THE PORT PIRIE
LEAD IMPLEMENTATION PROGRAM

FUTURE FOCUS AND DIRECTIONS

Edward J Maynard

Lynda J Franks

Mark S Malcolm

December 2005

Department of Health

Adelaide

December 2005
The Port Pirie Lead Implementation Program:
Future Focus and Directions

Review Panel;

- Edward J Maynard, Environmental Health Service, Department of Health, Adelaide
- Lynda J Franks, Uniting Care Wesley, Port Pirie
- Mark S Malcolm, Southern Flinders Ranges Development Board, Port Pirie

A Report Prepared for the South Australian Minister for Health by the Review Panel.

Key Words

1. Port Pirie
2. Lead Smelting
3. Lead Decontamination
4. Blood Lead
5. Fugitive Emissions
6. Household Contamination
7. Airborne Lead
8. Environmental Lead
9. Program Review

Glossary

DECS	Department of Education and Children's Services
DH	Department of Health
EHC	Environmental Health Centre (Port Pirie)
EIP	Environmental Improvement Program
EPA	Environmental Protection Agency
NH&MRC	National Health and Medical Research Council
PPLIP	Port Pirie Lead Implementation Program (Also called Lead Program)
SAHC	South Australian Health Commission
SAHT	South Australian Housing Trust

ACKNOWLEDGEMENTS

The review panel sincerely thanks the EPA, Zinifex, Port Pirie Regional Council, the Lead Program Steering Committee, the large number of Port Pirie stakeholders, members of the Port Pirie community and Environmental Health Centre (EHC) staff who generously made their time available to reflect on the strengths and weaknesses of the past and develop a vision and plans for the future. The panel regrets that individual contributions to this report can not be acknowledged but hopes the energy and commitment to the future of key stakeholders provides them with some satisfaction and acknowledgement for their efforts.

The Department of Health gratefully acknowledges the enormous time given by the panel members, the support of their families, and of the Uniting Care Wesley and the Southern Flinders Ranges Development Board.

The review panel also pays tribute to the Port Pirie Investigation Group. Its many staff members over the last 10 years or so have provided the foundations of understanding for a more effective future.

The review panel commends the Environmental Health Centre staff and many other SA Government employees, Port Pirie stakeholders, parents of the Port Pirie children, smelter staff, and a large group of committed supporters who together have worked to produce the benefits of reduced lead exposure. The Lead Program and its success to date has indeed been a sustained and remarkable collaborative effort.

The South Australian Government undertakes the Port Pirie Lead Implementation Program (PPLIP).

DISCLAIMER

The review was carried out and this report prepared by a panel of 3 members (listed elsewhere as authors) appointed by the Minister for Health. The contents of this report depend on a large number of generous contributors but remain the responsibility of the review panel.

The report will be considered by the Department of Health, the Minister for Health and the SA Government, but should not be considered a document endorsed by them nor a set of recommendations accepted by them.

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1.1 Background

The Port Pirie Lead Implementation Program (PPLIP or Lead Program) was established by the South Australian Government in 1984 in response to a history of environmental lead contamination which had accompanied 100 years of smelting in Port Pirie. The resultant lead burden exposed a high proportion of children in Port Pirie to an unacceptable level of lead in their environment. The primary objective of the Port Pirie Lead Implementation Program was to protect children from the deleterious effects of lead, and was directed at what was then considered the main source of lead, historical contamination.

In 1984, 98% of young children exceeded the current national goal (NH&MRC) of 10µg / dL. This has been significantly improved with a fall to 55% by 2001. In recent years the downward trend has reached a plateau, and in some areas of Port Pirie, increased a little. Although trends have fluctuated somewhat over the last 20 years, this recent situation is clearly unacceptable, and levels must continue to fall. The health of children in Port Pirie must continue to be a priority.

Continued funding of the Lead Program was announced in the 2004 SA State budget along with a review to determine the Program's future goals and focus. This report presents the review panel's vision for the future following extensive consultation.

The Zinifex Port Pirie Smelter plays a significant role in the South Australian economy with annual sales of metal products exceeding $400 million dollars per year, of which 80% is exported. As the world's largest lead smelter, handling some 320,000 tonnes per year of fine lead-rich new concentrates, it has over the last 100 years or so has caused substantial contamination of the Port Pirie environment with lead, zinc, arsenic, cadmium and other heavy metals.

At the exposure levels experienced in Port Pirie, lead interferes with the transport of constituents (particularly calcium) across membranes of cells which inhibits enzymes and disturbs the development of many organ systems particularly the central nervous system. Long lasting adverse effects in neurobehavioural function, particularly intellectual performance (decrement of 1-3 I.Q. points per 10µg / dL increment in blood lead), impaired haemoglobin synthesis and vitamin D metabolism appear to be the most sensitive effects of lead exposure. Lead exposure is not the only, nor the major, contributor to these effects.

Infants and toddlers are at greater risk due to increased exposure (mouthing behaviour), increased ability to absorb lead and the susceptibility of their rapidly developing central nervous systems. Older children, adolescents and non-occupationally exposed adults exhibit near normal blood lead levels unless significantly exposed during early life.

The Lead Program involves identification of all children; testing for blood lead levels; community education; casework support, education, house decontamination and selective relocation for high blood lead families; and development of heavily vegetated buffer zones around the smelter.

Supported by the Department of Housing and Construction, over 2,200 houses have been decontaminated and upgraded and many of the poorest removed.

Since 1984, the smelter operators have implemented substantial new fugitive emission controls and contributed directly to Program activities through services such as laboratory analysis and disposal of contaminated building waste.

The Port Pirie Regional Council sealed footpaths, rehabilitated parks and playgrounds, and amended its Supplementary Development Plan to limit the number of new dwellings adjacent to the smelter, and supervised vacant allotments.

The Environmental Protection Agency (EPA) has contributed actively through air monitoring, collaboration with investigations and regulating environmental performance.

In October 1993, State Cabinet considered a detailed review of the first 10 year program and approved a further ten year commitment which included an intensive investigation program into lead contamination sources and pathways to children.

Pirie West, Solomontown, the central business district and to a lesser extent other areas are subject to heavy ongoing contamination when viewed against the daily uptake required by young children to stay below 15µg / dL blood lead (approximately 30-40µg / day). The areas subjected to greater lead dust contamination levels are located down wind of the smelter or in close proximity to the western boundary of the smelter.

These regions are clearly circumscribed by the blood lead levels of children which on average are up to 9µg / dL higher than those of low contamination areas.

Airborne deposition of lead contaminated dust appears to be the primary pathway of contamination of Port Pirie children's living space. Dust is transported mainly through wind action, primarily by re-entrainment, from both environmental sinks around, the smelter and new fugitive emissions. Transport of airborne lead occurs principally on days of high velocity winds in association with dry conditions. Human, vehicle and material handling activities assist in dust raising. Plumes of fine particle emissions from the major processing plants are also important ongoing sources of offsite contamination.

Collaborative investigation with Zinifex (formerly Pasminco) has identified and prioritised the major ongoing sources and in collaboration with the EPA established an improvement program since 2003. A reduction of fugitive emissions from the smelter site is fundamental to the reduction of children's blood lead levels.

Investigation has shown that a complex set of normal family activities lead to exposure of young children in houses that have indoor lead dust reservoirs, from ongoing contamination. This finding suggests the need for strategies that reduce house contamination and the limited potential impact of daily behaviour change approaches.

The SA Government's continued support has always aimed at a collaborative approach to contamination problems and the development of innovative solutions toward a sustainable future.

1.2 Future Directions

1.2.1. Focus: Bold Action to Reduce Blood Lead Levels

The review panel strongly recommends that the principal focus for the future should be broad community commitment to a negotiated common plan to boldly reduce current unacceptable blood lead levels sponsored by a partnership between Zinifex, agencies of SA Government and Port Pirie stakeholders.

The bold, joint initiative, launched at a public commitment of principal stakeholders, will form the essential foundation for invigorated ownership of the lead issue.

1.2.2. Principles

(1) Safe Blood Lead Levels

Acceptable blood lead levels are considered to be essential to a sustainable community and industry.

(2) Reduce Smelter Emissions

In the face of ongoing contamination of houses from current smelter operations, major efforts to reduce emissions are essential to the future reduction of blood lead levels.

(3) Safer Household Environments

Reduce indoor contaminated dust reservoirs and dust entry into houses rather than focus on the daily behaviours of family and carers to reduce infant and toddler exposure.

(4) Unified, Target Driven Approach

A unique opportunity is currently provided by the willingness of principal partners to work together to a common plan to boldly address the children's exposure problem which is adversely affecting the Port Pirie community.

(5) Stretch Target

The review panel and Zinifex strongly endorse the need to set challenging, time limited blood lead targets that are beyond current capacity and understanding to stimulate commitment and the development of innovative approaches.

1.2.3. Goal

The only goal considered acceptable is to reduce young children's blood lead to safe levels, i.e. to the national goal of under 10µg / dL.

1.2.4. Stretch Target Blood Lead Level

The stretch target should be 95% of 0-4 year olds under 10µg / dL by the end of 2010, with no children over 20µg / dL.

1.2.5. Target Groups

Focus on early childhood exposure reduction with particular attention to infants and toddlers under two years of age and families of pre-school children with blood levels above 15µg / dL.

As blood lead testing will progressively not be offered to children older than 24 to 36 months who have had levels consistently below 10µg / dL: achievement of this target should be based on testing of all children up to 24 or 36 months of age as well as follow-up testing of children equal to or above 10µg / dL.

1.2.6. Primary Strategies

Focus on effective strategies that reduce blood lead by aggressively reducing smelter emissions and reducing exposure in the indoor home environment rather than by relying on the personal behaviours of residents.

