissue and seems, therefore, to depend on the rate of protein turnover in different tissue types. These results suggest that a direct correlation of porphyrin concentration to lead burden is not valid without knowledge of the dosing history. As well, evidence of compensation in one tissue does not imply successful compensation in other affected tissues where regeneration rates are slower. However, these observations do suggest that a correlation could be made between the extent of compensation in blood and that implicit for less accessible systems. Since blood compensation is most rapid, caution will be necessary in establishing tolerable lead levels for tissues at higher risk.

Chemical and biological monitoring of chronic lead poisoning in the rat: implications to the assessment of hazard of low-level lead.

WIGFIELD, D.C., CHAKRABARTI, C.L., WRIGHT, S.C., EASTWOOD, J.A., KARKOWSKA, R. & JOHNSON, P.M.
The Ottawa-Carleton Institute for Research and Graduate Studies in Chemistry, Department of Chemistry, Carleton University, Ottawa, Ontario.
Journal of Applied Toxicology 6(5): 371-376 (1986).

A study on rats of the effects of lead on s-aminolevulinate dehydratase (ALA-D) activity, and its pH-dependent maximal enzyme activity is reported. Over a 5-week period, the lead burden and ALA-D activity in kidney, liver and brain are documented. Lead levels in the organs, expressed as $\mu g/g$ protein decrease in the sequence kidney > liver > brain, and essentially reach a constant level after 3 days of exposure. This is consistent with the existence of an efficient mechanism removing lead from these organs. Lead affects the ALA-D in all three organs by reducing the activity and shifting the pH of maximum enzyme activity to more acidic values. In common with the lead levels, the ALA-D activity does not deteriorate beyond the levels reached after 3 days of exposure. The existence of a mechanism for removing lead from the organs is further supported by the results of a recovery study which showed that both lead levels and ALA-D activity essentially return to normal after 7 days with no exposure to lead.

Evaluation of the relationship between chemical and biological monitoring of low-level lead poisoning.

WIGFIELD, D.C., WRIGHT, S.C., CHAKRABARTI, C.L. & KARWOWSKA, R.
The Ottawa-Carleton Institute for Research and Graduate Studies in Chemistry, Department of Chemistry, Carleton University, Ottawa, Ontario.
Journal of Applied Toxicology 6(4): 231-235 (1986).

Blood lead levels, together with s-aminolevulinic acid dehydratase activity determinations have been measured in rats dosed with up to 1000 ppm lead acetate in their drinking water for periods of up to 5 weeks. Despite evidence from enzyme determinations that a compensatory mechanism develops, enzyme activity ratios, if properly chosen, still correlate reasonably well ($r=0.87$) with blood lead levels. Activity ratios using data on the shoulders of pH-activity profiles (e.g. activity ratios of 6.4 and 7.2), however, give much less satisfactory correlations. These data provide a more stringent test of the chemical monitor-biological monitor correlation than has previously been possible.

Study of the Transfer of Lead to the Cells of the Salivary Glands and Renal Tubules of the Rat.

P'AN, A.Y.S. & CRAAN, A.G.
Dépt. Med. Travail & Hyg. Milieu, Fac. Méd., Université de Montréal, Montréal, Québec.
Canadian Centre for Occupational Health and Safety, Hamilton, Ont., 3 pp., 1986.

The need to take blood samples can be a disadvantage when it comes to evaluating the lead exposure of a large group of workers. In this case, measuring lead in the urine seems to be an easier alternative. But this measurement fluctuates in an individual more than the lead level in blood, without even considering that contamination during handling is likely to distort the level of lead present in the urine. Research has been done to identify a biological fluid which is easier to collect than blood but which would provide as reliable an indication of the body's exposure to this toxin as the blood test. In the course of previous studies, researchers had established a connection between the levels of lead in the saliva and the blood. It was therefore decided to examine this relationship more closely, in order to determine if the presence

of lead in the saliva could be a valuable indicator of the lead concentration in the body, taking the kidneys as the reference organ.

Lead flux through the kidney and salivary glands of rats.

CRAAN, A.G., NADON, G. & P'AN, A.Y.S.
Dépt. Med. Travail & Hyg. Milieu, Fac. Méd., Université de Montréal, Montréal, Québec.
American Journal of Physiology: Renal, Fluid & Electrolyte Physiology 247(5, Part2): F773-F783 (1984).

The blood disappearance curve of lead injected intravenously into rats and its appearance curve in the saliva can be fitted to a three-compartment open model. The urinary elimination rate fluctuated over the first 10 days, but decreased progressively thereafter. In clearance experiments with low lead infusion (4 μg/min), renal reabsorption accounted for nearly all the filtered lead load, and salivary secretion was in the order of 1 ng/min. Experiments with renal and salivary tissue fragments indicated maximal accumulation in both tissues. In contrast with salivary tissue uptake, the renal accumulation of lead decreased in the presence of KCN and 2,4-dinitrophenol, and in Na^+-deficient media. Renal lead uptake therefore contains an important energy-dependent component. *In vitro* evidence that the lead transport mechanisms of the kidney and salivary glands are fundamentally different is consistent with the results of this pharmacokinetic study. The resemblance between the early profile of salivary lead secretion and its disappearance from the blood indicates that salivary glands represent diffusion barriers for the metal, in contrast to the kidney, where lead uptake may be controlled by energy and metabolism-dependent mechanisms.

Lead Distribution in Winnipeg as Reflected by City Area Dogs.

KUCERA, E.
Terrestrial Standards and Studies Section, Environmental Management Division, Department of Environment and Workplace Safety and Health, Winnipeg, Manitoba.
Terrestrial Standards and Studies Report 83-10, 20 pp., 1983.

Lead levels in 480 samples of dog blood were determined by atomic absorption. 95% of the samples had lead levels < 8 μg/dL, with dogs living in areas with a high traffic density showing higher blood lead levels than dogs living in areas with less traffic. It is suggested that surveys of blood lead levels in dogs is a feasible, low-cost alternative to large-scale surveys of humans in non-occupational situations.

INDUSTRIAL/OCCUPATIONAL EXPOSURE.

An analysis of occupational blood lead trends in Manitoba, 1979 through 1987.

YASSI, A., CHEANG, M., TENENBEIN, M., BAWDEN, G., SPIEGEL, J. & REDEKOP, T.
Depts. of Community Health Sciences, Pediatrics, Pharmacology and Biostatistical Consulting Unit, University of Manitoba, Winnipeg, Manitoba/Div. Workplace Safety & Health, Manitoba Dept. Labour, Winnipeg/Manitoba Dept. Environment, Winnipeg.
American J. Public Health 81(6): 736-740 (1991).

An analysis of 10,190 blood lead samples collected from employees of 10 high-risk workplaces in Manitoba between 1979 and 1987 was conducted as part of regulated occupational surveillance. A significant decrease in blood lead levels

was observed overall as well as for each individual company following 1979 government regulation to reduce blood lead levels to below 70 μg/dL; a similar government intervention in 1983, to further reduce lead in blood to 60 μg/dL was not followed by such a decrease. Industrial hygiene investigation revealed that after the first government intervention, some hygiene and/or engineering controls were implemented in all the companies involved, but that thereafter, companies complied with the regulation by using administrative controls (removing workers to areas of lower lead levels until the blood levels had fallen, and then returning them to areas with high lead levels).

Designated Substance Assessment. Worker Exposure to Inorganic Lead in Five Schools Near Secondary Lead Smelters.

A.J. CHANDLER & ASSOCIATES LTD.

Willowdale, Ontario.

A Report to the Board of Education of the City of Toronto, prepared by A.J. Chandler & Assoc. Ltd. in conjunction with Concord Environmental Corporation and Gore & Storrie Ltd., 15 pp., 1991.

South Riverdale and the Niagara Neighbourhood areas of Toronto have experienced a problem of lead contamination in soil and dust for many years. A lead dust reduction program was conducted at 5 Toronto Board of Education schools in 1989. Because of the concern for long term exposure to lead, assessment programs have continued in these areas. This report outlines the Board of Education's assessment of staff exposure to inorganic lead in these 5 schools. Included is a discussion of the potential toxicants, locations of lead dust reservoirs as well as the results of an inspection of the workplace (1990-1991), air sampling, and staff medical examinations. The study concludes that a formal lead control program is not required in the schools, but that personal hygiene should be encouraged as the best defence against the ingestion of lead. Included as an appendix is a detailed description of the air and dust sampling program for the determination of inorganic lead in the 5 Toronto Board of Education schools.

Evaluation of exposures to chemical and physical agents in radiator repair shops.

SAMPSON, S.S.

Nova Scotia Department of Labour, Halifax, Nova Scotia, Canada.

Applied Occupational and Environmental Hygiene 6(4): 266-270 (1991).

The Nova Scotia Department of Labour conducted a survey in the summer of 1988 on the occupational health and hygiene aspects of the radiator repair industry. The survey examined lead levels, as well as exposures to gasoline, silica, corrosives and heat amongst the workers of 19 shops (males only were employed in the radiator repair process). The results indicated that both airborne and blood-lead levels were generally within the regulatory standards in Nova Scotia. However, the airborne lead levels were often in excess of the U.S. Occupational Safety and Health Administration standards. No significant relationship was found between blood-lead levels and either smoking habits or ventilation design. The survey did indicate that exposures to gasoline, silica, corrosives, and heat could have adverse health effects. Based on the survey results, the Department of Labour concluded that industry-wide, mandatory working procedures are not required for radiator repair shops. Instead, detailed information and guidance were given to all shop owners.

Lead: age old hazard, age old problem.

KOSTYNIUK, B.

Occupational Health & Safety Magazine 13(2): 16-18 (1990).

(Paper not available for abstracting).

[Lead, this very old enemy.]
LEVESQUE, H.
Prévention au Travail 3(6): 9-10 (1990) (in French).

(Paper not available for abstracting).

[Monitoring of blood lead levels during decontamination and soil restoration.]
CHAGNON, M. & BERNIER, C.
Travail et Santé 6(2): 27-29 (1990) (in French).

(Paper not available for abstracting).

Lead toxicity in the shipbreaking industry: the Ontario experience.
NOSAL, R.M. & WILHELM, W.J.
Ontario Ministry of Labour.
Canadian J. Public Health 81: 259-262 (1990).

Occupational exposure to lead was investigated at the 4 shipbreaking operations in southern Ontario between 1984 and 1987. Lead exposure occurs during ship demolition when the ship structure has been previously coated with lead-based paint, and is primarily the result of exposure to lead fumes created during the burning/cutting of the metal. Air sampling results for lead were above the Ontario standard at all locations, and 30% of the workers (34/113) had blood lead levels above 70 μg/dL. The introduction of control measures (use of appropriate respirators and hygiene practices, worker education and training, and blood lead monitoring) reduced employee lead exposure and lowered blood lead levels.

A controlled investigation of the effects of industrial exposure to lead on frontal lobe function.
GILBERT, B., BRAUN, C.M.J. & DAIGNEAULT, S.
Dept. Psychology, Univ. Quebec, Montreal, Quebec.
Abstract. J. Clinical and Experimental Neuropsychology 12(1): 55 (1990).

51 heavily exposed male workers and ex-workers from a secondary lead foundry and 37 unexposed male workers or ex-workers were tested for 18 different parameters in frontal neuropsychological tests, of which only Simple Reaction Time indicated any impairment of the lead-exposed workers relative to the unexposed controls.

Lead titanate zirconate exposure. - Letter to the editor, and a reply from the authors (Roy et al.).
WEISS, R.J.
Medical Director, E.I. Du Pont de Nemours & Co., Chambers Works, Deepwater, N.J., US.
J. Occupational Medicine 32(7): 645-646 (1990).

Roy et al.'s conclusions (see below) regarding the low toxicity of lead titanate zirconate (LTZ) following occupational exposure are criticized, especially with reference to the lack of mortality/cancer epidemiological studies, as well as lifetime maximum tolerated dose inhalation studies on LTZ.

Health hazards in mineral assay laboratories.

BROWN, D.A.
Ontario Health and Safety Support Services Branch, Ontario Ministry of Labour.
Occupational Health in Ontario 10(3): 122-130 (1989).

The results of an occupational hygiene survey of 14 mineral assay labs carried out by the Health and Safety Support Services Branch (HSSSB) of the Ministry of Labour demonstrate that the potential for exposure to lead and silica exists in these labs. The laboratories have been advised of these potential health hazards.

Worker exposure to lead titanate zirconate in an Ontario company.

ROY, M.L., SIU, S., WADDELL, W. & KENNEDY P.
Health & Safety Support Services Branch, Ontario Ministry of Labour, Toronto, Ontario.
J. Occupational Medicine 31(12): 986-989 (1989).

Workers at an Ontario plant producing and using lead titanate zirconate (LTZ), a ceramic compound containing approximately 60% Pb used in the manufacture of sonar equipment, were examined for symptoms of lead exposure. The airborne lead levels in the plant greatly exceeded the Ontario standard. Although the dust in the plant was of respirable size and hygiene and work practices were poor, studies of the blood lead levels of the 101 workers showed that only those exposed to lead oxide at the beginning of the process had elevated blood lead levels. 82 workers who had been exposed to LTZ but not lead oxide showed normal blood lead levels. The authors postulate that the observed low toxicity of LTZ could be due to its low solubility in body fluids.

A generalized model for the prediction of lead body burdens.

BERT, J.L., VAN DUSEN, L.J. & GRACE, J.R.
Dept. Chemical Engineering, University of British Columbia, Vancouver, B.C.
Environmental Research 48(1): 117-127 (1989).

A compartmental model for lead intake, distribution and transport has been developed, based on previous pharmacokinetic models and experimental results for lead in the human body. Lead levels in blood, bone and other compartments following exposure via inhalation and/or ingestion are predicted as a function of time by solving a set of first-order, linear ordinary differential equations with constant coefficients.

Lead absorption resulting from exposure to lead naphthenate.