(1) Control the Contamination Source

Scientific investigations have shown that ongoing smelter operations are the major cause of household contamination and elevated blood lead levels in children. Zinifex recognises a

responsibility to aggressively reduce emissions under the supervision of the EPA and assisted by PPLIP scientific expertise. Principal sources relevant to childhood exposure have been identified, and a progressive program of control strategies will be implemented. Substantial work on the slag fuming and kilns plants has already been completed.

(2) Safer Household Environments

The investigation program has demonstrated the need to focus on providing safer physical house environments rather than on exposure avoidance behaviours of carers of young children. Exposure reduction during renovation, house dust proofing, and improvements in rental accommodation and advice on house suitability for home buyers can be implemented widely. Promising new dust control strategies are being developed.

(3) Reduce Absorption into Children

Reduce exposure by reducing lead absorption. Dietary programs should promote early morning snacks / breakfast to reduce the enhanced absorption that occurs during overnight fasting, and promote the prudent diet including adequate iron intake. Use of carpet phosphate treatment to bind lead will be evaluated.

(4) Minimise the Adverse Impact of Lead Exposure

Families of pre-school children with the highest exposure are further disadvantaged by poorer housing, socio-economic situation and complex and other concurrent problems. Social justice requires collaborative, individualised casework support for these families, special efforts to relocate them to safer environments where possible, housing improvements to reduce dust entry, enhanced pre-school education opportunities and early detection and intervention to reduce neurological development delay. Zinifex should be encouraged to work with the SA Government to support these community programs. The panel recognises housing improvement and relocation strategies are more expensive.

1.2.7. Supportive / Enabling Strategies

Several support programs are needed to enable implementation of bold and effective blood lead reduction strategies and contribute to more efficient community resource use by PPLIP and local services.

- Expanded consultation and engagement with the local community will be essential to community-wide commitment to a bold action plan.

- Ongoing community-wide education program on priority lead exposure protection behaviours is important for all families and particularly effective amongst the lower risk, more affluent parts of Port Pirie. Lead issues need to be part of a broader healthy living focus delivered in collaboration with local health services.

- Blood lead monitoring from early infancy and blood lead level tailored intervention and collaborative follow-up.

- Collaborate with other Port Pirie health, education and social services to improve the efficient use of local resources and strengthen local partnerships;

- Collaborate with the Port Pirie Regional Council to secure its active contribution to land use, housing and site contamination management strategies.

- Undertake a thorough review of management structures and of the skills and understanding of PPLIP staff to improve service delivery.

- Develop the skills and commitment of Zinifex staff to improve process control and environmental performance.

- The bold blood lead target requires a commitment to innovative strategy development, evaluation and monitoring to support effective major emission reduction, reduction in indoor dust contamination and to evaluate progress.

1.2.8. Implementation

The review panel acknowledges with pleasure the rapid progress that has been made in recent months toward joint and bold action to reduce blood lead levels. Under Zinifex leadership and energetic commitment, an innovative project – 10 by 10 – is taking shape (ie, blood lead levels of 95% of children, 0-4 years, below 10µg / dL by the end of 2010):

- An executive board for 10 by 10 has been formed consisting of chief executive level officers of the principal partners to provide strategic direction;

- A working party of senior officers from principal partners has been meeting regularly to develop implementation plans;

- Zinifex has committed as a company to controlling its emissions to achieve 10 by 10 and to achieve a sustainable smelter and community;

- Zinifex has identified key emission control strategies, has approved $18m over the next 3 years and is developing proposals for additional initiatives;

- Zinifex is leading 10 by 10 community consultation, discussions with smelter staff, exploration of interventions to reduce take-home lead by staff and other supportive projects; and

- A public commitment to 10 by 10 and launch is being planned.

The following recommendations outline other initial components of a detailed implementation plan which will be needed to support the foregoing vision for the future.

- Further negotiation between the EPA, SAHT, DECS and the Department of Health to refine specific and innovative strategies as the basis for a whole-of-government approach.

- Using a planned approach guided by a consultant, revise current PPLIP programs, budgets and staff roles and redevelop these to better reflect future directions. External advice on delivery planning and improved human resource outcomes including a targeted staff training plan is needed to enable PPLIP to function effectively as the key agent for delivering SA Government commitments to 10 by 10.

- Establish local interagency development groups around:
  - early childhood services,
  - community education and health promotion,
  - nutrition,
  - development delay, and
  - family-centred case management.

- Explore opportunities for additional funding for effective strategies:
  - increasing the availability of and bridging the financial gap to low risk area housing,
  - housing modifications to reduce contaminated dust entry,
  - clearing residual housing from agreed buffer zones, and
  - purchasing of substandard housing.

Encourage Zinifex to contribute to community programs where that is the most effective use of their resources towards achieving 10 by 10.

2. INTRODUCTION

The Port Pirie Lead Implementation Program (Lead Program) was established by the South Australian Government in 1984 in response to a history of environmental lead contamination which had accompanied 100 years of smelting in Port Pirie. The resultant lead burden exposed a high proportion of children in Port Pirie to an unacceptable level of lead in their environment. The primary objective of the Lead Program was to protect children from the deleterious effects of lead. In broad terms, the Program aimed to achieve:

- A reduction in the number of children who had a blood lead concentration greater than the National Health and Medical Research Council (NH&MRC) "level of concern", and

- A reduction in the average blood lead levels of Port Pirie children.

In 1984, 98% of young children exceeded the current national goal (NH&MRC) of 10µg/dL. That has been significantly improved with a fall to 55% by 2001. In recent years the downward trend has reached a plateau, and in some areas of Port Pirie, increased a little. This is clearly unacceptable, and levels must be reduced. The health of children in Port Pirie must continue to be a priority.

The SA Government has a long and distinguished history of protecting the health of Port Pirie children from the effects of environmental contamination. In the process, its Lead Program has helped to ensure a viable regional city and the future of a major SA economic enterprise.

The Lead Program is a source of pride for the SA Government both because of the progress made and because it leads the world in understanding how children become exposed to dust contaminants and in developing original strategies to protect them. It is viewed as a successful example of joint efforts of Government, industry and a local community to solve problems in pursuit of a sustainable future.

Continued funding for the Lead Program was announced in the 2004 SA State budget along with a review to determine the Program's future goals and focus.

The Lead Program has always sought new approaches to improve its services and health outcomes. It was extensively reviewed and revised in 1993, and to a lesser extent in 1998. The Program has also conducted a comprehensive investigation program to improve outcomes since 1994.

Much has been learned over the first 20 years of the Program in Port Pirie and from the experience of similar programs elsewhere. Investigations of sources at the smelter, pathways of residential contamination and of children's exposure in the home also provide a wealth of understanding relevant to future planning. The Review panel carefully considered this background material, aided by the presentations and discussion at the 2003 International Lead conference held in Port Pirie.

Nevertheless, a simple technical or scientific solution to the Port Pirie contamination problem is not available in the face of ongoing contamination from an operating smelter. In comparable situations overseas smelters have closed as part of efforts to reduce children's blood lead levels. In contrast, Port Pirie has sought a collaborative solution with industry and the community.

With future funding secure, the consultative review provided a good opportunity to talk to stakeholders and the Port Pirie community about experience over the last 20 years and their future vision for the Program.

Clearly, a concerted and co-operative effort is needed to deliver improved results. The review looked broadly to identify the future focus and goals and to determine the main strategies for achieving that vision. The review has incorporated:

- Wide public consultation,
- The Lead Program investigation findings,
- Decontamination program experience from elsewhere,
- Detailed consultation with the key partners: Zinifex, Port Pirie Regional Council, the EPA, and the Environmental Health Centre (EHC),
- Consultation with the broader group of Port Pirie stakeholders,
- Consideration of barriers to further blood lead reduction,
- Consideration of the strengths and weaknesses of the current Lead Program,
- The principles and values of the Government's Generational Health Review, and
- Identification of partnerships, roles and initiatives needed for the future.

Expressions of interest were sought from a wide range of community interests in Port Pirie for potential members of the review panel. Extensive community knowledge and involvement, credibility, acceptance as opinion leaders, and availability for the demands of the task were central criteria. Many have expressed interest but were unavailable for another major task over the review period. In the end, a small panel with considerable experience in community services, economic development, public health science and the previous 20 years of the Port Pirie Program was brought together to lead this review:

- Mrs Lynda Franks, Manager Accommodation / Reconnect, Uniting Care Wesley, Port Pirie;
- Mr Mark Malcolm, Executive Manager, Southern Flinders Ranges Development Board; and

- Dr Ted Maynard, Manager, Special Programs Section, Environmental Health Service, Department of Health and Chair, Port Pirie Lead Implementation Program Steering Committee.

During the course of the review, the panel has:

- Conducted review meetings in Port Pirie on over 25 occasions;
- Interviewed each principal partner on several occasions (Council, Zinifex, EPA, Lead Program Steering Committee, Mrs Cathy Phipps (Director, EHC));
- Interviewed stakeholders from Port Pirie Regional Health Service (x11), SA Housing Trust, Department of Administrative & Information Services, Child Care Centre, Kindergartens, Australian Workers Union, Child & Youth Health, the Department of Education & Children's Services, Aboriginal Housing Authority and Uniting Care Wesley;
- Conducted a half-day workshop with the above stakeholders;
- Distributed pamphlets to every residence and business in Port Pirie (7500) explaining the review and identifying several mechanisms for public involvement;
- Placed local newspaper adverts and conducted local media interviews;
- Held an evening public meeting;
- Held interviews with individual members of the community;
- Received written submission from members of the community; and
- Interviewed Port Pirie Environmental Health Centre staff.

The review panel is pleased to present its report which provides a combination of historical background, current program discussion, investigation findings and a considered vision for the future. We look forward to a re-invigorated effort to protect the health of the Port Pirie community and to a sustainable future.