BAWDEN, G. & TENENBEIN, M.
Manitoba Dept. Environment & Workplace Safety & Health/Faculty of Medicine, University of Manitoba, Winnipeg, Manitoba.
Letter to the Editor. J. Occup. Med. 30(5): 458 (1988).

Letter to the Editor regarding a report by Goldberg et al. (1987) describing excessive lead absorption from industrial exposure to lead naphthenate. Bawden & Tenenbein speculate that it was the inhalation of lead naphthenate combustion products rather than of the lead naphthanate itself that produced the lead toxicity.

Ceramic glazer presenting with extremely high lead levels.
OOI, D.S. & PERKINS, S.L.
Division of Biochemistry, Ottawa Civic Hospital, Ottawa/Dept. Biochemistry, University of Ottawa, Ottawa, Ontario.
Human Toxicology 7(2): 171-174 (1988).

A case of lead poisoning in a ceramic glazer is reported. The patient had an extremely high blood lead level (29.5 μmol/L), and displayed many of the laboratory features of lead toxicity: normocytic anaemia with marked basophilic stippling, abnormal blood and urinary porphyrins, and elevated liver enzymes. Surprisingly, the patient had no electromyographic evidence of neurologic involvement. The patient was treated with intravenous EDTA-calcium followed by oral penicillamine. Urinary porphyrin and porphyrin precursor excretion followed an interesting pattern, correlating with the chelator used. This patient illustrates that extremely high blood lead levels can be achieved in adults by the oral route.

Health Effects of Inorganic Lead with an Emphasis on the Occupational Setting: An Update.
NEARING, J.N.
Medical Consultant, Health Studies Service, Ontario Ministry of Labour, Toronto.
Ontario Ministry of Labour, Toronto, 143 pp., 1987.

This report was designed to update the previous health effects document included in the Report on the Designation of Lead in Ontario prepared by the Occupational Health and Safety Division, Ministry of Labour, in 1981. Some earlier literature is cited in the update, but the emphasis is on post-1980 data, with inclusion of material up to August, 1986. The document does not review all of the literature available on lead exposure, but focuses on human studies directly relevant to the worker in an occupational setting. Where human studies are limited in number or are unavailable, unclear, or inadequate to suggest a dose-response relationship, relevant experimental animal research has been considered. The source of information is peer-reviewed published medical and scientific literature. Relevant papers are not only cited but also critically appraised. In addition to original research, scientific reviews are also examined and their conclusions discussed.

[Ventilation in Radiator Repair Shops.]
NGUYEN, VAN HIEP.
Institut de Recherche en Santé et en Securité du Travail du Québec, Montréal, Québec.
M. Sc. Thesis, Université du Québec à Trois Rivières, Trois Rivières, 1987 (in French).

Inadequate ventilation practices were noticed in radiator repair shops, resulting in workers' exposure to lead. A more adequate ventilation system prototype was developed in the laboratory, and when tested both in the laboratory and the workplace, it proved to be more effective. The results of this study are being used by the sector's joint commission to prepare guidelines for ventilation in radiator repair shops.

Problems in the Lead-Acid Battery Recycling Industry.
TONOLLI CANADA LIMITED.
Presented by Tonolli Canada Limited to the Ontario Ministry of the Environment, Education Seminar, Sepember 11, 1986.

A presentation paper discussing the problems associated with the recycling of lead-acid batteries from the industry's perspective.

Guideline for Medical Monitoring of Workers Exposed to Inorganic Lead.
Alberta Workers' Health, Safety and Compensation. Medical Services Branch.
Alberta Workers' Health, Safety and Compensation, Edmonton, Alta., 11 pp., 1986.

Lead is a common heavy metal found in many inorganic salts and organic compounds. The most common lead ore (galena) is primarily PbS. The most common organic form of lead is tetraethyl lead (TEL), found in "leaded" gasoline. Organic and inorganic lead differ somewhat in their toxicology. There is limited occupational exposure to organic lead in Alberta, and the bulk of this document deals only with exposure to inorganic lead. Potential exposure to lead dust and fumes occurs in a vast number of occupations and industries including battery production, radiator shops, welding and ceramics. Although decreased use of lead in paints and fuel has substantially reduced exposure, lead poisoning still occurs more commonly than realized.

Smelter sets its sights on lead-free air.
Crandall, E.
OH&S Canada 2(1): 24-26 (1986).

Brunswick smelter has invested $15 million over a 15-year period to clean up its air that was once dense with lead dust and fumes. The investment has however paid-off in reduced lead-in-air levels and fewer employee relocations and worker compensation cases.

Effects of low-level lead and arsenic exposure on copper smelter workers.
LILIS, R., VALCIUKAS, J.A., MALKIN, J. & WEBER, J.P.
Environmental Sciences Laboratory, Dept. Community Medicine, Mount Sinai School of Medicine, N.Y./Centre de Toxicologie du Québec, Centre Hospitalier de l'Université du Québec.
Archives of Environmental Health 40(1): 38-47 (1985).

An analysis of reported symptoms and their relationship with indicators of lead absorption - blood lead (Pb-B) and zinc protoporphyrin (ZPP) - and of arsenic absorption - urinary arsenic (As-U) - was undertaken among 680 active copper smelter workers. Lead absorption in the copper smelter employees was characterized by the median value of 30.4 μg/dL for Pb-B and 41.5 μg/dL for ZPP. Blood lead levels of 40 μg/dL or higher were observed in 16.7%, and ZPP was 50 μg/dL or higher in 31.2% of cases of currently active smelter workers. The number of reported symptoms (from a total of 14 symptoms) increased with ZPP levels; the relationship with Pb-B was less marked. Mean Pb-B, ZPP, and As-U levels for subjects reporting each of the 14 symptoms were compared with those of subjects not reporting the symptoms. Mean Pb-B was found to differ significantly for one symptom, fatigue. Significant differences in mean ZPP levels were found for fatigue, sleep disturbances, weakness, paresthesia, and joint pain. Prevalence rates for these symptoms rose more markedly with increased ZPP than with Pb-B levels. The results indicate a relationship between certain CNS and musculo-skeletal symptoms and the increased lead absorption in this population. Adherence to exposure standards that preclude undue lead absorption and appropriate biological monitoring, including ZPP levels, are necessary to prevent adverse, especially long-term, health effects.

Health effects of low level occupational exposure to lead: The Trail, British Columbia Study.

NERI, L.C., HEWITT, D. & JOHANSEN, H.
Dept. Epidemiology & Community Medicine, University of Ottawa, Ottawa, Ontario/Dept. Epidemiology & Biostatistics, University of Toronto, Toronto, Ontario/Bureau of Epidemiology, Health & Welfare Canada, Ottawa, Ontario.
Archives of Environmental Health 38(3): 180-189 (1983).

Blood lead levels were measured in 245 lead smelter employees and their wives in Trail, B.C. and in 144 controls in Nelson, B.C. Average blood lead levels for smelter workers were 41, 33 and 16 μg/dL for directly-exposed, indirectly-exposed and office workers respectively, reflecting exposure level. Male smokers had significantly higher blood lead levels than non-smokers.

Occupational exposure to lead in ancient times.

NRIAGU, J.O.
National Water Research Institute, Burlington, Ontario.
Science Total Environment 31(2): 105-116 (1983).

A summary of the uses and regional production of lead in ancient times. There is no evidence to assume that any deliberate attempts were made to curtail personal exposure to the mine dusts or the emissions from the forges and crucibles, suggesting that many of the ancient artisans who worked with lead probably developed plumbism. It is estimated that over 140,000 workers per year were so exposed during the Roman Empire. However, the ancient literary records of work-related plumbism are surprisingly sparse.

Relationships between three indicators of lead exposure in workers: Blood lead, delta-aminolevulinic acid and free erythrocyte protoporphyrin.

LABRECHE, F. & P'AN, A.
Dépt. Santé Communautaire, Centre Hospitalier Maisonneuve-Rosemont, Montréal, Québec/Dept. Méd. du Travail et d'Hygiène du Milieu, Faculté de Médecine, Université de Montréal, Québec.
Int. Arch. Occup. Environ. Health 51(1): 35-44 (1982).

Values of free erythrocyte protoporphyrin and urinary delta-aminolevulinic acid were compared with blood lead levels in Canadian workers subjected to a wide range of lead exposures: 48 controls, 121 steel workers exposed to 0.003-0.093 mg/m^3, 40 battery factory workers exposed to 0.04-4.25 mg/m^3, and 35 secondary lead smelter workers exposed to 0.13-7.72 mg/m^3. Blood and urine samples were taken from exposed and non-exposed workers, and analyses of lead and free erythrocyte protoporphyrin (in blood) and delta-aminolevulinic acid (in urine) were performed. Mean blood lead levels were 0.19-0.25 μg/ml in controls and steel workers, 0.67 μg/ml in battery workers and 0.81 μg/ml in smelter workers, with 78 and 97% of workers in the 2 latter groups having blood lead levels greater than 0.60 μg/ml. The mean delta-aminolevulinic acid level was 2.5-3.0 μg/ml in controls and steel workers, 6.8 μg/ml in battery workers and 11.8 μg/ml in smelter workers, while mean free erythrocyte protoporphyrin was 0.55-0.56, 5.67 and 7.15 μg/ml respectively. The authors conclude that a cut-off point of 4 μg/ml urinary delta-aminolevulinic acid should be considered a warning signal of lead exposure, while a cut-off point of 1 μg/ml free erythrocyte protoporphyrin serves as an indication of chronic exposure to lead. Erythropoiesis may be impaired at blood lead levels of 0.50 μg/ml, the current ACGIH limit for lead in blood.

Lead levels in indoor pistol ranges.

WADDELL, W.R.
Ontario Ministry of Labour, Occupational Health Branch, Kingston, Ontario.
Occupational Health in Ontario 3(4): 198-205 (1982).

High air lead levels were almost universally found in a survey of the indoor pistol ranges in eastern Ontario. The blood lead levels in exposed range personnel were generally found to be low. Recommendations are made with regard to the practical control of lead hazard in such ranges.

Exposure-based case control approach to discovering occupational carcinogens: Preliminary findings.

SIEMIATYCKI, J., GERIN, M. & HUBERT, J.
Centre de Recherche en Epidemiologie et Médecine Préventive, Institut Armand-Frappier, Laval-des-Rapides and Dept. Epidemiology & Health, McGill University, Montreal, Quebec/Dépts. Médecine du Travail et d'Hygiène du Milieu & Chimie, Université de Montréal, Québec.
In: Peto, R. & M. Schneiderman, Eds. *Quantification of Occupational Cancer.* Banbury Report #9, Cold Spring Harbor Laboratory, pp. 471-481 (1981).

An exposure-based case-control methodology for detecting occupational carcinogens was evaluated in the preliminary results of a cancer study among a group of Canadian males aged 35 to 70 living in Montreal. Target subjects were incident cases of cancer of the esophagus, stomach, colon, pancreas, lung, melanoma of the skin, prostate, bladder, kidney and lymphoid tissue. Using a checklist of chemical and physical agents, job exposures were estimated from work histories by chemist/engineers familiar with industrial conditions. Preliminary results indicated certain associations between specific cancers and jobs. For example, auto mechanics and repairmen had the highest rate of stomach cancer, while lung cancer was associated with road work, railway transport and water transport. Specific exposures to leather and gasoline were associated with stomach cancer. Carbon monoxide, lead and smoke were related to colon cancer. The authors concluded that the practical aspects of the pilot exposure-based case-control study are feasible.

HEALTH EFFECTS OF EXPOSURE TO LEAD/BLOOD LEVELS.

[Study on the risk factors of lead poisoning in three groups of children aged 6 to 24 months.]

LEVALLOIS, P., RHAINDS, M., TURGEON O'BRIEN, H. ET AL.
Service Santé et Environnement, Département de Santé Communautaire, Centre Hospitalier de l'Université Laval, Ste-Foy, Québec.
Proposal for a new study to begin August, 1992.

The main objectives of this study are to assess the impact of lead-containing paint and contaminated first-draw water on the blood lead levels of young children. The survey will be carried out between August 1992 and March 1994, and will involve approximately 500 infants between the ages of 6 and 24 months. Children receiving vaccinations in any of the participating CLSC Centres will be invited to participate in the survey, and blood samples for the analysis of lead and iron will be drawn. An environmental and medical follow-up will be conducted in the children exhibiting iron deficiency or high blood lead levels.

Update of Evidence for Low Level Effects of Lead and Proposed Blood Lead Intervention Levels and Strategies.

LEAD WORKING GROUP, CHAIRMAN: M.J. INSKIP.
Health & Welfare Canada, Ottawa, Ontario.
Draft Final Report to the Canadian Federal/Provincial Advisory Committee on Environmental and Occupational Health, 1992.

CONFIDENTIAL. Not available for abstracting.

Sampling of cortical and trabecular bone for lead analysis: method development in a study of lead mobilization during pregnancy.

INSKIP, M.J., FRANKLIN, C.A., SUBRAMANIAN, K.S., BLENKINSOP, J. & WENDELMAIER, F.
Environmental & Occupational Toxicology/Monitoring & Criteria, Health & Welfare Canada, Ottawa, Ontario.
Submitted for publication to Neurotoxicology, 1991.

(Not available for abstracting.)

Childhood lead exposure in Trail revisited.

HERTZMAN, C., WARD, H., AMES, N., KELLY, S. & YATES, C.
Occupational & Environmental Health Division, Dept. Health Care & Epidemiology, University of British Columbia/Central Kootenay Health Unit, Castlegar, B.C.
Canadian J. Public Health 82: 385-391 (1991).

A survey of blood lead levels in 435 preschool children (2-5 years old) living in Trail, B.C. was conducted during August/September, 1989. An average blood lead level of 13.8 μg/dL (range 4-30 μg/dL) was obtained, approximately 40% lower than that seen in the 1975 survey. In Phase 2 of this study, environmental samples of drinking water, paint, housedust, soil and vegetables from the childrens' homes, as well as soil samples from nearby parks were collected and analysed for lead content. Soil lead levels and, secondarily, housedust lead levels were found to be the principal determinants of high blood lead levels, with children living in neighborhoods near the lead-zinc smelter showing the higher blood lead levels.