3. BACKGROUND

Port Pirie is a small provincial city with a population of approximately 14,000 people, situated 230 kilometres north of Adelaide.

The terrain is flat, the climate arid, and prevailing winds blow from the north west, south east and south west, depending upon the season. While Port Pirie originally developed as a grain port, the major industry for the last one hundred years has been lead smelting and refining.

3.1 Lead Smelting

Concentrated lead ore was first brought by road from Broken Hill to Port Pirie in August 1885. Two years later the ore began arriving by rail in open wooden trucks. Today, the ore arrives in covered 55 tonne metal rail wagons.

Until 1914, most of the lead concentrate and almost all the zinc concentrate, together with a great deal of unrefined lead bullion, was sold to overseas buyers and was shipped from Port Pirie to smelters in Europe.

When World War I stopped the export trade, the expansion of the Port Pirie smelter became a matter of national urgency.

In May 1915, the smelting operations were purchased by a consortium of companies called Broken Hill Associated Smelters (BHAS). The first objective of the new company was to provide permanent smelter facilities for Broken Hill's mining output.

The Zinifex Port Pirie smelter still meets that commitment today. In addition to lead production, zinc is recovered electrolytically from blast furnace slag and sulphuric acid from the sulphur dioxide produced during the smelting. Other valuable commodities such as antimony, cadmium, copper, gold and silver are extracted leaving the refined market lead with a purity of approximately 99.99% lead.

The Zinifex Port Pirie smelter plays a large role in the South Australian economy with annual sales of metal products exceeding $400 million dollars per year, of which 80% is exported. It is the world's largest lead smelter and handles some 320,000 tonnes per year of finely divided, lead-rich feedstock, which over the last 100 years or so has caused substantial contamination of the Port Pirie environment with lead, zinc, arsenic, cadmium and other heavy metals.

3.2 Historical Sketch

1925 Royal Commission

In 1925 a Royal Commission looked into the high numbers of lead affected Port Pirie workers and began the research into the properties of lead and its effects on the local environment.

Early to Middle 1970's

Extensive investigation by the CSIRO Division of Soils of heavy metal pollution in Port Pirie and the surrounding region found the most polluted soils in the central business district and south eastern areas of the City, with moderate levels in the north-western area.

1979

The Port Pirie Cohort Study of the effect of lead on the neurological development of children commenced although no blood lead data or other findings were available for some years.

1981

A request for blood lead testing of young children was launched by a local school council following notification that drinking water collected in a rainwater tank on the school campus contained elevated lead levels and was unsuitable for drinking purposes.

1982

In 1982, a survey of 50% of primary school aged children living in Port Pirie revealed that 7% of the 1,239 children tested had a blood lead level at or above 30 micrograms per decilitre (µg / dL), the National Health and Medical Research Council (NHMRC) level of concern at that time.

The survey also indicated that children with the highest blood lead levels tended to reside in areas which were later classified as "high risk areas" and known locally as Pirie West and Solomontown.

1983

In March 1983 a Task Force was established by Dr John Cornwall, the then Minister of Health, to undertake an assessment of the local environment and to provide recommendations to Government. It concluded that environmental lead contamination was both a personal and public health problem for the people of Port Pirie. Their report recommended a multi-faceted approach, based on environmental health and individual family considerations, to deal with the immediate sources and root causes of lead contamination, and with

lowering blood lead levels in children. 200 children were estimated to exceed the recommended limit of 30µg / dL of that time.

Consultants to Government and the Task Force included Dr Phillip Landrigan, Director of the Division of Surveillance, Hazard Evaluations and Field Services, National Institute for Occupational Safety and Health, Ohio, USA, Dr Tony McMichael, a senior research scientist with the CSIRO Division of Human Nutrition, Adelaide, and Professor Michael Rutter, an eminent British authority on the effects of lead contamination.

On the 19th December, 1983, the public release of all documents and reports was approved by the SA Cabinet. Cabinet also approved the establishment of a local steering committee to implement a program to reduce the risk of children having elevated blood lead levels, and the creation of a centre from which the program could be co-ordinated.

3.3 The Lead Implementation Program (1984-94)

In 1984 the South Australian Government made a commitment to a 10 year program for the decontamination of Port Pirie with the objective of reducing children's blood lead level below the existing Australian National Health and Medical Research Council (NHMRC) 'level of concern' of 30µg / dL, reduced in 1987 to 25µg / dL. The Lead Program was directed at what was then considered the main source of lead, the historical contamination of the city and houses. Emissions from current smelting operations were considered at the time to be at a satisfactory low level. The Lead Program initially focussed on identifying children with a blood lead level above the 'level of concern' and decontaminating their homes and then on systematic decontamination of the worst affected residential areas.

The first ten year program included decontaminating approximately 2,200 domestic residences managed by the Department of Housing and Construction, the demolition of nearly 100 properties unsuitable for decontamination, treatment of institutions frequented by young children, soil stabilisation and general city greening, footpath sealing, family support and counselling and community education.

Blood levels were substantially reduced with the proportion of children above 25µg / dL reduced from 30% in 1984 to 5-7% by the end of the first 10 years. To June 1993, the SA Government had spent over $ 25 million.

In October 1993, the SA Cabinet considered a detailed review of the first 10 year Lead Program (Maynard et al., 1993) which identified major obstacles to the further reduction of children's blood lead levels towards the new NHMRC goal of 10µg / dL. The review also brought back into question the ongoing contamination / re-contamination of houses and the need to urgently reconsider emission performance of the smelter, the location of major ongoing lead

sources, pathways of lead contamination into the living spaces of houses, and the indoor exposure of very young children.

The 1993 review identified several issues that needed to be acknowledged and / or tackled to achieve further reductions in children's blood lead levels:

- The long term unsustainability of the degree of behaviour change necessary to reduce blood lead in the high risk areas,
- The persistence of environmental lead contamination, especially in the form of lead bearing dusts in an arid often windy residential area,
- Recontamination of homes that had been subject to primary home-based decontamination,
- Proximity to an operating smelter,
- The social characteristics of high risk families affect blood lead and the practicability of intervention,
- The difficulty of identifying the relative contribution of lead dust sources to exposure within households,
- The 1983 Task Force conclusion that the smelter and its surroundings was not a significant ongoing source of lead contamination,
- The inadequate understanding of mechanisms (and their relative contributions) for household lead contamination from the wider Port Pirie environment,
- The need for voluntary participation, and limits to the active support of the Port Pirie community,
- The lack of precise information on the relative long term impact of the different Program components,
- Limitations of the physical environment to greening, and buffer development,
- Ongoing contamination of rainwater and its consumption, and
- Difficulties and costs associated with permanent relocation of children and their families.

In view of this assessment and the agreed necessity of further reducing children's blood lead, the second Lead Program included a major investigation component to provide a better basis for identifying and controlling major sources and for developing strategies for reducing exposure within households.

Clearly, removal of historical contaminated dust and paint had proved to be an insufficient intervention.

In suggesting appropriate goals for Port Pirie, a locality affected by substantial contamination, it was recognised that the new national goal of 10µg / dL would require the Program to tackle a much larger group of newly defined high risk children and need strategies beyond those already employed to reach current blood lead levels. In this context, the need to more effectively address the environmental sources of lead as well as refocus Program strategies became quite evident. A goal of 10µg / dL was seen as clearly impossible to achieve in a short timeframe without the very substantial resources required to relocate large parts of the City. As a result, setting out options for realistic goals defined in terms of population percentages, age groups and areas, to be achieved over a ten year time-span, was considered the best approach.

Cabinet approved a further ten year commitment of $2.4 m per annum beginning with the 1994-95 financial year and endorsed the need for collaborative action to identify and control ongoing fugitive metal emissions in order to further reduce children's blood lead levels towards the newly established Australian goal of 10µg / dL.

3.4 Other Important Contributions

3.4.1. Pasminco and previous proprietors also implemented a substantial program at the smelter to reduce the transfer of lead to the Port Pirie environment:

- Internal ameliorative measures costing more that $1.8 million involved upgrading the change rooms, showers and laundry facilities for workers and providing full work clothing. These improvements were directed at reducing the exposure of workers' family members.
- Completed slag dumps were faced with rock mulch, covered with soil and revegetated.
- This effort was increased from 1987 with the Environmental and Economic Enhancement Program costing some $30 million.

Pasminco made direct contributions to the Lead Program by:

- Analysing blood and rain water for lead,
- Collecting and safely disposing of contaminated soil and material from the decontamination and demolition of houses,
- Supporting an air lead monitoring program, and
- Donating industrial vacuum cleaners.

3.4.2. The Port Pirie Regional Council undertook a footpath sealing program, rehabilitation of parks and playgrounds, and amended its Supplementary Development Plan to limit the number of new dwellings adjacent to the smelter. Council has also assumed caretaker ownership of allotments resulting from the demolition of substandard houses purchased by the Lead Program and has an agreement with Government controlling the future disposal of these allotments.

3.4.3. The Department of Environment and Planning substantially increased air monitoring and conducted several investigations to improve understanding of lead sources and movement around Port Pirie.

3.5 Lead and Health

At the exposure levels experienced in Port Pirie, lead interferes with the transport of constituents (particularly calcium) across the membranes of cells and structures within cells which inhibits enzymes and disturbs the development of many organ systems particularly the central nervous system. Long lasting adverse effects in neurobehavioural function, particularly intellectual performance, impaired haemoglobin synthesis and vitamin D metabolism appear to be the most sensitive effects of lead exposure. While exposure to the other heavy metals appear to be below the threshold of significant adverse effects, world research on the effects of non-occupational exposure to these heavy metals is much less developed. Infants and toddlers are at greater risk due to increased exposure (mouthing behaviour), increased ability to absorb lead and the susceptibility of their rapidly developing central nervous systems.