Lead poisoning in children. - An analysis of the causes and proposals for prevention.

MARTIN, D.
Public Health Inspector, Mississauga, Ontario.
J. Environmental Health 54(1): 18-19 (1991).

The realization in recent years that low-level lead exposure may have a negative impact on the health and development of children prompted the author to discuss the possible sources of lead contamination, as well as the different approaches that can be taken when designing prevention programs.

Blood lead levels in children and pregnant-women living near a lead-reclamation plant.

LEVALLOIS, P, LAVOIE, M., GOULET, L., NANTEL, A.J. & GINGRAS, S.
Dépt. Sante Communautaire, CHU Laval, Ste-Foy, Québec/Ctr. Toxicol. Québec, Ste-Foy, Québec/Dépt. Médicine Sociale & Prévent., Univ. Montréal, Québec/CHU Laval, Dept. Community Health, Ste-Foy, Quebec/Dept. Community Health, Hôpital du Haut-Richelieu, St-Jean, Quebec.
Canadian Medical Association J. 144(7): 877-885 (1991).

The objective of this study was to determine the effect of lead contamination from a lead-reclamation plant on the blood lead levels of children aged 10 years and under as well as pregnant women living in the area. The blood levels of the 38 women who participated in the study were low (0.15 and 0.13 μmol/L for the high-exposure and "other" areas respectively). Within each age group, children in the high-exposure area had the highest levels. The mean levels for children aged 6 months to 5 years were 0.49, 0.35 and 0.28 μmol/L in the high-exposure and two "other" areas respectively. Within each exposure group, children aged 1 to 2 years had the highest levels. No potential confounding variables could explain the relationship between blood lead level and soil lead concentration. The pregnant women's blood lead levels did not seem to be affected by exposure level, but the children's levels were primarily related to the soil lead concentration.

Lead exposure among mothers and their newborns in Toronto.

KOREN, G., CHANG, N., GONEN, R., KLEIN, J., WEINER, L., DEMSHAR, H., PIZZOLATO, S., RADDE, I. & SHIME, J.
Chemistry Section, Laboratory Services Branch, Ontario Ministry of Health/Motherisk Program, Dept. Pediatrics, Division of Clinical Toxicology & Pharmacology, Hospital for Sick Children/Dept. Obstetrics & Gynecology, Research Institute, Hospital for Sick Children/Dept. Obstetrics & Gynecology, Women's College Hospital/Depts. of Pediatrics, Pharmacology and Obstetrics & Gynecology, University of Toronto, Toronto, Ontario.
Can. Med. Assoc. J. 142(11): 1241-1244 (1990).

Maternal and umbilical cord blood levels of lead and free erythrocyte protoporphyrin (FEP) were measured among 95 Toronto mother-infant pairs, and a significant correlation was observed ($r=0.59$, $p < 0.0001$) between maternal and cord blood lead levels. 99% of the infants had cord blood lead levels below 0.34 μmol/L, while the cord blood FEP levels were higher than the maternal levels. The authors concluded that living in Toronto does not increase the risk for teratogenic effects due to intrauterine exposure to lead, although residents in high-risk areas should be followed up.

Does lead poisoning occur in Canadian children?

Tenenbein, M.
Depts. of Pediatrics and Community Health Sciences, University of Manitoba, Winnipeg, Manitoba.
Can. Med. Assoc. J. 142(1): 40-41 (1990).

The article discusses two separate case reports of toddlers admitted to hospital and diagnosed with lead poisoning caused by ingestion of paint chips peeling from the walls and window sills of their inner city homes. In both cases, the toddlers exhibited high lead levels in blood (4.05 μmol/L) and urine (1320 μg/L) respectively, and underwent chelation therapy. Follow-up of their development several years later revealed some degree of mental retardation in both cases. The author notes that the prevalence of neurotoxic lead levels in asymptomatic children is unknown in Canada, and suggests that sound epidemiological studies of blood lead levels involving children living in Canadian inner city areas be carried out, in order to define the extent of lead poisoning from lead-based paint.

Transplacental transport of lead.
GOYER, R.A.
Department of Pathology, University of Western Ontario, London, Ontario.
Environmental Health Perspectives 89: 101-105 (1990).

An overview is given of the available information on the mechanisms for the transplacental transport of lead and of the factors that may influence it, as well as a discussion of possible experimental models for the further study of lead effects *in utero*.

[Results of the epidemiological survey carried out in St-Jean-sur-Richelieu subsequent to environmental lead contamination.]
GOULET, L., TREMBLAY, Y., MESSIER, A., LEVALLOIS, P., LAVOIE, M., NANTEL, A. & GINGRAS, S.
Département de Santé Communautaire, Hôpital du Haut-Richelieu, St-Jean-sur-Richelieu, Québec.
In: [*Complementary Reports and Annexes to the Report on the Activities Coordinated by the Department of Community Health of the Haut-Richelieu Hospital.*], Vol. II, 1990 (in French).

In August 1989, the Quebec Ministry of the Environment conducted soil analyses on samples collected from residential neighbourhoods located in the vicinity of Balmet Canada, and identified a zone heavily contaminated by lead. Following these findings, an epidemiological survey designed to evaluate the impact of the environmental contamination on the health of the population was conducted. The survey found that children living in the vicinity of the plant presented signs of over-exposure, and in some sectors the blood lead levels of children aged 6 months to 5 years were comparable to those found in South Riverdale, Ontario in 1985. Inspection of the homes of children with elevated blood lead levels confirmed that contaminated dust was a major source of exposure.

Trail Lead Study Report.
HERTZMAN, C., AMES, N., WARD, H., KELLY, S. & YATES, C.
Division of Occupational & Environmental Health, Dept. Health Care & Epidemiology, University of British Columbia.
Report submitted to the B.C. Ministries of Health and the Environment, 26 pp., 1990.

A study of lead in the Trail region of British Columbia was conducted in 1989. The first phase of the study involved the collection of blood samples from all children between the ages of 2 and 6. In Phase 2, those children in the highest and lowest quartile of blood lead levels were followed up with a questionnaire survey, and residential environmental samples of drinking water, paint, housedust, soil and vegetables were collected. The study revealed that the mean blood level among the children was 13.8 μg/dL (range 4-30 μg/dL). This is a significant decrease from the late 1970's, but is still high compared to other studies. The environmental determinants of lead revealed that soil lead levels and secondarily, housedust lead levels are the principal determinants of high blood lead in children in Trail. Children with high blood levels tend to concentrate in certain neighborhoods, designated as area 3 in this report. The data from this study were used to develop a number of recommendations for a lead remediation program in the Trail area.

Blood Lead Levels in Vancouver Children. - October-December, 1989. Executive Summary.
JIN, A., HERTZMAN, C. & PECK, S.
Community Medicine, Dept. Health Care & Epidemiology, University of British Columbia.
Draft Summary Report, March 1990.

In the fall of 1989, a study of blood lead levels in 172 Vancouver children aged 24 to 36 months old was conducted in order to assess the risk to Vancouver children resulting from environmental lead contamination. The study found that the frequency distribution of blood lead levels was log-normally distributed, with a geometric mean of 5.3 μg/dL, a value much lower than expected when compared with the results of a similar survey in Ontario children in 1984. Possible explanations for the lower than expected lead levels in Vancouver children include: the steady decline in lead emissions in Canada (largely as a result of the decline in the use of leaded gasoline); seasonal variations in exposure, as cold wet weather prevents children from playing outside and coming into contact with contaminated dirt, as well as reducing the dust dispersion in the urban environment; and the presence of fewer heavy industries in Vancouver as compared to Toronto and Windsor.

[Study of Lead Absorption in a High Risk District in the Municipality of Rouyn-Noranda, Quebec.]

LETOURNEAU, G. & GAGNE, D.
Report prepared for the Département de Santé Communautaire du Conseil Régional de la Santé et des Services Sociaux de l'Abitibi-Témiscamingue, Rouyn-Noranda, Québec, 90 pp., 1990.

The purpose of this study was to establish the blood lead levels of 2-5 year old children living in a district of Rouyn-Noranda, Quebec adjacent to the Minéraux Noranda smelter . The study showed that of 117 children tested, more than 50% had blood lead levels higher than 10 μg/dL, and 2 had levels in excess of 25 μg/dL, a level that the US Center for Disease Control (CDC) at that time considered indicative of lead overexposure in children (*Note: In October 1991 the CDC revised the 1985 intervention level downwards to 10 μg/dL*). Analyses of soil samples collected from the region confirmed that the soil was contaminated with lead, and in some places the lead levels in soil were above the Quebec Ministry of the Environment Criteria of 600 ppm. The report discusses the different alternatives for the decontamination of the region, as well as emphasizing the existence of sources of lead other than smelter emissions, i.e. motor vehicles emissions and lead-based paint used in the homes.

Survey of blood lead levels from children exposed to lead-contaminated soil at a former oil refinery site.

AUDETTE, R.J., WALKER, K., & FRIESEN, B.T.
University of Alberta Hospitals, Edmonton, Alberta/Calgary Board of Health, Calgary, Alberta.
Abstract. Ann. Clin. Lab. Sci. 20(4): 294-295 (1990).

Blood levels were measured on 100 children aged 1-15 years who had been potentially exposed to lead-contaminated soil while living in a residential area established on the site of a former oil refinery storage tank. The results indicated that blood lead levels were within the normal background range (mean = 6.2 μg Pb/dL, range = 3.1-15.5 μg Pb/dL), with no indication of lead poisoning.

Blood Lead Concentrations and Associated Risk Factors in a Sample of Northern Ontario Children, 1987.

GOSS, GILROY & ASSOCIATES LTD.
Management and Statistical Consultants, Ottawa.
Report prepared for the Ontario Ministries of Health and the Environment, 96 pp., 1989.

The purpose of this study was to determine the blood lead levels of a selected population of Northern Ontario children aged 3 to 6 years, and to identify any demographic, environmental and lifestyle characteristics associated with higher

blood lead levels. The overall arithmetic mean of the blood lead levels was 7.6 μg/dL, with two children showing levels above the 20 μg/dL alert level. Upon retesting, these two individuals were also found to have normal blood lead levels. Boys were found to have slightly higher levels than girls, but no age-dependent difference in levels was observed. Blood lead levels were highest in urban and remote regions, followed by towns and rural regions. Analysis showed no apparent reason for the higher levels in the remote region. A statistically significant correlation was found between blood lead levels and lead levels in air, soil and residential drinking water; an association was also found between socio-economic status of the parents and blood lead levels.

Blood lead screening in Ontario children: blood lead and free erythrocyte protoporphyrin levels.

WANG, S.T., PIZZOLATO, S. & DEMSHAR, H.P.
Biochemistry Section, Laboratory Services Branch, Ontario Ministry of Health, Toronto, Ontario.
Sci. Total Environ. 89: 251-259 (1989).

A blood lead survey on samples from 2459 children aged 3-6 years in the Province of Ontario found incidence of lead poisoning in 26 subjects (1.1% of the samples showed blood levels > 25 μg Pb/100 ml). The mean blood lead level was 0.50 μmol/L for children from southern Ontario as compared to 0.37 μmol/L for children from northern Ontario. The free erythrocyte protoporphyrin levels were also monitored to detect the presence of iron deficiency in the children.

Lead concentrations in human bones from the Canadian population.

SAMUELS, E.R., MERANGER, J.C., TRACY, B.L. & SUBRAMANIAN, K.S.
Environmental Health Centre, Health Protection Branch, Health & Welfare Canada, Ottawa, Ontario.
Sci. Total Environ. 89: 261-269 (1989).

Lead was determined in post-mortem samples of human bones (both sexes and all age groups were included) from Winnipeg, Montreal and Charlottetown. Mean lead levels were 8.98, 11.11 and 8.47 μg Pb/g ash) respectively, with values ranging from 0.45 to 240.07 μg Pb/g ash, and the highest levels being found in the > 20-year age group. Higher than average levels were observed in samples obtained from Winnipeg for 1976-1980, particularly in the 1-4-year age group, which correlated well with the observed air lead concentrations for that period in Winnipeg.

Blood lead and associated risk factors in Ontario, Canada children.

O'HEANY, J., KUSIAK, R., DUNCAN, C.E., SMITH, J.F., SMITH, L.F. & SPIELBERG, L.
Ontario Ministries of Labour (Special Studies & Services), Health & the Environment, Toronto, Ontario.
Sci. Total Environ. 71(3): 477-484 (1988).

The purpose of this study was to determine blood lead levels in Ontario children and to identify the risk factors associated with higher blood lead levels. A random sample of 1315 children aged 7 and younger from urban, suburban and rural Ontario was selected. Blood lead levels were determined in finger prick blood samples by graphite furnace atomic absorption spectrophotometry. Measurement of lead in air, tap water, soil and gasoline were also established. The traffic pattern was also determined in each area. A questionnaire was given to a random sample of 800 families of the children tested to assess the presence of other risk factors. Urban children had statistically significant higher blood lead levels (geometric mean=12.02, S.D.=4.4 μg/dL) than suburban children (geometric mean=9.95, S.D.=3.5 μg/dL), who in turn had higher blood lead levels than rural children (geometric mean=8.91, S.D.=3.9 μg/dL). Blood

lead levels were slightly higher for males than females and for pre-schoolers aged 3 and 4 compared to school age children aged 5 and 6. The blood lead levels of these children were significantly lower than those of children surveyed near a point source of industrial emissions. All of the environmental measures were related to the presence of lead in the air, and the major contributor to air lead in the areas tested was lead in gasoline. When "site" is controlled for, univariate analysis showed that socio-economic status, younger age and male sex were associated with higher blood lead levels.

[Lead intoxication during indoor shooting: problematics and risk assessment.]

TOUGAS, G. & TREMBLAY, M.