The most substantial evidence relates to the reduction in intelligence quotient (IQ) (as assessed at age 4 and above) of between 0-5 points for each 10µg / dL increase in blood lead level within the range 10-25µg / dL.

Following international consideration of the adverse health effects of lead, the NHMRC announced in June 1993 a new goal that ALL Australians should have a blood lead level less than 10µg / dL, with particular attention to young children and pregnant women. The NHMRC guidelines required community action to reduce lead exposure where more than 5% of children exceeded 15 µg / dL and individual action for every child with a level above 15µg / dL. While a threshold of no effect could not robustly be established, the United States, Canadian, Australian and other Governments all set this operational goal of 10µg lead per 100mL of blood to provide practicable protection.

4. THE LEAD IMPLEMENTATION PROGRAM (1994-2004)

4.1 Current Strategies and Program Components

4.1.1. Program Management

The Port Pirie Lead Implementation Program is managed as a health protection component of the Department of Health's Environmental Health Service (EHS).

In Port Pirie the focus of the program is the Environmental Health Centre (EHC). The Director of the EHC reports to the Director of Public Health and to the Manager, Special Programs Section (EHS) who is both Chairman of the Program Steering Committee and has overall responsibility for EHC scientific services including source and exposure investigations, evaluation and monitoring programs.

The Principal Scientific Officer of the EHS Special Programs Section provides scientific leadership of the investigation program and manages EHC's scientific staff.

The Lead Program Steering Committee provides advice and co-ordination and is representative of Government agencies involved, Port Pirie Regional Council, Zinifex, medical practitioners, the Trades and Labour Council, and other local expertise co-opted to assist the Program.

4.1.2. Blood Lead Screening

Blood lead testing is available during pregnancy and always made available to a new mother in the week following the birth of their baby. Research has demonstrated a close correlation exists between a mother's blood lead level and that of her new born. Routine screening of children is provided at six monthly intervals for the first year and then annually until the child is four years of age. Older children aged five to seven years are screened either bi-annually or tri-annually through schools depending on the school's distance from the smelter.

All children with blood lead levels above 15µg / dL receive follow up testing, the frequency of which depends on their age and blood lead level.

4.1.3. Recruitment & Compliance

The Program enjoys a high enrolment and compliance outcome for Port Pirie children. Close working relationships with staff in birthing and childcare institutions plus community word-of-mouth ensures a high percentage of enrolments are achieved. Methods employed to maximize

retention and keep track of enrolled clients together with quality service delivery ensures a high compliance.

4.1.4. Pregnancy & Early Infancy

Every expectant mother is encouraged to visit the EHC for a blood test to identify any problems and to receive information on diet such as the importance of calcium and iron-rich food. Calcium and iron supplements have been provided to a number of financially disadvantaged clients who have been under direction to take supplements by their medical practitioner.

Within the first week of birth, the mother and baby are visited at home and a blood sample taken from the mother to give an accurate estimate of her infant's blood lead level. The visit assists in identifying high risk clients and with the mother's consent appropriate referrals are made.

The infant is seen again at six months of age with the subsequent result determining intervention.

4.1.5. Publicity & General Community Awareness

Public awareness of the lead issues and education has occurred through the media, which have played an important educational role in partnership with a proactive contribution from the EHC. Other strategies have included the development of specific materials for the public, pre-schools and schools, specific health promotional events and activities, contributions to other agency's newsletters and by increasing the educational role of agencies and health workers.

4.1.6. Family Education

Printed educational materials for children, parents and care providers containing basic information on prevention or intervention strategies are provided for all children above 10µg / dL. Quarterly newsletters are mailed to EHC clients with specific strategies designed to reduce a child's exposure to seasonal sources of lead. Information packs are also provided to new residents particularly teachers, via their employers.

Staff participate in antenatal classes conducted by the Mid North Regional Health Service and provide student nurses and trainee mid-wives with orientation sessions.

4.1.7. Schools

Educational 'service on demand' sessions are provided to local kindergartens and schools, students are assisted with projects throughout the year and bi-annual (high risk areas) or tri-annual (lower

risk areas) blood lead screening is provided for first and second year primary students.

4.1.8. Family Support Services

The Program has provided a graduated response with the level of resources tailored to the needs of the child and their parents or care providers.

Interventions, depending on the age of the child and calculated risk of lead exposure, may consist of more frequent blood lead testing, in-home counselling on exposure reduction measures such as dust control, personal hygiene, nutrition and general home maintenance and the lead testing of exposed soils, house dust and painted surfaces.

Standard items distributed by intervention officers to protect children from sources of lead contaminated dust include washable mattress covers, cleaning equipment, entrance matting, door seals, cornice sealing agents and loaned or purchased vacuum cleaners. In some instances, parents have accepted regular house dedusting services, however, it appears those parents in greatest need of support services, such as single teenage mothers, are the most reluctant to accept this type of intervention and are more likely to fail to keep appointments.

4.1.9. Disadvantaged & High Risk Families

Single mothers and other benefit recipients generally appear to be the most disadvantaged with few family assets. They often have had limited schooling opportunities, are rarely in paid employment, are living in poor housing and have limited financial resources. It is not uncommon for these families to be sharing bedding on the floor with children and visitors due to a lack of other furnishings. In many instances when families have moved to escape debt, items not able to fit into a normal sized sedan car have been left behind. These families also appear to have a greater number of health problems with many of their children being subject to respiratory illnesses and other problems, and in turn are the children most likely to have elevated blood lead levels.

4.1.10. House Decontamination

In recognition of the ongoing problem of recontamination, this strategy has only been selectively used for the houses of children with blood lead levels persistently above 20µg / dL. Some parents of children with elevated blood lead levels have been assisted with regular house dedusting for defined periods. Carpet shampooing has been undertaken over the last few years as part of a dust minimisation strategy to protect infants and toddlers.

4.1.11. Relocation of children

Given the substantially higher cost of housing in the less contaminated areas of Port Pirie, the decision by Government in the mid 1990s not to assist these parents financially has limited this strategy to supplying assistance with the process of moving for a limited number of families.

4.1.12. Buffer Zone

Early consideration of extensions to the current "no further development" zone in Port Pirie West met with local resident opposition and has not been pursued further by Port Pirie Regional Council or the Lead Program. However, the program has continued to progressively purchase houses that have become available on the open market in the current "no further development" zone north of Frederick Road, (the northernmost area of Port Pirie West 1: "PW1" – see Figure 3). Purchased houses are subsequently demolished and the blocks greened with trees and shrubs to form part of an expanding buffer zone. To date some 92 houses have been purchased and demolished and there remain a further 17 residential dwellings in the area.

The relocation of children from this area, which has experienced the highest blood levels, contributed to the 1990s decline in the number of children with elevated blood lead levels.

An active program to produce a densely greened buffer zone to prevent wind re-entrainment of coarse dust from the highly contaminated soil adjacent to the smelter perimeter has largely been completed. Wherever practicable, mounds of some three metres in height have been established on the city side of the smelter boundary. These have been planted with shrubs and trees that should achieve substantial height and augment similar barriers established by the smelter inside their smelter fence. All plantings have been drip irrigated to accelerate height gain and ameliorate salinity problems.

4.1.13. Home Renovation

Of concern is the now growing number of households undertaking home renovations. Much of the decontamination work carrier out by the program throughout 1984 to 1994 was not of a permanent nature and has now reached the limits of its serviceable life. Reality television programs which can create a false sense of ease and cost effectiveness for do-it-yourself renovations may also be encouraging families to commence projects around the home which are subsequently leading to children being exposed to additional sources of lead. White ant damage, which is highly prevalent in Port Pirie, also leads to necessary renovation work.

A number of families have invested in cheap affordable housing as a direct result of obtaining the first home owner's grants. Unfortunately, this is the very type of housing that requires renovating or upgrading.

In many instances it emerges that parents often lack the time, skills, or financial resources to bring the work to a timely conclusion.

4.2 Progress with Reducing Blood Lead Levels

The Port Pirie Lead Implementation Program was established in 1984 with the major purpose of reducing the blood lead level of the child population in Port Pirie. In reviewing the effectiveness of this Program it is therefore necessary to consider the evidence for a decrease in blood lead levels since 1984 and for a reduction in the percentage of children over the NH&MRC level of concern. At the time the Program commenced (1984) the level of concern was 30µg / dL, which was reduced in 1987 to 25µg / dL.

In 1993 the National Health and Medical Research Council (NHMRC) introduced a national goal that all children should have blood lead levels below 10µg / dL.

Table 1: Proportion (%) of children above blood lead level targets (µg/dL).

All residential areas

Year	n	Geometric Mean (µg/dL)	% children ≥10 µg/dL	% children ≥15 µg/dL	% children ≥20 µg/dL	% children ≥25 µg/dL
1984-1985	376	22.4	98	87	69	45
1988	570	17.4	93	75	47	25
1992	626	15.0	86	58	28	14
1995	821	12.2	67	32	11	4
1998	808	10.4	59	23	9	4
2001	711	9.8	55	22	8	3
2004	618	10.6	60	31	15	5

High risk residential area

Year	n	Geometric Mean (µg/dL)	% children ≥10 µg/dL	% children ≥15 µg/dL	% children ≥20 µg/dL	% children ≥25 µg/dL
1984-1985	197	24.7	100	92	77	57
1988	309	20.4	97	87	63	36
19h92	317	18.0	95	77	43	22
1995	336	15.2	87	58	26	11
1998	356	12.8	78	36	15	7
2001	290	12.9	76	40	16	6
2004	275	14.1	82	51	28	9

Low risk residential area

Year	n	Geometric Mean (µg/dL)	% children ≥10 µg/dL	% children ≥15 µg/dL	% children ≥20 µg/dL	% children ≥25 µg/dL
1984-1985	179	20.1	96	82	60	32
1988	261	14.3	89	61	28	12
1992	309	12.5	77	39	14	5
1995	485	10.5	59	23	6	2
1998	452	8.8	45	12	4	2
2001	421	8.1	41	11	3	2
2004	343	8.5	42	17	6	3

Over the past 20 years of the Lead Program, dramatic reductions in blood lead have occurred. The average level amongst 1-4 year olds has declined from 22.4µg / dL to just under 10µg / dL (2001, Table 1), the proportion above the 1987 national goal (25µg / dL) has declined from 45% to 3% (2001) and the proportion above the current national goal (10µg / dL) has declined from 98% to 55% (2001, Table 1).

Nevertheless, these reductions have reached a plateau and started to rise somewhat since 2001 serving a timely reminder that Port Pirie is still the most contaminated area in Australia and much remains to be done.

Blood lead levels continue to be geographically uneven with young children living in suburbs near or downwind of the smelter (high risk areas) experiencing the highest concentrations. Figure 4 identifies the risk status of residential areas within Port Pirie according to grid co-ordinates used in the blood testing program.

Table 2: Geometric mean blood lead, children aged 1-4 years, by risk status of residential location (µg/dL with number of children in brackets).

Year	PW1	PW2	SOL1	SOL2	MID	LOW	Totals
1993	20.3 (56)	15.1 (109)	18.2 (66)	14.6 (124)	13.0 (217)	11.3 (146)	14.1 (718)
1994	21.4 (41)	15.8 (99)	19.9 (52)	13.7 (113)	12.3 (157)	10.7 (132)	13.7 (594)
1995	17.4 (53)	13.8 (97)	18.6 (71)	12.8 (131)	10.7 (259)	10.5 (210)	12.2 (821)
1996	17.4 (47)	13.6 (95)	17.2 (76)	12.9 (127)	10.8 (207)	10.0 (143)	12.3 (695)
1997	16.9 (55)	13.0 (103)	16.2 (78)	12.4 (122)	10.4 (280)	9.0 (180)	11.5 (818)
1998	15.2 (49)	12.0 (101)	16.0 (80)	11.1 (117)	9.1 (268)	8.5 (193)	10.4 (808)
1999	18.2 (49)	12.4 (115)	16.8 (83)	11.6 (138)	9.7 (293)	8.2 (203)	10.8 (881)
2000	14.7 (49)	10.9 (91)	14.0 (60)	10.4 (108)	8.0 (243)	7.5 (189)	9.3 (740)
2001	15.6 (52)	12.0 (90)	14.8 (51)	11.0 (92)	8.5 (235)	8.0 (191)	9.8 (711)
2002	16.4 (48)	11.6 (83)	14.9 (58)	9.6 (95)	8.6 (235)	7.7 (151)	9.7 (670)
2003	17.9 (53)	12.5 (78)	16.1 (66)	11.2 (98)	8.5 (254)	8.3 (154)	10.2 (703)
2004	16.5 (39)	12.1 (73)	17.5 (65)	11.4 (97)	9.2 (207)	8.2 (137)	10.6 (618)

The decline in blood lead has occurred in both high and lower risk areas of Port Pirie (Table 1) but has been smallest in the highest risk areas of northern Port Pirie West (PW1) and northern Solomontown (SOL1) (Table 2). These 2 areas have shown the most fluctuations in trend over the years and account for much of the recent increase in levels.

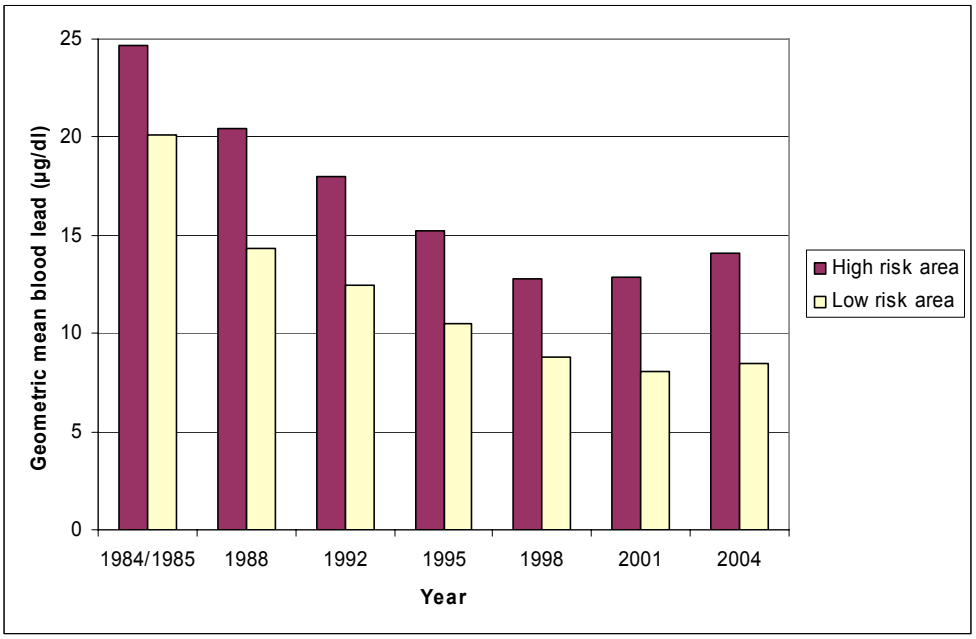


Figure 1:Geometric mean blood lead (µg/dL) of children aged 1-4 by risk area.

Figure 2: Percentage of children aged 1-4 years with blood lead levels above target values.

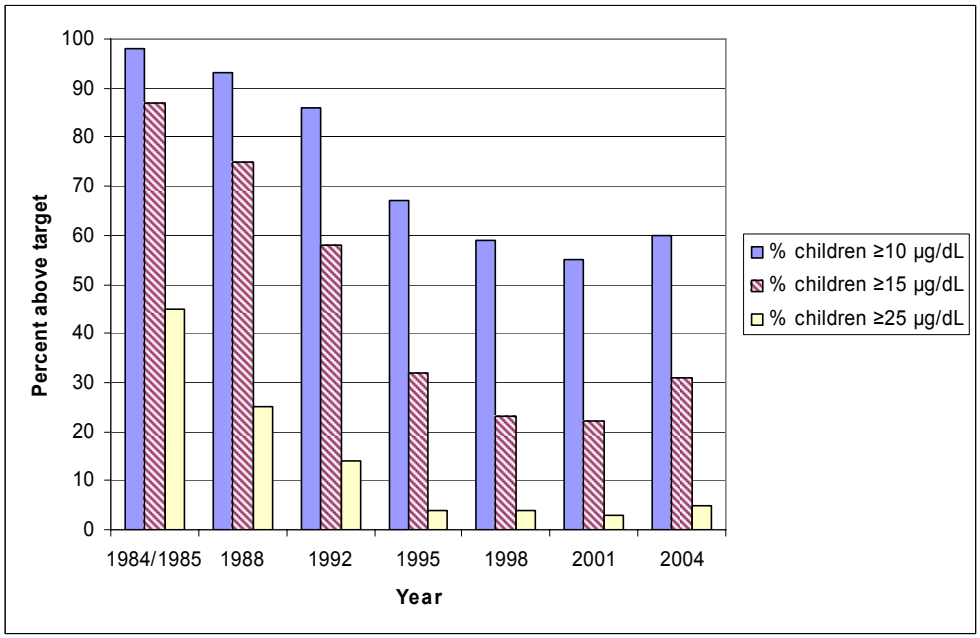


Figure 3: Geometric mean blood levels of children aged 1-4 by regions (2004).