Travail et Santé 4(1): S4-S7 (1988) (in French).

An indoor firing range was investigated following the findings of two cases of lead poisoning amongst sportsmen. Poor ventilation was indicated by the finding that the levels of airborne lead were up to 10 times the maximum permissible level of 0.45 mg/m^3. Blood lead levels and free erythrocyte protoporphyrin (FEP) were measured in 17 other people attending the range for more than 3 hours/week. More than half of the blood lead level measured exceeded 300 μg/L. These results illustrate the need for adequate ventilation, even for sportsmen who are only subjected to short term exposure to lead.

A Compendium of Current Practices in Canada for the Management of Blood Lead in Excess of Prescribed Limits.

HEALTH & WELFARE CANADA.

Environmental Health Directorate, Health Protection Branch, Health & Welfare Canada, Ottawa, Ontario.

Minister of Supply & Services Canada, 24 pp., 1988. (Publication 88-EHD-140).

This report summarizes the responses to two questions which were addressed to lead experts from the 10 Provinces, 2 Territories and the Federal Government: 1) What are the current practices in your jurisdiction for dealing with the problem of lead found in blood above the acceptable level? and 2) What treatment(s) is (are) employed in response to what you would consider excessive levels of lead in blood? Three provinces (New Brunswick, Newfoundland and PEI) reported that at the time of writing, no Provincial policy was in place for the treatment of blood levels above acceptable levels. All other provinces provided summaries of their usual treatment practices, which generally include removal of the individual from the source, biological monitoring, and in some extreme cases, the administration of EDTA or similar chelating agents.

Monitoring and Intervention Programs for Lead Exposure in the General Population and in Occupational Groups: the Situation Outside Canada.

INSKIP, M.J.

Environmental & Occupational Toxicology, Health & Welfare Canada, Ottawa, Ontario.

Report to the Minister of Health & Welfare Canada, 1988.

(Report not available for abstracting).

Blood Lead Monitoring and Intervention Programmes: the Needs and Resources of the Provinces and Territories in Canada.
INSKIP, M.J.
Environmental & Occupational Toxicology, Health & Welfare Canada, Ottawa, Ontario.
Report to the Minister of Health & Welfare Canada, 1988.

(Report not available for abstracting).

Multimedia Exposure Assessment for Lead.
INSKIP, M.J.
Environmental & Occupational Toxicology, Health & Welfare Canada, Ottawa, Ontario.
Report to the Minister of Health & Welfare Canada, 1988.

(Report not available for abstracting).

The Human Health Impacts of Lead.
INSKIP, M.J.
Environmental & Occupational Toxicology, Health & Welfare Canada, Ottawa, Ontario.
Report to the Minister of Health & Welfare Canada, 1988.

(Report not available for abstracting).

Review of the Recent Evidence Concerning the Health Effects of Low-Level Lead Exposure.
INSKIP, M.J.
Environmental & Occupational Toxicology, Health & Welfare Canada, Ottawa, Ontario.
Report to the Minister of Health & Welfare Canada, 1988.

(Report not available for abstracting).

Blood lead and blood pressure: Analysis of cross-sectional and longitudinal data from Canada.
NERI, L., HEWITT, D. & ORSER, B.
Dept. Epidemiology & Community Medicine, University of Ottawa, Ottawa, Ontario/Dept. Preventive Medicine & Biostatistics, University of Toronto, Toronto, Ontario/Brunswick Mining & Smelting Corp. Ltd., Belledune, Gloucester, New Brunswick.
Environmental Health Perspectives 78: 123-126 (1988).

Based on the 1978-1979 Canada Health Survey data, a weak correlation between blood lead levels and blood pressure amongst the general public was suggested: a blood lead level in excess of 10 μg/100 ml (median value) entailed a 37% higher risk of having a diastolic pressure above 90 mm Hg. An association between short-term changes in blood lead levels and contemporary changes in diastolic pressure was also found in a longitudinal study of lead foundry workers. Short-term changes in urinary cadmium levels also correlated with blood pressure changes.

Lead absorption by children living near a primary copper smelter.
CHENARD, L., TURCOTTE, F. & CORDIER, S.
Dépt. Santé Communautaire, Centre Hospitalier Régional de Rimouski, Rimouski, Québec/Dépt. Médecine Sociale et Préventive, Faculté de Médecine, Université Laval, Québec/INSERM, U 170, Villejuif, France.
Canadian Journal of Public Health 78(5): 295-298 (1987).

In response to concerns expressed by the population of an isolated mining community living in the vicinity of a primary copper smelter, children were surveyed to determine if they had been exposed to lead emissions from the smelter. Blood and hair lead levels in 132 children aged 2-12, who were either directly exposed to the smelter emissions, or indirectly exposed as a result of their father's employment in the smelter, or both, were compared with those of 216 controls. Blood lead levels, while below 300 μg/L for all but one child, were significantly greater than those of control children. Hair lead levels showed a similar trend. No significant difference was found in erythrocyte protoporphyrin.

Report of the Federal/Provincial Task Force on Acceptable Levels of Lead in Human Blood.
HEALTH & WELFARE CANADA.
Environmental Health Directorate, Health Protection Branch, 33 pp., 1987 (Publication 87-EHD-133).

In order to set guidelines for the protection of human health from lead toxicity, it is essential to establish, as precisely as possible, the relationship between levels of exposure to lead, the body concentration of lead and significant biological events associated with the presence of lead in the body. Blood lead levels represent the most accurate, but not exclusive, basis for estimating dose-effect relationships. An acceptable blood lead level is one which is unlikely to result in any irreversible or significant adverse effect on health and well-being. A reasonable intervention value based on blood lead levels was set at 30-35 μg/dL for adult males, and at 20-25 μg/dL for adult females. Because of the adverse effects on the cognition and behaviour at levels of 30-50 μg/dL in children, a reasonable intervention value for children based on blood lead concentration was set at 20-25 μg/dL. Assuming that the developing brain of a fetus is at least as sensitive to the effects of lead as the brain of a young child, acceptable fetal blood limits were set at 30 μg/dL, with the intervention value for females capable of bearing children at 20-25 μg/dL.

Health Effects of Lead.
HOTZ, M.C.B., ED.
Report to the Commission on Lead in the Environment, The Royal Society of Canada, 524 pp., 1986.

This is one of three complementary volumes of scientific papers used by the Royal Society of Canada's Commission on Lead in the Environment in the preparation of its final report, Lead in the Canadian Environment: Science and Regulation. The report consists of a number of papers submitted by various members of the Commission, as well as scientific papers presented at workshops held in Ottawa and Toronto in 1985. It discusses the intake, absorption and excretion of lead from the body, as well as a number of analytical methods for the determination of lead in human samples. So much work has been done on the impact of lead on biological systems that it is not surprising to find connecting threads leading from subcellular effects through metabolic processes to functional impairment and the clinical symptoms of lead toxicity. The primary connecting link appears to be the hematopoietic system, which can be followed all the way from heme biosynthesis in cell mitochondria, through effects on the central and peripheral nervous systems, ultimately to impairment of kidney and liver processes and anemia at toxic blood lead levels.

South Riverdale Blood Lead Testing: 1984.
MACPHERSON, A.S., ELLIS,E., ERB, J. & MCFARLANE, G.
Dept. of Public Health.
City of Toronto Department of Public Health, Toronto, 25 pp., 1985.

Blood lead testing has been conducted for three consecutive years on children under six years of age in a designated area in South Riverdale, where soil lead levels are frequently greater than 1000 ppm. Previous data showed that the blood lead of young children tends to increase in such an area due to the ingestion of soil during play, etc. This urban area, roughly south of Queen Street East between Laing Street and Booth Avenue, hosts several industries including a lead smelter and streets with high traffic volume. These test results were to be compared with data from the Provincial Blood Lead Study of children to be reported by the Ministry of Health later in 1985, and recommendations were to be made regarding testing in 1985 and soil replacement.

Blood Lead and Associated Risk Factors in Ontario Children, 1984.
DUNCAN, C., KUSIAK, R.A., O'HEANY, J., SMITH, L.F., SPIELBERG, L. & SMITH, J.
Report prepared for the Ontario Ministries of Health, Labour and the Environment, Toronto, 1985.

The objectives of the study were: to determine the distribution of blood lead levels in a selected sample of Ontario children six years of age and under residing in areas free of known sources of industrial lead emissions; to determine if there is any urban-suburban-rural pattern in blood lead levels; to detect the presence of any risk factors associated with elevated blood lead levels; and to identify any factors associated with variations in blood lead levels in Ontario children. Air levels ranged from 0.1 to 0.4 $\mu g/m^3$, with the lowest values in rural areas and the highest in urban areas. Soil concentrations were between 6 and 180 ppm with a great deal of variation between individual sites. Air, soil and water lead levels were all well below the Ontario maximum allowable concentration (MAC). Blood lead levels ranged from 8.9 $\mu g/dL$ to 12.0 $\mu g/dL$ with the lowest value occurring in rural sites and the highest in urban sites. 54 of the children had levels above the alert level of 20 $\mu g/dL$ but no correlation was found between the place of residence and the frequency of blood lead levels above 20 $\mu g/dL$. The three risk factors found to be significantly related to blood lead levels in the children were: socio-demographic factors (younger age, male sex, lower socioeconomic family status, as measured by occupation of the household head); residential/neighbourhood/housing factors (e.g. number of gas stations within six blocks of the home); and lifestyle factors (presence of household pets, and the tendency of the child to chew or eat non-food items (pica)).

The Lead Report: A Study of the Concentration of Blood Lead in the General Population of Southern Alberta.
GRETTON, A.R.
Occupational Health & Safety Division, Alberta Community and Occupational Health, Edmonton, Alberta.
Alberta Workers' Health, Safety and Compensation, Edmonton, 1980.

The purpose of this study was to determine the blood lead levels in the normal Alberta population. The results were used to assist in the development of an occupational lead standard for Alberta.

ANALYTICAL METHODS FOR THE DETERMINATION OF LEAD.

Digestion of soil samples for the determination of trace amounts of lead by differential-pulse anodic-stripping voltammetry.

FERNANDO, A.R. & PLAMBECK, J.A.
Department of Chemistry, University of Alberta, Edmonton, Alberta.
Analyst 117(1): 39-42 (1992).

The differential-pulse anodic stripping voltammetry (DPASV) method, previously developed for the analysis of synthetic samples, has been successfully applied to the determination of trace amounts of lead in soil, following dissolution of the soil samples in HNO_3-$HClO_4$, evaporation, re-dissolution in HNO_3 and dilution with a CH_3COOH-KNO_3 electrolyte.

Determination of lead in soil by slurry-electrothermal atomic absorption spectrometry with a fast temperature program.

HINDS, M.W., LATIMER, K.E. & JACKSON, K.W.
Royal Canadian Mint, 320 Sussex Drive, Ottawa/Dept. Chemistry, University of Saskatchewan, Saskatoon/New York State Dept. of Health, State University of New York, Albany, N.Y., US.
J. Analytical Atomic Spectrometry 6(6): 473-476 (1991).

A fast temperature programme for the determination of lead in soil by slurry-electrothermal atomic absorption spectrometry was developed by omitting the charring step and drying at a higher temperature for a shorter time.

Determination of lead in soil by vortex mixing slurry-graphite furnace atomic-absorption spectrometry.

HINDS, M.W. & JACKSON, K.W.
Royal Canadian Mint, Ottawa/New York State Dept. Health, Albany, N.Y., US.
Atomic Spectroscopy 12(4): 109-110 (1991).

The determination of lead in iron-rich soil by slurry-graphite furnace atomic absorption spectrometry may give low results because of particles that adhere to the magnetic stir ring bar used to suspend the slurry. In this instance, vortex mixing provides an alternative to magnetic stirring.

Improved sample preparation for accurate determination of low concentrations of lead in whole blood by graphite furnace analysis.

JACOBSON, B.E., LOCKITCH, G. & QUIGLEY, G.
Dept. Pathology, British Columbia Children's Hospital, Vancouver, B.C.
Clinical Chemistry 37(4): 515-519 (1991).

A method of sample preparation for the direct determination of lead in whole blood by Zeeman graphite-furnace atomic absorption spectrometry is described. This procedure is said to improve the analytical precision and accuracy of lead determinations at low concentrations as compared with published furnace data.

National Standards System. Directory of Accredited Testing Organizations.
STANDARDS COUNCIL OF CANADA.
Sixth Edition, Standards Council of Canada, Ottawa, Ontario, 77pp., 1991.

This directory contains a list and description of accredited testing organizations and their accredited testing capabilities by classes of products and services.

Comparison of palladium nitrate and chloride as a chemical modifier for the determination of lead in solutions and soil slurries by electrothermal atomic-absorption spectrometry.
HINDS, M.W. & JACKSON, K.W.
Royal Canadian Mint, Ottawa/New York State Dept. Health, Albany, N.Y., US.
J. Analytical Atomic Spectrometry 5(3): 199-202 (1990).

A systematic study of various amounts of Pd-Mg nitrate mixtures as a chemical modifier for the determination of Pb in aqueous solutions and soil slurries was conducted, and the results compared with similar methods using Pd chloride. In both, solutions and slurries, small amounts of Pd (in either form) effectively delayed the atomisation of Pb until furnace conditions were nearly isothermal.

Determination of cobalt, nickel, lead, bismuth and indium in ores, soils and related materials by atomic-absorption spectrometry after separation by xanthate extraction.
DONALDSON, E.M.
Mineral Sci. Labs., Energy, Mines & Resources, Ottawa, Ontario.
Talanta 36(5): 543-548 (1989).

A method for determining 0.5 μg/g or more of Co, Ni and Pb and 3 μg/g or more of Bi and In in ores, soils and related materials is described. These elements are separated from iron and other matrix elements by a triple chloroform extraction of their xanthates at pH 2 in the presence of ascorbic acid and ammonium fluoride, and are ultimately determined by atomic absorption spectrometry in an air-acetylene flame. The method is not applicable to samples with high copper content.

Determination of lead in blood by graphite furnace atomic absorption spectrometry - A critique.
SUBRAMANIAN, K.S.
Environmental Health Centre, Health & Welfare Canada, Ottawa, Ontario.
Sci. Total Environ. 89: 237-250 (1989).

A critical review is given of the different procedures used to prepare blood samples prior to analysis by graphite furnace atomic absorption spectrophotometry (GFAAS), one of the most popular techniques for the determination of lead in blood. The introduction of modern furnace technology, in particular the stabilized temperature platform furnace (STPF) technique is also discussed.

Graphite-furnace atomic absorption spectrometric determination of lead, cadmium, cobalt and nickel in infant formulas and evaporated milks after nitric-perchloric acid digestion and coprecipitation with ammonium pyrrolidine dithiocarbamate.

DABEKA, R.W.
Food Research Division, Bureau of Chemical Safety, Food Directorate, Health Protection Branch, Health & Welfare Canada, Ottawa, Ontario.
Sci. Total Environ. 89: 271-277 (1989).

A graphite furnace atomic absorption spectrophotometry (GFAAS) method developed for lead and cadmium was modified to enable simultaneous determination of lead, cadmium, cobalt and nickel in infant formula and evaporated milks.

Lead atomisation from soil by slurry introduction electrothermal atomisation atomic-absorption spectrometry. Part 2. Atomisation characteristics with various matrix modifiers.

HINDS, M.W. & JACKSON, K.W.
Dept. Chemistry, University of Saskatchewan, Saskatoon/New York State Dept. Health, Albany, N.Y., US.
J. Analytical Atomic Spectrometry 3(7): 997-1003 (1988).

The effects of various matrix modifiers on the absorbance-peak characteristics of lead atomic absorption signals were studied on a model soil matrix. Several soils were analysed using Mg, phosphate, a Mg-phosphate mixture, Pd and a Mg-Pd mixture as modifiers, and although they were all effective, the Mg-Pd mixture was found to be the most suitable because it produced similar absorbance appearance and peak maximum times for the slurries and aqueous calibration standards. Other matrix modification methods were less suitable because the lead atomisation characteristics differed from those of aqueous standards.

Effectiveness of palladium plus magnesium as a matrix modifier for the determination of lead in solutions and soil slurries by electrothermal atomisation atomic-absorption spectrometry.

HINDS, M.W., KATYAL, M. & JACKSON, K.W.
Dept. Chemistry, University of Saskatchewan, Saskatoon, Saskatchewan.
J. Analytical Atomic Spectrometry 3(1):83-87 (1988).

A systematic study of various amounts of Pd+Mg as a matrix modifier for the determination of lead using platform atomisation was carried out. In solutions, small amounts of Pd were effective in delaying analyte vaporisation, but Pb recoveries were low unless Mg was also present. Optimum amounts were 0.6 μg Pd + 1.0 μg Mg for the determination of 1.0 ng Pb.

Direct determination of lead in bovine liver by solid sampling with graphite furnace atomic absorption spectrometry: a comparison of tube wall atomization, platform atomization and probe atomization.

CHAKRABARTI, C.L., KARWOWSKA, R., HOLLEBONE, B.R. & JOHNSON, P.M.
Department of Chemistry, Carleton University, Ottawa, Ontario.
Spectrochimica Acta 42B(11-12): 1217-1225 (1987).

A comparative study of three atomization techniques is presented. Also presented is the effect of oxygen ashing on the lead atomic absorption signal and on the background absorption due to the organic matrix of bovine liver. Study of the lead atomic absorption pulses given by the three atomization techniques using a detection system having a short time constant relative to the atomization and the residence time of lead from Bovine Liver, SRM No. 1577, has provided a new insight into the atomization processes involved in the techniques. The importance of isothermal atomization in reducing or eliminating matrix interferences, and the role of oxygen gas in the ashing cycle are presented and discussed.

[Blood Lead Analysis.]
IRSST (QUEBEC).
Notes et Rapports Scientifiques et Techniques. Méthode Analytique/IRSST 14-1, 7 pp., 1986 (in French).

(Report not available for abstracting).

[Air Lead Analysis.]
IRSST (QUEBEC).
Notes et Rapports Scientifiques et Techniques. Méthode Analytique/IRSST 13-1, 10 pp., 1986 (in French).

(Report not available for abstracting).

Preconcentration of cadmium, chromium, copper and lead in drinking water on the polyacrylic ester resin, XAD-7.
SUBRAMANIAN, K.S., MERANGER, J.C. WAN, C.C. & CORSINI, A.
Environmental Directorate, Health & Welfare Canada, Ottawa, Ontario/Dept. Chemistry, McMaster University, Hamilton, Ontario.
Int. J. Environ. Anal. Chem. 19(4): 261-272 (1985).

A new preconcentration procedure designed to overcome the effect of trace metal complexation by humic substances on their determination by graphite furnace atomic absorption spectrophotometry was developed. The results of the trace metal analysis of drinking water samples taken from taps at 15 sites in Hamilton, Ontario showed that leaching of copper and lead from the distribution system occurred.

Blood lead analyses: Methods, proficiency and trends in results.
WALKINSHAW, I.R.
Occupational Health Laboratory Service, Ontario Ministry of Labour, Weston, Ontario.
Occupational Health in Ontario 6(4): 170-176 (1985).

The three principal techniques for blood lead analysis, including the one chosen by the Occupational Health Laboratory of the Ontario Ministry of Labour, and programs for testing proficiency of lead-in-blood analyses are described. A review of the analyses performed by the Occupational Health Laboratory over the last 6 years indicates that, on average, the blood lead levels in workers are decreasing.

LIST OF CANADIAN EXPERTS / CENTRES OF EXPERTISE DEALING WITH LEAD ISSUES.

This section has been sub-divided into two parts:

- A list of **Canadian individuals** with an expert knowledge in a particular field of lead research;
- A list of **Canadian centres** with expertise in lead issues.

The first part of this section consists of a list of individuals with expertise in various areas of lead research. For each person listed there is a brief description of their research interests or involvement in lead research, as well as details of their affiliation and background. The "experts" listed in this section can be divided into two categories: a) research scientists associated with research institutions such as universities and hospitals who are actively involved in research on lead-related topics, and b) individuals who have been involved in lead surveys and/or remediation projects in lead-contaminated communities accross the country, and have therefore acquired an in-depth knowledge of lead issues. This first part has been organized geographically, province by province.

The second part of this section lists the main centres of expertise and consulting firms who are known to have experience in lead issues. It should be noted that besides the centres listed here, each province will have within their municipal and provincial governments (especially the provincial ministries of Health, the Environment, and Labour), officials with varying degrees of knowledge in lead-related topics. Such expertise will usually be found in regions where environmental contamination with lead has been an issue, for example in areas where contamination has occurred in the vicinity of urban centres.

CANADIAN EXPERTS DEALING WITH LEAD ISSUES.

BRITISH COLUMBIA.

NELSON AMES, MD

Director & Medical Health Officer
Central Kootenay Health Unit
813-10th Street
Castlegar, British Columbia V1N 2H7

Phone: (604) 365-8525
Fax: (604) 365-8542

Field of Specialty: **Blood lead surveys.**

Together with Dr. Hertzman and co-workers (see below), Dr. Ames has been actively involved in the Trail Lead Study, and is currently a member of the Federal/Provincial working group on blood lead intervention levels in children and adults.

CLYDE HERTZMAN, MD, M.Sc., FRCPC

Director
Division of Occupational and
Environmental Health
Department of Health Care and Epidemiology
University of British Columbia
5804 Fairview Avenue
Vancouver, B.C. V6T 1W5

Phone: (604) 228-5550
Fax: (604) 228-4994

Field of Specialty: **Occupational & Environmental Health.**

Following a request from the B.C. Ministries of Health and Environment, Dr. Hertzman and co-workers conducted a survey of blood lead levels in preschool children living in Trail, B.C. during the summer and autumn of 1989, and presented their findings and conclusions in the Trail Lead Study Report, submitted to the Ministries in June, 1990.

GILLIAN LOCKITCH, MD, FRCPC

Associate Professor
Department of Pathology
University of British Columbia
British Columbia's Children's Hospital
4480 Oak Street
Vancouver, B.C. V6H 3V4

Phone: (604) 875-2331
Fax: (604) 875-2193

Field of Specialty: **Clinical biochemistry, analysis of trace metals in biological materials from infants and children.**

Dr. Lockitch is the Head of Clinical Biochemistry in the Department of Pathology at the B.C. Children's Hospital. Her laboratory provides clinical monitoring of zinc, copper and selenium status in sick infants and children, as well as performing most of the pediatric and obstetric blood lead level analyses in the province. Dr. Lockitch and her colleages also monitor oral and intravenous chelation therapy in infants/children who have been severely lead poisoned, and are at present studying the transfer of lead and other metals from mother to fetus and infant across the placenta and during lactation. Dr. Lockitch has published several papers over the years dealing with supplementation, tissue levels and the toxic effects of trace metals in infants and children, and has been actively involved in the blood lead survey of 2-3 year old children in Vancouver and in the Trail Lead Program.

JOHN E.H. WARD, Ph.D.

Environmental Protection Division
Ministry of the Environment
810 Blanshard Street
Victoria, B.C. V8V 1X5

Phone: (604) 387-9951
Fax: (604) 356-7197

Field of Specialty: **Toxicology of Hazardous Contaminants.**

Dr. Ward is Head of the Toxicology Unit for the B.C. Ministry of the Environment's Hazardous Contaminants & Technical Services.

CHERYL YATES, BSN

c/o Regional District of Kootenay Boundary
202-843 Rossland Avenue
Trail, B.C. V1R 1S8

Phone: (604) 368-9148
Fax: (604) 368-3990

Field of Specialty: **Community blood lead screening.**

Ms. Yates was actively involved in the Trail Lead Study conducted by Dr. Hertzman and co-workers, and is currently working for the Trail Blood Lead Community Task Force.

MANITOBA.

GEOFFREY BAWDEN, B.Sc.

Director, Field Operations
Division of Workplace Safety & Health
Manitoba Department of Labour
1000 - 330 St Mary Avenue
Winnipeg, Manitoba R3C 3Z5

Phone: (204) 945-3446

Field of Specialty: **Occupational & Environmental Health.**

K.J.T. KJARTANSON, P. Eng.

Research Engineer
City of Winnipeg
Waterworks, Waste & Disposal Dept.
Laboratory Services Division
1500 Plessis Road
Winnipeg, Manitoba R2C 2Z9

Phone: (204) 986-4807
Fax: (204) 224-0032

Field of Specialty: **Lead in drinking water.**

Mr. Kjartanson conducted a study on the lead content of drinking water in Winnipeg in 1989, and found that leaching of lead into the drinking water was influenced by the presence of lead in water connections, the age of the lead solder/copper plumbing, and the length of time the water had been standing ("first draw" samples had higher levels of lead than samples taken after flushing for five minutes). Further studies were carried out in 1990 and 1991, and the results will be published by the summer of 1992.

T.V.N. PERSAUD

Department of Anatomy
Faculty of Medicine
University of Manitoba
730 William Avenue
Winnipeg, Manitoba R3E 0W3

Phone: (204) 788-6651

Field of Specialty: **Teratogenic effects of heavy metals in mice.**

Dr. Persaud and co-workers have conducted several studies in experimental animals dealing with the adverse effects of exposure to heavy metals (mercury, lead and cadmium) on the mother and foetus during pregnancy.

MILTON TENENBEIN, MD, FRCPC, FAAP

Director
Poison Control Centre
Children's Hospital
840 Sherbrook Street
Winnipeg, Manitoba R3A 1S1

Phone: (204) 787-2444
Fax: (204) 787-4807

Field of Specialty: **Lead poisoning and other health effects of lead exposure in children.**

Dr. Tenenbein is also an Associate Professor of the Departments of Pediatrics, Pharmacology, and Community Health Sciences at the University of Manitoba, and has been actively involved in all aspects of the health effects of lead, ranging from industrial exposure to lead in drinking water, blood lead analyses, and treatment of lead poisoning in children.

ANNALEE YASSI, MD, M.Sc.	Director Occupational & Environmental Health Department of Community Health Sciences University of Manitoba S113-700 Bannatyne Avenue Winnipeg, Manitoba R3E 0W3
Field of Specialty:	**Occupational & Environmental Health**

NEW BRUNSWICK

SCOTT GIFFIN, MD

District Medical Health Officer
Dept. Health & Community Services
P.O. Box 93, 157 Duke St.
Saint John, N.B. E3N 1N7

Phone: (506) 658-2734

Field of Specialty: **Community Health.**

Dr. Giffin has been actively involved in the screening of blood lead levels of residents of Saint John, N.B., and is a member of the Ad-Hoc Committee formed to study the sources and effects of lead exposure on Saint John residents (see below).

PETER JOSEPH HANLON, P. Eng.

Operations Engineer
Water & Sewerage Dept.
Saint John Waterworks
P.O. Box 1971
Saint John, N.B. E2L 4L1

Phone: (506) 658-2928
Fax: (506) 658-4740

Field of Specialty: **Lead in drinking water.**

In 1990/1991, Mr. Hanlon conducted a survey of the water supply on 24 homes in Saint John, and found that in homes served through lead pipes and/or brass plumbing, water lead levels were above the 10 ppb guideline in 58% of the cases, and that 37% of the tested residents had greater than acceptable levels of lead in their blood (> 0.50 µmol/L). An Ad-Hoc Committee was formed in association with Dr. Richard Scott and Dr. Scott Giffin, to further study and follow-up the lead problem in N.B.

RICHARD E. SCOTT, Ph.D.