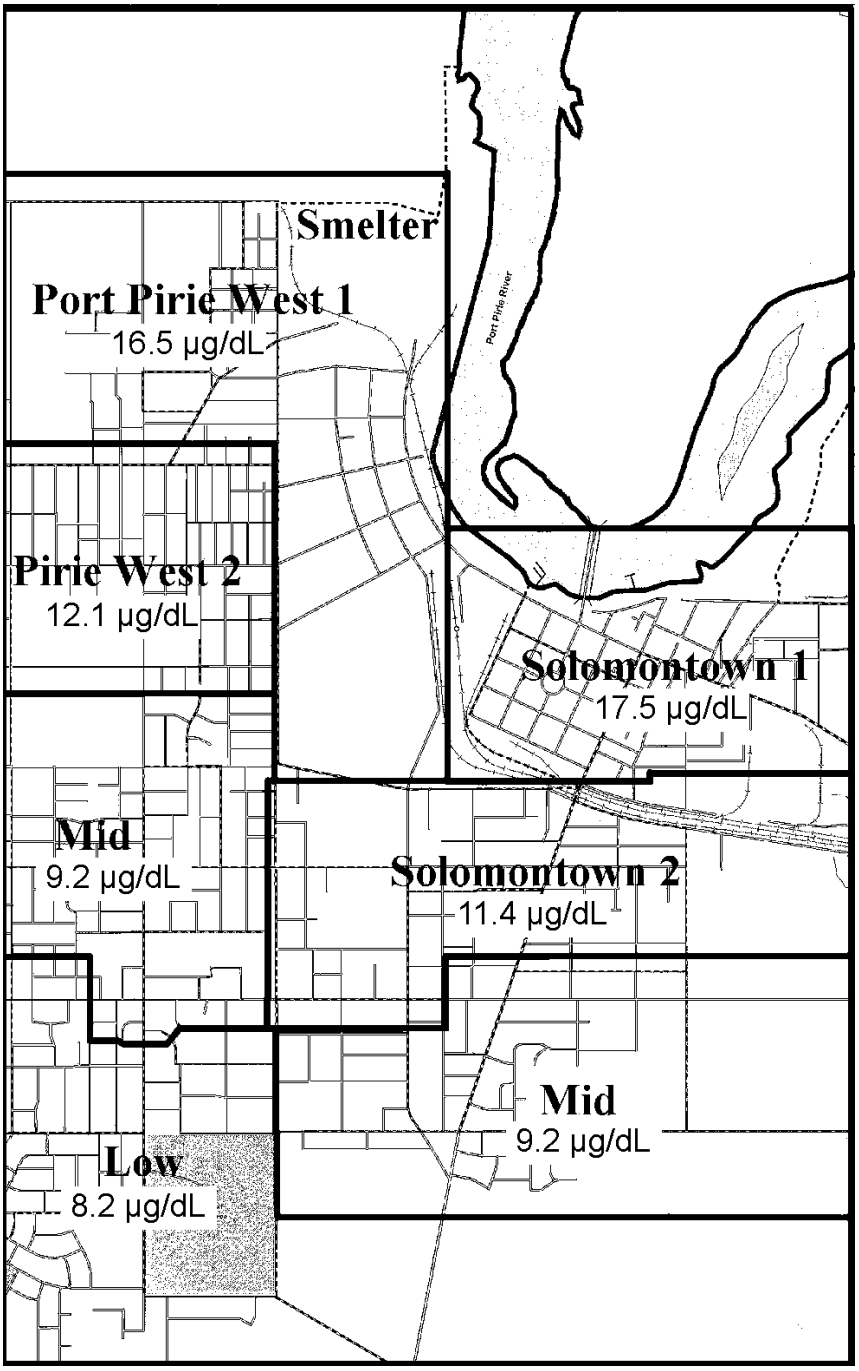
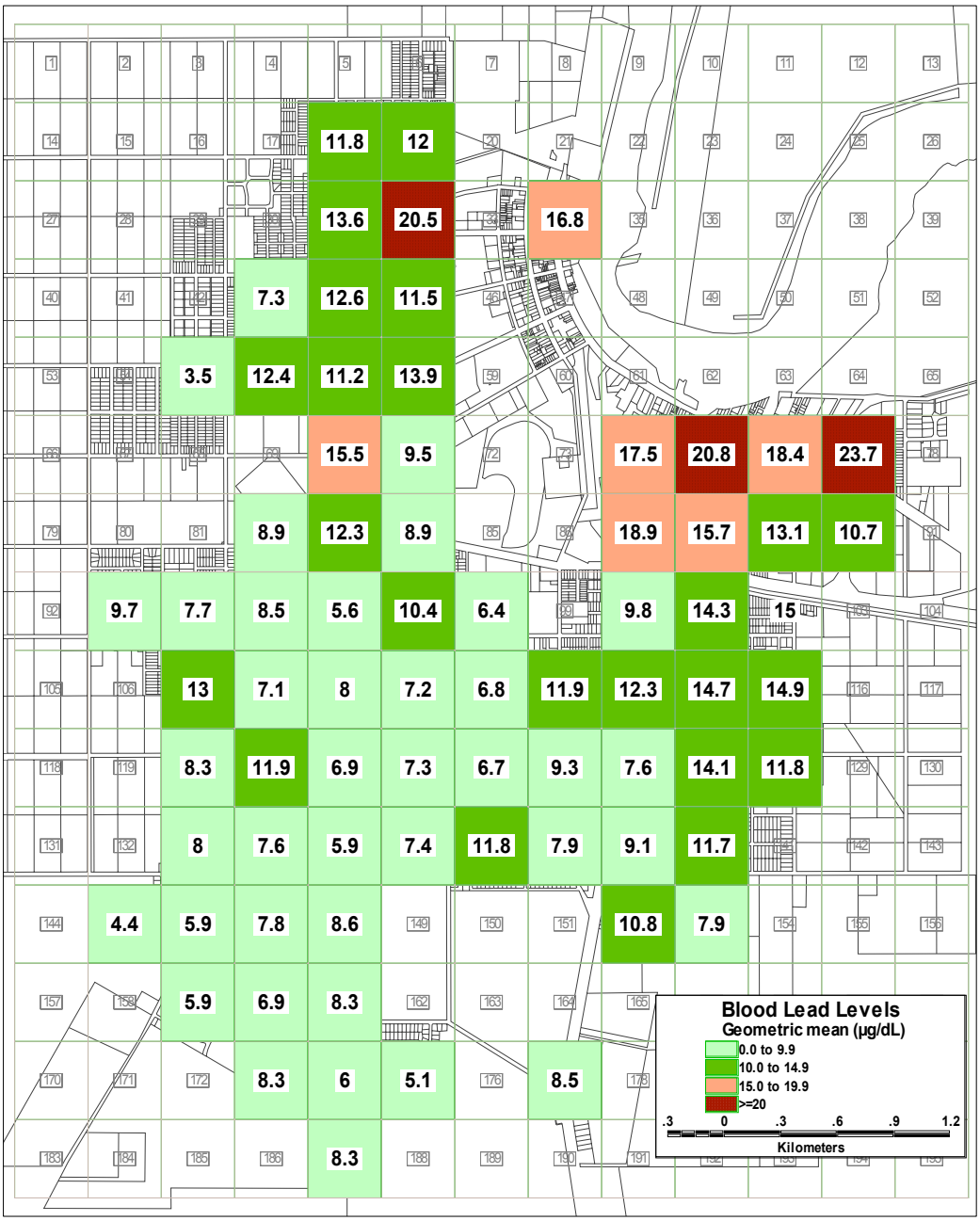


Figure 4: Blood lead levels (geometric mean µg/dL) by grid for 2004 (children aged 1-4 yrs). Grids that have only one child are not shown.



4.3 Investigation Program

The 1993 Review identified major barriers to a further substantial reduction in blood lead that would require new information and a better understanding of lead dust sources and pathways of household contamination.

- It was unknown which components of the complex smelter site were the important sources of emissions thereby precluding effective control measures;
- It was unknown from studies anywhere in the world how infants and toddlers were being exposed to leaded dust while confined to indoor environments; and
- It was poorly understood how the different parts of houses and yards were being contaminated and at what rate.

The second Lead Program (1994–2004) added a major investigation component to provide a better basis for controlling major sources and for identifying and developing strategies for reducing exposure within households.

The projects undertaken and the improved understanding that has resulted are presented in Chapters 5 and 6. By way of introduction, the following summarises the current causes of elevated exposure to lead (Pb), which is a combination of:

- Ongoing fugitive (non-stack) emissions from many smelter operations during which over 300,000 tonnes of new finely divided metal rich dust and large amounts of recycled fine materials are processed;
- Wind carriage of contaminated dust to the indoor and exterior areas of houses depending on direction and distance from the smelter. Ease of dust entry depends on age and construction features of the houses'
- Accumulation of contaminated dust in indoor reservoirs; carpets and floors; soft furnishings; windowsills and wells. Foot traffic and exterior items also bring contaminated dust into the house;
- Normal mouthing behaviour of infants during contact with their indoor environment and carers;
- Diet, cleaning and child management skills and practices of carers;
- For mobile young children, ongoing contact with a heavily contaminated outdoor environment.

While ongoing Lead Program interventions serve to reduce children's exposure, the primary effort needs to minimise smelter emissions.

5. SOURCES OF CONTAMINATION

5.1 Source Investigation Working Party

The Lead Program established in 1984 was planned on the considered assessment that the major source of lead contamination in Port Pirie resulted from the historical lead burden, the estimated 160,000 tonnes of lead which had been lost from the smelter over nearly 100 years of operation. Based on lead in air monitoring available at the time, ongoing contamination of the city from the smelter or other sources was considered to be small and generally within the NHMRC recommended levels for lead in air.

The major review of the Program prepared in 1993 explored in some detail all the evidence available on the contribution of different sources of lead around the city to household contamination. The smaller than expected impact of household decontamination, evidence of house recontamination, the lack of any reduction in air lead levels and preliminary evidence that elevated lead in air occurred on days where the winds were directed from the smelter all brought the question of major ongoing lead sources back into consideration and challenged the existing historical contamination assessment.

While evidence assembled in the Program review of 1993 clearly suggested that the major sources were located in the vicinity of the smelter lease, it was unclear at the time what was the relative importance of the myriad of sources from this smelter area.

From late 1993, the Lead Program commenced an urgent investigation effort into ongoing smelter lead emission sources and the processes underlying the transfer of contamination to the Port Pirie residential indoor environment. Pasminco was an active collaborator in this effort. Investigations have materially helped to identify and prioritise those sources of fugitive emission from ongoing operations that contribute most to children's lead exposure and have contributed to the planning and evaluation of control strategies.

Lead contaminated dust is lost to the city from storage areas, dust that has been deposited in and around the plant and on a myriad of structural surfaces over many decades of operation as well as being lost as fugitive emission from all the stages of the processing. Needless to say, the task of identifying from this enormously complex site, the priority sources with sufficient accuracy to allow capital planning and control strategies to be implemented has been a major task.

A valuable and informative range of projects to this end has now been completed and approaching $2.5 million committed. Joint understanding of smelter emission sources has improved substantially to the point that the slag fumer, roasting kilns, and sinter plant areas have been identified as the 3 most important of 5 major source areas in terms of their contribution to indoor

household contamination and consequently should be priorities for control measure expenditure.

Evidence from overseas studies of smelter closures, or significant smelting process changes show how critical ongoing emissions are to blood lead levels in children, and to the major reductions in blood lead that follows emission reduction.

The Lead Program's Investigation Group has played a valuable role and been a prime instrument in demonstrating the ongoing role of smelter sources and in implementing an on-site investigation program into defining sources of emission. Smelter management has been grateful for the assistance of Lead Program scientific expertise, in assembling evidence as to the specific plant component responsible for the fugitive emission, definition of the design requirements for the control engineering required, and evaluation of the control strategy to ensure the success of the engineering works and confirm the identity of the fugitive emission source.

5.2 Smelter Sources

Modelling, lead in air and lead dust deposition studies have confirmed that the overwhelming sources of household contamination are the several smelter production plants. The lead production area dominates as the emission source, not the wharf nor the materials storage area. Wind re-entrained lead dust from the historical city sink is a minor source.

Outdoor lead deposition averages 5,000 micrograms (µg) per square metre per day and indoor deposition exceeds 100 micrograms (µg) per square metre per day. Winds from the smelter direction produce ten to one hundred times more lead deposition than winds from other directions. The lead deposition indoors that occurs on a high wind day could at times exceed the US Environmental Protection Agency floor load criterion for keeping blood lead levels below 10µg / dL.

The smelter is large and complex, with loss of material arising from a number of sources via various mechanisms (direct emissions, wind erosion of material deposited on site).

Increases in wind speed dramatically increase both the concentration of lead in air and the amount of lead deposited downwind of the smelter. This mechanism, particularly during the NW-N wind season (August – October), appears to best explain the contamination of Solomontown.

Process emission, particularly in the evening and overnight, is often trapped by temperature inversions and washed across into Pirie West by cold air drainage from the Flinders Range.

Shut-down of the blast furnace and other process plants for maintenance purposes is also accompanied by significant reductions in air lead concentrations in the small particle size fraction, suggesting fugitive plumes from process plant sources are also important.

Particle analysis and multi-element source apportioning studies using house deposition material indicates that the slag fumer, roasting kilns, sinter plant, blast furnace and raw materials are the major contributors to house lead. Modifications to the blast furnace appear to have lessened its fugitive emissions.

Process dusts are the most soluble in the stomach and hence are more accessible to the infant's blood. Other household sources of lead, such as from raw and feed materials may be major sources of dust, but probably contribute less to the blood lead of the infant.

While primary attention has been on exposure to lead contaminated dust, indoor house dust is also significantly contaminated with other heavy metal emissions: particularly zinc, but also antimony, arsenic, cadmium, bismuth, mercury and gold. Preliminary health risk assessment has suggested these metals are below the levels that are likely to cause adverse health impacts although world knowledge on their toxicity is substantially less developed than for lead.

5.3 State of the Environment Report (2003)

Trends
Air quality in Port Pirie: IMPROVING overall but sulphur dioxide and lead levels still unacceptable in some areas.

Attention Required
The level of lead in the air from the Pasminco lead smelter in Port Pirie is the most significant air quality issue for South Australia. Over 50% of children in Port Pirie exceed the blood-lead goal set by the National Health and Medical Research Council. Sulphur dioxide emissions also frequently exceed national health guidelines, however, no clear relationship with health has been found in several studies undertaken to date in Port Pirie.

What more should we be doing?
The EPA should continue to ensure, as a high priority, the management of air quality issues on the basis of risk to public health and amenity. Industry Environment Improvement Programs for such issues must focus on high priority risks, and contain short and long term strategies to provide outcomes that are based on recognised national and state standards.

5.4 Emission Control Action

The Port Pirie smelter has been active over the years in developing strategies to reduce emissions in compliance with its regulatory licence conditions. Projects undertaken during 1984-1993 were presented in Chapter 3 Background.

From 1993, the smelter accepted the need to be more pro-active in identifying the sources and controlling ongoing fugitive emissions, joining the SA Government to co-ordinate an urgent investigation into ongoing smelter lead sources and the processes underlying the transfer of emissions from the smelter site to the city.

Pasminco simultaneously embarked on an environmental action plan. This plan focused on all areas of the smelter perimeter, slag dumps and lead rich material storage areas. Interventions consisted of covering all bare areas of spent slag with clay and subsequent vegetation and the planting of some 20,000 plants in order to create wind breaks and buffer zones to break northerly wind flows. Outdoor lead concentrate stockpiles have been sealed over with paper mulch, and all lead bearing materials have been relocated to a central holding pit. Several unmade roads have been closed off to traffic with a re-routing of vehicles to sealed roads which are regularly watered.

These modifications aimed to reduce windborne dust from the stockpile areas and roads on site. A major reduction in the area occupied by on-site stockpiles has occurred.

While local reductions in airborne lead have resulted from these initiatives, extensive air monitoring across the township, however, has failed to identify the impact of these improvements on air lead concentrations. Analysis by the Lead Program showed air lead concentrations to be so strongly influenced by wind conditions that temporal variations in wind speed and direction overshadowed any consistent trend that could be attributed to emission controls.

This perimeter work is now essentially complete. It is anticipated that the barrier will interrupt large particle leaded dust material that deposits in the near vicinity of the smelter from reaching or being re-entrained by wind to reach nearby roads and housing. It is unlikely to contribute to the reduction of very fine particulate lead reaching residential areas that is emitted from the process areas of the smelter and assisted in its dispersion by heat and light winds.

Since the mid 1990s, modifications have been made to lead concentrate conveyors, rail wagons have been fitted with fibreglass covers, and there has been a $33M upgrade of the of the lead refinery. Two sheds have been constructed at a total cost of $18M to house a range of concentrate materials including lead and zinc.

By 2003, joint understanding of smelter emission sources had improved substantially to the point that the slag fumer, roasting kilns and sinter plants were identified as the 3 most important of 5 major source areas in terms of their contribution to bioaccessible indoor household contamination.

The EPA has actively responded to this source and recent blood lead levels evidence and has renegotiated the Zinifex Environment Improvement Program. The first stage of emission reduction ($3.7m) has been completed, and a further $12.2m committed over the next 3 years with a focus on the first 2 of these sources. Further collaborative work is needed on these 2 sources and to delineate ongoing sources in the sinter plant and help focus and evaluate control measures.

The EPA has adopted a human health and environment impact based priority system for managing Zinifex's requirements to address its multiple pollutant discharges.

It is recognised that Zinifex has the responsibility to identify sources, and to plan and implement control measures. As indicated previously, Pasminco has already spent large amounts on engineering upgrades to reduce emissions to air. Other large and medium sized projects have been submitted to the company board and approved. The Lead Program has contributed to the smelter source control work to accelerate its progress because source reduction is essential to reducing children's blood lead levels.

6. PATHWAYS OF HOUSE CONTAMINATION & CHILDHOOD EXPOSURE

6.1 Residence in a Higher Risk Area: the second most important factor in influencing blood lead levels

6.1.1. Port Pirie Contamination Patterns

Certain parts of Port Pirie are more contaminated than others.

Pirie West, Solomontown, the central business district and to a lesser extent other areas are subject to heavy ongoing contamination when viewed against the daily uptake required by young children to stay below 15µg / dL blood lead (30-40µg / day). These areas are subject to greater lead dust contamination levels: both in terms of lead in dust concentration, and the lead load per unit surface area, and are located down wind of the smelter or in close proximity on the western boundary of the smelter.

These regions are clearly circumscribed by the blood lead levels of children which on average are up to 9µg / dL (110%) higher ie double those of low contamination areas.

Geographic area differences in blood in blood lead that reflect area differences in lead contamination emerge during the first 6 months of life and are amplified during the second 6 months.

6.1.2. Meteorology Patterns

Winds from the Northwest (NW) through North (N), particularly those above 8 metres per second speed, entrain contaminated dried dust from the smelter site and deliver it to Solomontown. Lighter winds may also bring emission plumes from processing plants to this part of the city. Meteorology studies show that NW – N winds occur commonly during late winter and spring (August – October).

Winds from the Northeast (NE) through East (E) occur mostly at night and are most often very light cold air drainage from the Flinders Range. These conditions bring contaminated dust to Pirie West. Often this is fine material from processing plants trapped near the ground at night by boundary layer (inversion) temperature conditions.

6.1.3. Dust Deposition Patterns

Short term dust deposition studies indicate that when wind blows from the direction of the smelter, rates of lead deposited into trays, both inside and outside houses, are 10-1000 times more than when wind is from non-smelter directions. Outdoors in residential areas, with the

wind from the direction of the smelter, lead deposition of 1000µg / m2 can occur over a few hours.

Long term dust deposition studies indicate:

- Contamination is persistent and ongoing, arising directly from activities on the smelter site, and
- Houses are bathed in a constant "sea" of lead.

6.1.4. House Contamination by Airborne Dust

Airborne deposition of lead contaminated dust appears to be the primary pathway of contamination of Port Pirie children's living space. Dust is transported mainly through wind action, primarily by reentrainment, from both environmental sinks around the smelter and new fugitive emissions. Transport of airborne lead occurs principally on days of high velocity winds in association with dry conditions. Human, vehicle and material handling activities assist in dust raising.

Houses are both readily penetrated by airborne fine contaminant dust and effective in retaining it, thereby producing an escalating build up of the lead contamination load.

Houses are subject to substantial ongoing airborne lead contamination, particularly through open doors and windows when winds are from the direction of the smelter. With winds from the smelter, indoor deposition rates of 300-1800µg / m2 of lead per day can occur.

For vacant houses, long term average indoor 'window-closed' deposition is 14µg lead / m2 / day, whereas in an 'open-house' condition it is 137 µg lead / m^2 / day. The lead in house dust is found predominantly in the fine fraction (less than 45 thousandths of a millimetre).

Twenty four hours of winds from the direction of the smelter can produce lead deposition indoors that exceeds the US Environmental Protection Agency criterion of 500µg lead / ft2 calculated as the upper floor loading limit for keeping children's blood lead below 10µg / dL (which is also the NHMRC national blood lead goal).

6.1.5. House Features Promote Dust Entry

Houses in the higher risk areas are more readily contaminated because they allow more wind entry:

- Older eg poorly sealed windows, gaps in cladding.
- Timber and iron construction: older with more gaps.

- Construction style eg through passageway, fireplaces.

Many other features have been identified.