Forensic & Clinical Toxicologist
Saint John Regional Hospital
Saint John, N.B. E2L 4L2

Phone: (506) 648-6579
Fax: (506) 648-6576

Field of Specialty: **Clinical toxicology, blood lead levels and health effects of lead in New Brunswick.**

Dr. Scott is the Clinical & Forensic Toxicologist at the Saint John Regional Hospital, the Provincial Forensic Toxicologist for the New Brunswick Coroners Service, and an Assistant Professor of Pathology at Dalhousie University. He is also the Director of New-Tox, a private consulting firm for forensic and clinical toxicology. He is currently President of the N.B. Society of Clinical Chemists and is chairing the CSCC Task force on Lead Intoxication in Canada.

ONTARIO.

MICHAEL W. HINDS, Ph.D.

Assay Chemist
Assay Department
Royal Canadian Mint
320 Sussex Drive
Ottawa, Ontario K1A 0G8

Phone: (613) 993-8975
Fax: (613) 991-1741

Field of Specialty: **Lead analysis in soils.**

Dr. Hinds received his Ph.D. in Analytical Chemistry from the University of Saskatchewan, and has published several methodological papers on the determination of lead in soil slurries by atomic absorption spectrometry.

LUCIANO C. NERI, M.D., M.Sci., F.R.C.P.

Physical Medicine & Rehabilitation
Saint-Vincent Hospital
60 Cambridge N.
Ottawa, Ontario K1R 7A5

Phone: (613) 782-2766
Fax: (613) 782-2751

Field of Specialty: **Epidemiology and Community Medicine.**

Dr. Neri was a member of the Commission on Lead in the Environment in 1986, and has published several epidemiological studies on lead exposure. He has since retired from the University of Ottawa's Department of Epidemiology and Community Medicine, but has remained associated with the Saint-Vincent Hospital in Ottawa.

CLIFF J. SHIRTLIFFE

Building Performance Laboratory
Institute for Research in Construction
National Research Council
Montreal Road Campus, Building M-24
Ottawa, Ontario K1A 0R6

Phone: (613) 993-9617
Fax: (613) 954-3733

Field of Specialty: **Applications of lead-based paint to buildings, encapsulation, clean-up and precautionary measures.**

DON L. SINGLETON, Ph.D.

Environmental Chemistry
National Research Council
Montreal Road Campus, Building M-12
Ottawa, Ontario K1A 0R6

Phone: (613) 993-2500
Fax: (613) 952-1275

Field of Specialty: **Lead migration in the environment and high sensitivity measurements.**

ROBERT W. DABEKA

Food Research Division
Bureau of Chemical Safety
Food Directorate
Health Protection Branch
Health and Welfare Canada
Ottawa, Ontario K1A 0L2

Phone: (613) 957-0950
Fax: (613) 941-4775

Field of Specialty: **Trace metal analysis in foods.**

MICHAEL J. INSKIP

Toxicological Advisor
Div. Environmental & Occupational Toxicol.
Bureau of Chemical Hazards
Environmental Health Directorate
Health Protection Branch
Health and Welfare Canada
Tunney's Pasture
Ottawa, Ontario K1A 0L2

Phone: (613) 957-1885
Fax: (613) 952-9798

Field of Specialty: **Effects of low level exposure to lead in experimental animals.**

Prior to his arrival in Canada in 1988, Dr. Inskip worked and published several papers dealing with human exposure to lead-based paint and lead in dust/soil in the U.K. Currently, he is involved in research on the toxicity of exposure to low levels of lead in experimental animals, but remains interested in the issues of exposure to lead-based paint.

J.C. MERANGER, M.Sc.

Health Protection Branch
Health and Welfare Canada
Ottawa, Ontario K1A 0L2

Phone: (613) 957-1870
Fax: (613) 954-2486

Field of Specialty: **Metal analysis in water, biological material.**

DEBORAH C. RICE, Ph.D.

Research Scientist
Toxicology Research Division
Bureau of Chemical Safety
Food Directorate
Health Protection Branch
Health and Welfare Canada
Tunney's Pasture
Ottawa, Ontario K1A 0L2

Phone: (613) 957-0967

Field of Specialty: **Neurobehavioral toxicity of lead in primates.**

Dr. Rice has been involved in research on behavioral toxicology in monkeys for the past 12 years, and has published a dozen research papers dealing with exposure to lead as well as writing chapters on lead toxicity for several books.

KUNNATH S. SUBRAMANIAN, Ph.D.

Research Scientist
Environmental Health Centre
Health & Welfare Canada
Tunney's Pasture
Ottawa, Ontario K1A 0L2

Phone: (613) 957-1874
Fax: (613) 941-4545

Field of Specialty: **Metal analysis in water, biological material.**

GRACE WOOD, M.Sc.

Monitoring & Criteria Division
Health Protection Branch
Health & Welfare Canada
Ottawa, Ontario K1A 0L2

Phone: (613) 957-1503
Fax: (613) 941-4546

Field of Specialty: **Preparation of drinking water guidelines, multi-media health risk assessments and development of guidelines and standards for lead.**

RICHARD H. BOEHNKE, B.A., CPHI(C)

Manager
Environmental Health & Inspection Services
City of Toronto, Department of Public Health
Western Health Area
2340 Dundas Street West
Toronto, Ontario M6P 4A9

Phone: (416) 392-0996
Fax: (416) 392-0715

Field of Specialty: **Community health issues.**

Mr. Boehnke played an integral role in the organization and management of the Lead Reduction Program - Housedust Cleaning Projects in the South Riverdale and Niagara Neighbourhoods of Toronto, Ontario.

JEREMY CLAPP, Ph.D.

Assistant Professor
Medical Biochemistry
University of Toronto
c/o Pace Environs
81 Finchdene Square, Unit 1
Scarborough, Ontario M1X 1B4

Phone: (416) 293-5008
Fax: (416) 293-2492

Field of Specialty: **Detection of lead in paint, water and consumer products.**

Dr. Clapp and his associates have developed test kits to detect the presence of lead in coated surfaces (Frandon Lead Alert Kit) and in water (Frandon Lead in Water Kit). He has conducted small-scale surveys in homes and day care centres in the Toronto area, and has been actively following the lead abatement programs and training of remediation personnel in the US.

DR. SCOTT FLEMMING

Senior Regulatory Toxicologist
Risk Assessment Unit
Hazardous Contaminants Branch
Ontario Ministry of the Environment
135 St. Clair Avenue West
Toronto, Ontario M4V 1P5

Phone: (416) 323-5003
Fax: (416) 323-5166

Field of Specialty: **Regulatory toxicology.**

Dr. Flemming is responsible for multi-media health risk assessments and the development of criteria. He is in the process of finalizing a 350 pp. report: "Scientific Criteria Document towards the Development of Multi-Media Standards for Lead", to be released later this year.

GIDEON KOREN, M.D.

Div. of Clinical Pharmalogy & Toxicology
Hospital for Sick Children
555 University Avenue
Toronto, Ontario M5G 1X8

Phone: (416) 787-5376

Field of Specialty: **Pediatric pharmacology and perinatal toxicology.**

Dr. Koren holds several positions at the Hospital for Sick Children in Toronto, including: Staff Pediatrician and Acting Ward Chief of the Department of Pediatrics, Associate Director for Clinical Research at the Research Institute, and Director of the Motherisk Program for drug/chemical exposure during pregnancy. He is also a career scientist of the Ontario Ministry of Health, and a member of the Institute of Bioethics of the University of Toronto. Dr. Koren has written dozens of papers dealing with maternal and fetal outcome following exposure to drugs and chemicals during pregnancy and lactation. His current research interests include the disposition and effects of drugs on the developing organism of infants, the application of various in vivo and in vitro methods to study the handling of drugs by the kidney on a molecular and physiological level, and the adverse teratogenic and developmental effects of drugs and chemicals in the perinatal period.

DR. LESBIA F. SMITH, M.D.

Senior Medical Consultant
Environmental Health and Toxicology Unit
Disease Control Service
Public Health Branch
Ontario Ministry of Health
15 Overlea Boulevard, Room 502
Toronto, Ontario M4H 1A9

Phone: (416) 327-7424
Fax: (416) 327-7439

Field of Specialty: **Blood lead analysis.**

Dr. Smith has been actively involved in the blood lead surveys of children in Southern (1984) and Northern Ontario (1987), and is at present conducting a survey of blood lead in Moosonee children. Her other areas of interest include the health effects of electromagnetic radiation, human exposure to metals in the environment, in particular, human exposure to aluminium in drinking water and the possible relationship between aluminium and Alzheimer's disease.

ROBERT A. GOYER, M.D.

Professor and Chairman
Department of Pathology
University of Western Ontario
London, Ontario N6A 5C1

Phone: (519) 661-2032
Fax: (519) 661-3370

Field of Specialty: **Toxic effects of lead exposure.**

Dr. Goyer has published over the years a number of papers dealing with adverse effects of lead exposure, nephrotoxicity of metals, human health effects of acid rain, transplacental transport, and fetal toxicity of trace metals. He has also written reviews, editorials and chapters in books dealing with these subjects. Amongst many other appointments, he was the Chairman of the Federal/Provincial Task Force to determine acceptable blood lead levels for Canadians in 1990/91, Chairman of the WHO Task Group on Environmental Health Criteria for Lead (1975) and Chairman of the IPCS Working Group on Cadmium (1984). Unfortunately, Dr. Goyer is planning to retire and leave Canada later this year.

BARBARA MCELGUNN

Research & Liaison Officer (Health)
Learning Disabilities Association of Canada
74 Holmcrest Trail
West Hill, Ontario M1C 1V5

Phone: (416) 281-9676

Field of Specialty: **Environmental health and policy development.**

Ms. McElgunn has been involved in various aspects of the lead issue in Canada, including lobbying for the development of stricter guidelines and regulations.

EVERT NIEBOER, Ph.D.

Department of Biochemistry
McMaster University
1200 Main Street West
Hamilton, Ontario L8N 3Z5

Phone: (416) 525-9140
Fax: (416) 522-9033

Field of Specialty: **Biogeochemistry of trace metals in the environment.**

JEROME O. NRIAGU, Ph.D., D.Sc.

Research Scientist
National Water Research Institute
Environment Canada
Burlington, Ontario L7R 4A6

Phone: (416) 336-4784
Fax: (416) 336-4989

Field of Specialty: **Biogeochemistry of trace metals in the environment.**

Dr. Nriagu is a very respected scientist in the field of environmental impact/levels/distribution of trace metals, and has writen/edited chapters/books and research papers on lead.

PAMELA M. WELBOURN, Ph.D.
(formerly Stokes)

Conjunct Professor
Watershed Ecosystems
Trent University
Environmental Centre
Peterborough, Ontario K9J 7B8

Phone: (705) 748-1256
Fax: (705) 748-1569

Field of Specialty: **Heavy metals in soils, water and vegetation.**

Dr. Welbourn was vice-chairman of the Commission on Lead in the Environment, 1986 and was responsible for editing the Report on "Pathways, Cycling and Transformation of Lead in the Environment". She has worked on numerous aspects of aquatic biology, mainly on the cycling of metals through the ecosystem. She has served on the Royal Society of Canada/National Academy of Sciences Joint Committee on Acid Precipitation, the Advisory Committee of the Canadian Centre for Toxicology, the Science Advisory Committee of Pollution Probe and the SCOPE Committee on Metals Cycling in the Biosphere. Until recently, she was a Professor of Botany at the Institute for Environmental Studies at the University of Toronto.

QUEBEC.

PATRICK J. LEVALLOIS, M.D., M.Sc., FRCPC

Service Santé et Environnement
Dept. Santé Communautaire
Centre Hospitalier de l'Université Laval
2050 Boul. St-Cyrille ouest
Sainte-Foy, Québec G1V 2K8

Phone: (418) 687-1090
Fax: (418) 681-5635

Field of Specialty: **Surveys of lead exposure on sensitive populations.**

Dr. Levallois is a professor and medical advisor at the Department of Social & Preventive Medicine, Laval University. He has conducted studies dealing with the contamination of water by lead in day care centres, the absorption of lead by children, and the poisoning of newborns with lead. He is at present carrying out a study on the risk factors associated with lead poisoning in children aged 6 months to 2 years, as well as a follow-up study on the neuropsychological development of young children exposed to low levels of lead during infancy. He has been an advisor on the evaluation of risk associated with soil contamination by lead in the vicinity of the Ste-Croix-de-Lotbinière smelter and the residential neighbourhoods of Quebec City and St-Jean-sur Richelieu. He was a member of the provincial task force on the environmental contamination by lead, and is currently a member of the Federal/Provincial working group on blood lead intervention levels in children and adults.

ALBERT NANTEL, MD, M.Sc.

Toxicologist
Centre de Toxicologie du Québec
Centre Hospitalier de l'Université Laval
2705 Boulevard Laurier
Québec City, Québec G1V 4G2

Phone: (418) 687-1090
Fax: (418) 681-5635

Field of Specialty: **Industrial exposure, medical toxicology, surveys of lead exposure on sensitive populations.**

Dr. Nantel has been working in the field of industrial exposure to lead for over 15 years, and has participated in several surveys on lead exposure in Québec.

MARC RHAINDS, M.D., M.Sc., FRCPC

Service Santé et Environnement
Dept. Santé Communautaire
Centre Hospitalier de l'Université Laval
2050 Boul. St-Cyrille ouest
Sainte-Foy, Québec G1V 2K8

Phone: (418) 687-1090
Fax: (418) 681-5635

Field of Specialty: **Epidemiology & Community Medicine.**

Dr. Rhainds is a community physician with the DSC-CHUL, and has been involved in several studies on lead contamination. He is at present collaborating with Dr. Levallois (see above) on a study of the risk factors of lead poisoning in children aged 6 to 24 months, and is responsible for the collection and analysis of environmental data.

PIERRE AUBE, Ing. Géologue, M.Sc.

Gouvernement du Québec
Ministère de l'Environnement
Direction des Substances Dangereuses
3900 rue Marly
Saint-Foy, Québec G1X 4E4

Phone: (418) 644-3395

Field of Specialty: **Residential remediation.**

Mr. Aubé was involved in the clean-up of lead-contaminated soil in St. Jean, Quebec.

MICHEL BEAULIEU, Biologiste

Gouvernement du Québec
Ministère de l'Environnement
Direction des Substances Dangereuses
3900 rue Marly
Saint-Foy, Québec G1X 4E4

Phone: (418) 644-3393

Field of Specialty: **Phytotoxicology.**

Mr. Beaulieu was the phytotoxicologist in a study of heavy metal contamination in the vicinity of the Balmet site in St. Jean, Quebec.

CHANTAL BERGERON

Gouvernement du Québec
Ministère de l'Environnement
Direction des Communication et de l'Education
3900 rue Marly, 6ème étage
Saint-Foy, Québec G1X 4E4

Phone: (418) 644-3989

Field of Specialty: **Information & Education.**

Ms. Bergeron was involved in the community education and information component of the clean-up in St. Jean, Quebec.

FRANCIS PERRON, Ing. Géologue, M.Sc.

Gouvernement du Québec
Ministère de l'Environnement
Direction des Substances Dangereuses
3900 rue Marly
Saint-Foy, Québec G1X 4E4

Phone: (418) 644-2914

Field of Specialty:

Mr. Perron was in charge of the lead clean-up in St. Jean, Quebec.

CENTRES WITH EXPERTISE IN LEAD ISSUES.

CONSUMER AND CORPORATE AFFAIRS CANADA PRODUCT SAFETY BRANCH	Place du Portage I Hull, Quebec K1A 0C9 Phone: (819) 953-3859 Fax: (819) 953-3857
Field of Specialty:	**Lead in consumer products.**

HEALTH AND WELFARE CANADA HEALTH PROTECTION BRANCH	Environmental Health Centre Tunney's Pasture Ottawa, Ontario K1A 0L2 Phone: (613) 957-2991 Fax: (613) 952-7646
Field of Specialty:	**Health effects of lead exposure.**

CANADA MORTGAGE AND HOUSING CORPORATION NATIONAL OFFICE	700 Montreal Road Ottawa, Ontario K1A 0P7 Phone: (613) 748-2000 Fax: (613) 748-2402
Field of Specialty:	**Lead in paint and building materials.**

CANADIAN CENTRE FOR OCCUPATIONAL HEALTH AND SAFETY	250 Main Street East Hamilton, Ontario L8N 9Z9 Phone: (416) 572-2981 Fax: (416) 572-2206
Field of Specialty:	**Industrial/occupational exposure to lead.**

CANADIAN PAINT AND COATINGS ASSOCIATION	9900 Cavendish Boulevard Suite 103 St-Laurent, Quebec H4M 2V2 Phone: (514) 745-2611 Fax: (514) 745-2031
Field of Specialty:	**Lead in paint.**

OCCUPATIONAL HEALTH CENTRE AT QUEEN'S UNIVERSITY	Abramsky Hall - 2 Kingston, Ontario K7L 3N6 Phone: (613) 545-2909 Fax: (613) 545-6686
Field of Specialty:	**Lead abatement evaluation project.**

DIVISION OF OCCUPATIONAL AND ENVIRONMENTAL HEALTH	Department of Health Care and Epidemiology University of British Columbia 5804 Fairview Avenue Vancouver, B.C. V6T 1W5 Phone: (604) 228-5550 Fax: (604) 228-4994
Field of Specialty:	**Epidemiological studies, blood lead surveys.**

CONCORD ENVIRONMENTAL CORPORATION	1410 Blair Place, Suite 412 Gloucester, Ontario K1G 9B9 Phone: (613) 745-4644 Fax: (613) 745-1290
Field of Specialty:	**Lead abatement/remediation projects, environmental health & risk assessments, hazardous waste management.**

GORE & STORRIE LIMITED CONSULTING ENGINEERS	255 Consumers Road North York, Ontario M2J 5B6 Phone: (416) 499-9000 Fax: (416) 499-4687
Field of Specialty:	**Lead abatement/remediation projects, hazardous waste management.**

GOSS, GILROY & ASSOCIATES LTD. MANAGEMENT AND STATISTICAL CONSULTANTS	222 Queen Street, Suite 400 Ottawa, Ontario K1P 5V9 Phone: (613) 230-5577 Fax: (613) 235-9592
Field of Specialty:	**Blood lead surveys.**

HILCON SCIENTIFIC & ENVIRONMENTAL CONSULTANTS	503 Edgeworth Avenue Ottawa, Ontario K2B 5L2 Phone: (613) 820-4384 Fax: (613) 829-9862
Field of Specialty:	**Environmental health & risk assessments.**

EXISTING LEGISLATION REGARDING LEAD LEVELS.

The following section contains a compilation of Canadian legislation and guidelines regarding the permissible levels of lead in the environment or in various consumer products. The federal legislation has been summarized first, and then, as in the previous section, the material has been arranged in alphabetical order, province by province.

Most of the information was extracted from computer print-outs kindly provided by Ms. Ruta Whittaker, of the Monitoring & Criteria Division of the Health Protection Branch, Health and Welfare Canada, and was accessed by searching the IRPTC Databases On-Line. The IRPTC Databases, which can be searched free of charge, can be accessed through Health and Welfare Canada (HWC), the Canadian National Correspondent for the International Register of Potentially Toxic Chemicals (IRPTC), an agency of the United Nations Environment Programme (UNEP). The IRPTC legal database contains information on both Canadian and international legislation, regulations and recommendations, as well as on legal mechanisms related to chemical substance control in media such as air, water, drinking water, wastes, soil, sediments, animal and plant tissues, food and beverages, drugs, consumer products, agriculture and animal husbandry.

In addition, inquiries were made at the federal, provincial and municipal levels (see Appendix A), and any information received from those sources has been incorporated into the appropriate section. No further effort has been made to update or confirm the IRPTC data.

Table 3.1. Federal Legislation/Regulations/Guidelines Dealing with Lead in the Canadian Environment.

Controlling Authority	Lead source	Lead Level	Date	Legislation and Current Status
FEDERAL GOVERNMENT.				
Consumer and Corporate Affairs	Childrens furniture, toys pencils and other articles	0.50% w/w	Nov/88	Schedule 1, Hazardous Products Act Regulations
	Coatings (furniture & household products)	0.50% w/w	Nov/88	Schedule 1, Hazardous Products Act Regulations
	Glazed ceramics for use in storing, preparing or serving any food	7 ppm	Nov/71	Hazardous Products (Glazed Ceramics) Regulations
	Kettles for household use	0.050 ppm (in water)	Jun/74	Hazardous Products (Kettles) Regulations
	Paints & liquid coatings for interior use	0.50% w/w	Nov/88	Hazardous Products (Liquid Coating Materials) Regulations
	Hazardous products in the workplace	0.1% w/w	Dec/87	WHMIS Ingredient Disclosure Hazardous Products Act/Controlled Products Regulations
Department of Labour	Inorganic dust and fumes (threshold limit)	0.15 mg/m^3 (TWA)	Mar/86	Occupational Safety and Health Regulations, Canada Labour Code
Environment Canada	Domestic leaded gasoline for: trucks ($\geq$ 3856 kg), farm equipment and boats	30 mg/L max.	Dec/90	Gasoline Regulations, Canadian Environmental Protection Act

Table 3.1. (Continued).

Controlling Authority	Lead source	Lead Level	Date	Legislation and Current Status
Environment Canada	Imported leaded gasoline for same use as above	26 mg/L max.	Dec/90	Gasoline Regulations, Canadian Environmental Protection Act
	Leaded gasoline for any other purpose (domestic & imported)	5 mg/L max.	Dec/90	Gasoline Regulations, Canadian Environmental Protection Act
	Secondary lead smelter emissions from the use of:		Feb/91	Secondary Lead Smelter Release Regulations, Canadian Environmental Protection Act
	blast furnace, cupolas	0.046 g/m^3 max.		
	holding, kettle furnaces, etc.	0.023 g/m^3 max.		
	scrap, slagging, cleaning, etc.	0.023 g/m^3 max.		
	Physical-chemical-biological waste treatment plant effluents	0.1 mg/L max. (dissolved)	Aug/89	Physical-Chemical-Biological Treatment of Hazardous Waste National Guidelines, Hazardous Waste Action Plan
Fisheries and Oceans	Liquid effluent discharges from mines:		Feb/77	Metal Mining Liquid Effluent Regulations, Fisheries Act
	monthly arithmetic mean	0.2 mg/L max.		
	composite sample	0.3 mg/L max.		
	grab sample	0.4 mg/L max.		
	Liquid effluent discharges from metal finishing industry	1.5 mg/L max.	Nov/77	Metal Finishing Liquid Effluent Guidelines, Fisheries Act
National Health and Welfare	Drinking water	0.01 mg/L (MAC)	1989	Guidelines for Canadian Drinking Water Quality, Federal-Provincial Subcommittee on Drinking Water
	Beverages	0.2-10 ppm	Mar/79	Food and Drugs Act Regulations
	Other food sources	0.2-20 ppm	1968	Food and Drugs Act Regulations

Table 3.2. Provincial Legislation/Regulations/Guidelines Dealing with Lead in the Canadian Environment.

Controlling Authority	Lead source	Lead Level	Date	Legislation and Current Status
PROVINCIAL GOVERNMENTS.				
ALBERTA				
Department of the Environment	Waste water effluents from:			Waste Water Effluent Guidelines, Clean Water Act
	fertilizer plants	0.10 mg/L	Oct/76	Waste Water Effluent Guidelines for Fertilizer Plants
	petroleum refineries	0.10 mg/L	Aug/76	Waste Water Effluent Guidelines for Petroleum Refineries
	gas processing plants	0.10 mg/L	Sep/73	Gas Processing Plants Waste Water Management Standards
	Liquid waste in landfill	500 mg/kg max.	Apr/88	Hazardous Waste Regulation, Hazardous Chemicals Act
	Secondary lead smelter emissions from the use of:		Feb/84	Clean Air Act Regulation
	blast furnaces, cupolas, etc.	0.029 g/m^3 max.		
	holding furnaces, pot furnaces, melting/refining operations, etc.	0.014 g/m^3 max.		
Ministry of Workers' Health, Safety and Compensation	Inorganic fumes & dust		Mar/89	Chemical Hazards Regulation, Occupational Health and Safety Act of Alberta
	8 hour exposure TLV	0.15 mg/m^3		
	15 min. exposure TLV	0.45 mg/m^3		
	Workplace products	0.1% w/w	Mar/89	Ingredients Disclosure under WHMIS, Occupational Health and Safety Act
BRITISH COLUMBIA				
Ministry of Energy, Mines and Petroleum Resources	Mine air contamination		Jun/83	Mines Regulation, Mines Act of British Columbia
	8 hour TLV	0.15 mg/m^3		
	15 min TLV	0.45 mg/m^3		
	Workplace products	0.1% w/w	Oct/88	Ingredients Disclosure under WHMIS Regulation (Mines), Mines Act of British Columbia

Table 3.2. (Continued).

Controlling Authority	Lead source	Lead Level	Date	Legislation and Current Status
BRITISH COLUMBIA (Continued)				
Ministry of the Environment	Gaseous & particulate emissions from food process. & misc. ind.		Jan/75	British Columbia Waste Management Act Objectives
	new or proposed (Level A)	7.0 mg/m^3		
	intermediate upgrade (Level B)	11.0 mg/m^3		
	immediate upgrade (Level C)	23.0 mg/m^3		
	Particulate emissions, metal ind. Lead smelting		Jan/75	British Columbia Waste Management Act Objectives
	new or proposed	0.9 lb/ton prod.		
	intermediate upgrade	1.5 lb/ton prod.		
	immediate upgrade	2.0 lb/ton prod.		
	Effluent discharges to marine/ fresh waters from metal fin. ind.		Jan/75	British Columbia Waste Management Act Objectives
	new or proposed (dissolved)	0.20 mg/L		
	immediate upgrade (dissolved)	0.50 mg/L		
	Ambient air quality objective Misc. industries (Level A)	4.0 μg/m^3 (24 hr) 2.0 μg/m^3 (year, geometric mean)	Jan/75	British Columbia Waste Management Act Objectives
	Municipal waste discharges to all receiving water and to soil		Sep/75	British Columbia Waste Management Act Objectives
	new or proposed (Level A)	0.05 mg/L		
	intermediate upgrade (Level B)	0.1 mg/L		
	Mining & smelting industries:		Feb/79	British Columbia Waste Management Act Objectives
	Ambient air control objectives	1.0-2.5 μg/m^3		
	gaseous & partic. emissions	0.16-0.27 mg/mol		
	final effluents discharge to marine/fresh waters	0.05-0.2 mg/L		

Table 3.2. (Continued).

Controlling Authority	Lead source	Lead Level	Date	Legislation and Current Status
BRITISH COLUMBIA (Continued)				
Ministry of the Environment	Chemical and petroleum industries: Air emmissions from Chlor-alkali and sodium chlorate industries:		Mar/74	British Columbia Waste Management Act Objectives
	new or proposed (Level A)	7 mg/m^3		
	intermediate upgrade (Level B)	11 mg/m^3		
	immediate upgrade (Level C)	23 mg/m^3		
	Effluents discharge to marine/fresh waters from petroleum refineries	0.20 mg/L	Mar/74	British Columbia Waste Management Act Objectives
	Effluents discharge to marine/fresh waters from other chemical ind.	0.20 mg/L	Mar/74	British Columbia Waste Management Act Objectives
	Special waste facilities:		Apr/88	British Columbia Waste Management Act Regulations
	effluent discharge	0.1 mg/L max.		
	thermal treatment emissions	5 mg/m^3		
	leachate extract concentration	5.0 mg/L		
Ministry of Labour Workers' Compensation Board	Workplace ambient air		Oct/79	British Columbia Workers' Compensation Act Regulations
	8 hour TLV	0.15 mg/m^3		
	15 min. TLV	0.45 mg/m^3		

Table 3.2. (Continued).

Controlling Authority	Lead source	Lead Level	Date	Legislation and Current Status
MANITOBA				
Department of the Environment and Workplace Safety & Health	Ambient Air MALC (Max. Accept. Level Conc.)	5.0 $\mu g/m^3$ (24 h)	Jul/85	Guidelines for Various Air Pollutants -Manitoba
	Workplace products	0.1% w/w	Oct/88	Ingredients Disclosure under WHMIS Regulations, Manitoba Workplace Safety and Health Act
	Hazardous waste leachate extract concentration	5 mg/L	Aug/87	Dangerous Goods Handling and Transportation Act Regulations
	Inorganic dust & fumes emissions	0.15 mg/m^3 (TWA)	Oct/88	Workplace Health Hazard Regulation, Manitoba Workplace Safety and Health Act
NEW BRUNSWICK				
Occupational Health and Safety Commission	Inorganic dust & fumes emissions			
	in mines (TWA)	0.15 mg/m^3	Jun/77	New Brunswick Mining Regulations, Mining Act
	all other workplaces (TWA)	0.15 mg/m^3	Jul/80	Occupational Health and Safety Act Regulations
	Workplace products	0.1% w/w	Oct/88	Ingredients Disclosure under WHMIS Regulations, Occupational Health and Safety Act
NEWFOUNDLAND				
Department of the Environment	Ambient air emissions standard		Nov/82	Air Pollution Control Regulations, Department of the Environment Act
	30 min average	10.0 $\mu g/m^3$ max.		
	Ambient air quality criteria			
	24 hour average	5.0 $\mu g/m^3$		
	30 day average	2.0 $\mu g/m^3$		

Table 3.2. (Continued).

Controlling Authority	Lead source	Lead Level	Date	Legislation and Current Status
NEWFOUNDLAND (Continued)				
Department of the Environment	Liquid effluent discharges:		Jul/80	Environment Control (Water and Sewage) Regulations
	into sewage	0.2 mg/L max.		Department of the Environment Act
	into any water body	0.2 mg/L max.		
Department of Labour and Manpower	Inorganic dust & fumes All workplaces (TWA)	0.15 mg/m^3	Jun/79	Occupational Health and Safety Act Regulations
	Workplace products	0.1% w/w	Oct/88	Ingredients Disclosure under WHMIS Regulations, Newfoundland Occupational Health and Safety Act
NORTHWEST TERRITORIES				
Department of Justice and Public Service	Inorganic dust & fumes			
	Mines		Jan/85	N.W.T. Mining Safety Act Regulations
	15 min. TLV	0.45 mg/m^3		
	8 hour TLV	0.15 mg/m^3		
	All workplaces (TWA)	0.15 mg/m^3	May/88	Northwest Territories Safety Ordinances
NOVA SCOTIA				
Department of Labour and Manpower	Inorganic dust & fumes All workplaces (TWA)	0.15 mg/m^3	Dec/76	Nova Scotia Health Act Regulations
Ministry of the Environment	Waste oil	100 mg/L max.	Nov/88	Waste Oil Regulation, Dangerous Goods and Hazardous Waste Management Act of Nova Scotia

Table 3.2. (Continued).

Controlling Authority	Lead source	Lead Level	Date	Legislation and Current Status
ONTARIO				
Ministry of the Environment	Drinking water (MAC)	0.05 mg/L	1983	Ontario Drinking Water Objectives
	Surface and ground water (dependent on alkalinity):		May/84	Provincial Water Quality Objectives
	≤ 20 mg/L ($CaCO_3$)	5 μg/L		
	20-40 mg/L ($CaCO_3$)	10 μg/L		
	40-80 mg/L ($CaCO_3$)	20 μg/L		
	> 80 mg/L ($CaCO_3$)	25 μg/L		
	Livestock watering	0.1 mg/L	May/84	Water Quality Criteria for Livestock Watering
	Irrigation water used:		May/84	Ontario Water Management Guidelines
	continuously, all soils	5.0 mg/L		
	up to 20 yr., fine textured soils (pH 6.0-8.5)	10.0 mg/L		
	Ambient air		Mar/75	Environmental Protection Act
	24 hour mean	5.0 $\mu g/m^3$		
	30 day geometric mean	2.0 $\mu g/m^3$		
	Point of impingement		Feb/90	Environmental Protection Act
	30 min. average	10 $\mu g/m^3$		
Ontario Ministry of Labour	Workplace air exposure		Aug/81	Occupational Health and Safety Act Regulations
	TLV-TWA	0.15 mg/m^3		
	15 min. TLV	0.45 mg/m^3		

Table 3.2. (Continued).

Controlling Authority	Lead source	Lead Level	Date	Legislation and Current Status
PRINCE EDWARD ISLAND				
Ministry of Fisheries and Labour	Inorganic dust & fumes (all workplaces)	0.15 mg/m^3 (TWA)	May/87	Occupational Health and Safety Regulations, Occupational Health and Safety Act of P.E.I.
	Workplace products	0.1% w/w	Oct/88	Ingredients Disclosure under WHMIS Regulations, Occupational Health and Safety Act
QUEBEC				
Commission de la Santé et de la Securité du Travail	Inorganic fumes & dust average concentration maximum concentration	 0.15 mg/m^3 0.45 mg/m^3	Dec/79	Quality of the Work Environment Regulation, Occupational Health and Safety Act of Quebec
	Workplace products	0.1% w/w	Apr/89	Ingredients Disclosure under WHMIS Regulations, Quebec Occupational Health and Safety Act
Ministère de l'Environnement du Québec	Drinking Water	0.05 mg/L	Jun/84	Quebec Environment Quality Act
	Solid waste disposal landfill leachates	 0.1 mg/L max.	Jan/82	Regulation Respecting Solid Waste, Quebec Environment Quality Act
	Hazardous waste (liquid waste or solid waste leachate)	2.0 mg/L	Oct/85	Hazardous Waste Regulation, Environment Quality Act of Quebec
	Ambient Air annual geometric mean	 0-2 μg/m^3	Feb/85	Regulation Respecting the Quality of the Atmosphere, Environment Quality Act of Quebec
	Secondary lead smelter emissions: reverb. & rotary furnaces, cupolas holding/kettle furnaces, etc.	 30 mg/m^3 max. 15 mg/m^3 max.	Feb/85	Regulation Respecting the Quality of the Atmosphere, Environment Quality Act of Quebec

Table 3.2. (Continued).

Controlling Authority	Lead source	Lead Level	Date	Legislation and Current Status
SASKATCHEWAN				
Department of the Environment	Spills (must be reported)		Apr/83	Environmental Spill Control Regulations
	on-site	≥ 10 kg		Saskatchewan Department of the Environment Act
	not on-site	≥ 2 kg		
	Surface water		Nov/88	Saskatchewan Surface Water Quality Objectives
	wildlife protection	0.02 mg/L		
	irrigation use	0.2 mg/L		
	livestock watering	0.1 mg/L		
	Drinking Water	0.05 mg/L	June/80	Municipal Drinking Water Quality Objectives -
Saskatchewan		(MAC)		
Department of Labour	Inorganic fumes & dust		Oct/88	Occupational Health and Safety Act Regulations
	8 hr TLV	0.15 mg/m^3		
	15 min. TLV	0.45 mg/m^3		
YUKON				
Department of Consumer Corporate and Labour Affairs	Inorganic fumes & dust		Nov/86	Yukon Occupational Health and Safety Act Regulations
	8 hr TLV	0.15 mg/m^3		
	15 min. TLV	0.45 mg/m^3		
	Workplace products	0.1% w/w	Oct/88	Ingredients Disclosure under WHMIS Regulations, Yukon Occupational Health and Safety Act

APPENDIX A.

ORGANIZATIONS AND INDIVIDUALS CONTACTED FOR THE PREPARATION OF THIS DOCUMENT.

ORGANIZATIONS.

1. Environmental Protection, Conservation & Protection, Yukon Branch, Environment Canada, Whitehorse, Yukon.
2. Environmental Health Division, Medical Services Branch, Whitehorse, Yukon.
3. Department of Municipal & Community Affairs, Yellowknife, Northwest Territories
4. Air Management, Waste Management Branch, Ministry of the Environment, Victoria, British Columbia.
5. Occupational Safety & Health Division, Workers' Compensation Board, Richmond, British Columbia.
6. Consumer and Corporate Affairs Canada, Vancouver, British Columbia.
7. Regional Director's Office, Health and Welfare Canada, Burnaby, British Columbia.
8. Water Quality Assessment Section, Alberta Environment, Edmonton, Alberta.
9. Consumer and Corporate Affairs Canada, Calgary, Alberta.
10. Consumer and Corporate Affairs Canada, Edmonton, Alberta.
11. Regional Inspector's Office, Health and Welfare Canada, Edmonton, Alberta.
12. Regional Inspector's Office, Health and Welfare Canada, Calgary, Alberta.
13. Occupational Health & Safety Branch, Saskatchewan Labour & Employment, Regina, Saskatchewan.
14. Consumer and Corporate Affairs Canada, Saskatoon, Saskatchewan.
15. Regional Inspector's Office, Health and Welfare Canada, Regina, Saskatchewan.
16. Waterworks Waste and Disposal Department, City of Winnipeg, Manitoba.
17. Consumer and Corporate Affairs Canada, Winnipeg, Manitoba.
18. Regional Director's Office, Health and Welfare Canada, Winnipeg, Manitoba.
19. Air Resources Branch, Ontario Ministry of the Environment, Toronto, Ontario.
20. Occupational Health & Safety Division, Ontario Ministry of Labour, Toronto, Ontario.
21. Water Resources Branch, Ontario Ministry of the Environment, Rexdale, Ontario.
22. Director of Water Supply, Metropolitan Works Department, Toronto, Ontario.
23. Regional Director's Office, Health and Welfare Canada, Scarborough, Ontario.

24. Consumer and Corporate Affairs Canada, Montreal, Quebec.

25. Regional Director's Office, Health and Welfare, Longueuil, Quebec.

26. Air Quality Section, Environmental Protection Branch, Department of Municipal Affairs and Environment, Fredericton, New Brunswick.

27. Soil surveyor, Plant Industry Branch, Department of Agriculture, Fredericton, New Brunswick.

28. Environmental Sciences Branch, Department of Municipal Affairs and Environment, Fredericton, New Brunswick.

29. Consumer and Corporate Affairs Canada, Moncton, New Brunswick.

30. Occupational Health, N.S. Department of Labour, Halifax, Nova Scotia.

31. Chief Public Health Inspector, Department of Health and Fitness, Halifax, Nova Scotia.

32. Consumer and Corporate Affairs Canada, Halifax, Nova Scotia.

33. Regional Inspector's Office, Health and Welfare Canada, Halifax, Nova Scotia.

34. Regional Inspector's Office, Health and Welfare Canada, Charlottetown, Prince Edward Island.

35. Consumer and Corporate Affairs Canada, St. John's, Newfoundland.

36. Regional Inspector's Office, Health and Welfare Canada, St. John's, Newfoundland.

37. Canadian Center for Occupational Health & Safety, Hamilton, Ontario.

38. Canadian Medical Associations in all 10 provinces and 2 territories.

INDIVIDUALS.

1. Mr. Mark Allen, Environmental Health, N.B. Department of Health & Community Services, Fredericton, New Brunswick.

2. Mr. Richard Murry, Canadian Paint and Coatings Association, St-Laurent, Quebec.

3. Dr. Sam Kacew, Department of Pharmacology, Faculty of Health Sciences, School of Medicine, University of Ottawa, Ottawa, Ontario.

4. Dr. Robert A. Goyer, Department of Pathology, University of Western Ontario, London, Ontario.

5. Dr. Gillian Lockitch, Department of Pathology, B.C. Children's Hospital, Vancouver, British Columbia.

6. Dr. Jerome O. Nriagu, National Water Research Institute, c/o University of Michigan, Ann arbour, Michigan, USA.

7. Dr. Milton Tenenbein, Poison Control Center, Children's Hospital, Winnipeg, Manitoba.

8. Dr. Jeremy Clapp, Pace Environs, Scarborough, Ontario.

9. Dr. Evert Nieboer, Department of Biochemistry, McMaster University, Hamilton, Ontario.

10. Dr. Pamela Welbourn, Watershed Ecosystems, Trent University, Peterborough, Ontario.

11. Dr. Patrick Levallois, Département de Santé Communautaire du Centre Hospitalier de l'Université Laval, Ste-Foy, Québec.

12. Dr. Lesbia Smith, Environmental Health & Toxicology Unit, Public Health Branch, Ontario Ministry of Health, Toronto, Ontario.

13. Peter Hanlon, Water & Sewerage Department, Saint John Waterworks, Saint John, New Brunswick.

14. Dr. Richard Scott, Forensic & Clinical Toxicology, Saint John Regional Hospital, Saint John, New Brunswick.

15. Dr. Michael Inskip, Health Protection Branch, Health & Welfare Canada, Ottawa, Ontario.

16. Grace Wood, Health Protection Branch, Health & Welfare Canada, Ottawa, Ontario.

17. Ruta Whittaker, Health Protection Branch, Health & Welfare Canada, Ottawa, Ontario.

18. Dr. Deborah Rice, Health Protection Branch, Health & Welfare Canada, Ottawa, Ontario.

19. Dr. Scott Flemming, Hazardous Contaminants Branch, Ontario Ministry of the Environment, Toronto, Ontario.

20. Dr. Michael Hinds, Assay Department, Royal Canadian Mint, Ottawa, Ontario.

21. Dr. Gideon Koren, Clinical Pharmacology & Toxicology, Hospital for Sick Children, Toronto, Ontario.

22. Linda Peros, Gore & Storrie Ltd., North York, Ontario.

23. Dr. Marc Rhainds, Département de Santé Communautaire du Centre Hospitalier de l'Université Laval, Ste-Foy, Québec.

24. Geoffrey Bawden, Workplace Safety & Health, Manitoba Department of Labour, Winnipeg, Manitoba.

25. France Lemieux, Product Safety Branch, Consumer and Corporate Affairs, Hull, Quebec.