6.1.6. House Contamination by Passive Carriage of Dust

Large amounts of lead can be brought into the entryway area on shoes even after just 1 or 2 steps on a lead contaminated surface. Since verandahs and porches are heavily loaded with lead, this pathway of entry is of importance.

Dust is carried into the house on objects that have been in the more heavily contaminated outdoor environment including toys, pets, clothing, hair, skin, hands and many other items.

Parents working in high lead exposure jobs still contribute to household contamination and / or young children's blood lead levels despite the benefits from hygiene measures introduced at the smelter.

6.2 Children's Exposure: Age is most important

6.2.1. Newborn

Pregnant mothers and their babies at birth have lower average blood lead levels now (3-4µg / dL) compared with 1994 (5-7 µg / dL). Unlike later in the child's life, there is little difference in blood lead levels across parts of the city at birth.

Lead exposure occurs before birth. Infants are born with the same lead level as the mother. The infant's and mother's blood lead levels diverge 'dramatically' after the first 5 weeks or so of life, particularly in high risk suburbs. From birth for the first month or so, newborn blood lead levels remain static or fall.

6.2.2. One to Six Months

Following the first month, blood lead levels steadily rise. The major route of entry to the body is by placing contaminated hands into the mouth. Although young infants are relatively immobile and lack co-ordination in mouthing objects, even these very young infants have contaminated hands, in a contaminated environment, which inadvertently transfers lead to the mouth. Hand contamination occurs easily and rapidly.

The number of times their hands (usually thumb and surrounding region or the hand) touches the mouth is sufficient to dose the infant with lead.

These frequent low dose exposures are supplemented at times by a higher dose exposure such as by mouthing a parent or siblings finger.

Inhalation probably provides a small percentage of the total exposure.

Other sources of lead include food and other items that are sucked.

6.2.3. Six to Fifteen Months

Usually the steepest increase in blood lead occurs between 6 months and 12-15 months of age. This steep increase and peak in blood lead coincides with normal child development patterns where children tend to increase mouthing frequency at about 6 months. It also coincides with child locomotive development, often with the infant face down and on the floor.

Substantial amounts of lead can be found on children's hands at all ages. After washing, the amount re-accumulates quickly. The amount of hand lead is related to the child's blood lead.

The commonest mouthing is of non-food items, particularly after the first 6 months of life, and these items are readily loaded with lead by contact with linoleum, carpet and soft furnishings.

Floor lead as well as lead on soft furnishings are important indoor reservoirs. Covering the floor can reduce the transfer of lead onto hands.

Hands of parents have similar levels to their own children. Adult males tended to have higher lead loadings than infants and mothers lower. This suggests that the environmental load of lead is one of the important contributors to blood lead, and is one which all people become contaminated from.

Touching contaminated objects such as flat surfaces (eg top of TV) or objects that have been outside (eg pets or toys) will rapidly contaminate hands. Hands that are sticky from food or not dried properly add to the potential for high hand lead loadings.

6.2.4. Fifteen to Twenty Four Months

After 12-15 months, most children have passed out of infancy and are walking. Progressively mouthing and the use of support aids for walking (hand contact) diminishes.

Children less than the age of peak blood lead (18 months) spend little time (3%) outside in the yard. Even though while outdoors their hands accumulate 7 times more lead dust than during the equivalent time indoors, outdoor exposure contributes little to blood lead at this age.

6.2.5. Location of Lead Inside the House

It is apparent that houses contain many kilograms of lead. Lead can be found in and on furnishings especially soft furniture and resides on all hard surfaces, especially floors. Carpets become a very large reservoir for lead which can be remobilised into the room by vacuum cleaning or walking or jumping on it. Overall, carpets can be one of the largest reservoirs in the house although others such as the ceiling space can also harbour high loads of lead. The amount of lead on floors, for instance, strongly relates to the blood lead level of children.

Other than carpets and soft furnishings, the highest loadings of lead can be found on objects that have been outside the house, such as hands, shoes, pets, toys and pushers.

There is a steep gradient of lead from the outside of the house to the infant. Verandahs, porches, entry halls and carpets are heavily loaded with lead. Soft furnishings, toys and hands are less loaded.
It is probably only because the transfer of lead to hands or toys is relatively inefficient that these children do not have even higher blood lead levels. Lead levels are lowest on objects in contact with the infants.

6.2.6. Lead Dose and Blood Lead Levels

Exposure models show that for the blood lead level to rise with age, infants need a continual increase in dose of lead. This means the dose increase needs to exceed the rapid increase in body weight that occurs during early life. In absolute terms though, the dose needed is very small: 5-10µg / kg / day. Periodic high or continuous low dose exposures may both occur.

7. FUTURE GOALS AND FOCUS

7.1 Focus: Sustainable, Healthy and Prosperous Community

7.1.1. Special provision is needed to protect health in the presence of ongoing contamination from an operating smelter. Current blood lead levels amongst most pre-school children are quite unacceptable.

7.1.2. A sustainable smelter is central to community prosperity and wellbeing: smelting operations and downstream support are the biggest employers. Port Pirie and the wider SA community have derived enormous benefits over the years.

7.1.3. Smelting is also the overwhelming cause of community contamination. Negative publicity impacts Port Pirie's image, economic and employment opportunities, recruitment and reputation as a safe place to live. Blood lead levels are the worst in Australia, providing a potent symbol of the contamination problem, which must be energetically addressed.

7.1.4. Port Pirie is an environmental success story reflecting the joint efforts of community, industry and government. All parties recognise that much still needs to be done.

7.1.5. The consistent support of the SA Government has enabled a far better understanding of emission sources, processes of house contamination and mechanisms of indoor exposure in Port Pirie than anywhere else in the world. This innovative work was the core of the "Local Solutions: Smart Future" international conference held in Port Pirie on 29 & 30 September 2003 which drew participants from USA, Europe, Canada, Mexico and around Australia.

7.1.6. An urgent need for bold action towards stretch blood lead targets is recognised by Zinifex, the Port Pirie Regional Council, the EPA and Department of Health. These stakeholders seek a partnership to pursue joint strategically focussed action.

7.1.7. This is a unique opportunity for a common effort with:

- An ambitious blood lead target,
- Community plan with negotiated and agreed roles and timetables for key stakeholders,
- Launch of the future program with public declaration of commitment to initiate increased engagement with the Port Pirie community, and

- Zinifex committed to emission reduction based on current understanding of sources and contamination pathways.

7.2 Goal: Children's Blood Lead at Safe Levels

7.2.1. Current children's blood lead levels are unacceptable. There is no excuse for the 95 children still above 20µg / dL. It is a disgrace.

7.2.2. In concert with Zinifex, PPLIP stakeholders and the Port Pirie community, the review panel believes the only acceptable blood lead goal is to meet the national goal, i.e. all people below 10µg / dL with particular intervention efforts for children under 5 years of age.

7.2.3. The national goal reflects current views of international public health best operational practice. It is likely that there is no threshold below which exposure to lead is entirely safe. Pressure is growing in some USA academic circles to further reduce the blood lead goal.

7.3 Stretch Targets

The stretch target should be 95% 0-4 year old children below 10µg / dL by the end of 2010 with no children above 20µg / dL.

7.3.1. Interim, less ambitious targets are only acceptable to assist the planning and management of remediation efforts.

7.3.2. The panel firmly believes that targets should be set to stretch and challenge the capacity of the Program and its stakeholders to keep driving blood lead levels downward as aggressively as possible.

7.3.3. Targets should reflect achievement beyond current technical knowledge providing structure and direction for innovation and community planning.

7.3.4. The need to further extend technical knowledge requires an investment in strategy development, evaluation and monitoring.

7.3.5. Intervention should focus on early childhood because;

- Blood lead levels begin to rise soon after birth: the biggest increases occur during first 12 months and peak by 18-24 months,
- Intervention needs to be focussed on the indoor home environment and settings used during the first 24 months of life,
- The developing nervous system is considered to be far more vulnerable to the toxic effects of lead than in maturity, and
- Exposure and blood lead levels during pregnancy is low.

7.4 Target Groups

- Pre-school children with a focus on 0-2 years of age.
- Families with pre-school children above 15µg / dL.

7.5 Key Strategies

7.5.1. Capture the unique opportunity to boldly reduce blood lead levels by participating in an active partnership with Zinifex, EPA, Council and other stakeholders to develop and sponsor a joint plan.

7.5.2. Each partner makes a public commitment to the common purpose and to developing a community plan with Port Pirie stakeholders and advocating public engagement.

7.5.3. Specific SA Government agency roles to be negotiated in a Whole-of-Government commitment.

7.5.4. Strengthen orientation towards primary prevention aimed at early childhood: reduce emissions, reduce exposure from contaminated houses, reduce absorption of ingested lead.

7.5.5. Reduce dependence on daily exposure reduction through parental child protection behaviours.

7.5.6. Reduce impacts of contamination (secondary prevention) on high risk families by developing individual, family centred responses based on service integration and co-ordination.

7.5.7. Provide enabling strategies to support implementation of effective blood lead reduction.

8. EFFECTIVE STRATEGIES

8.1 Principles for Effective Primary Prevention

- Ongoing smelter operations are the primary sources of household contamination and elevated blood lead in children. Zinifex has a primary responsibility and needs to have a sustained commitment to major reduction in children's blood lead levels.
- Whole-of-Government approach required involving several agencies (eg. DECS; SA Housing Trust; Department of Health) and particularly the Environment Protection Authority (EPA).
- Strengthen and reorient intervention strategies towards prevention which benefit the whole community.
- The effectiveness of reducing emissions at source is greater than minimising the impact of widespread deposition on the residential community.
- Focus on reducing exposure by effective, durable, environmental improvement strategies, and by reducing absorption into the body, rather than by depending on residents' exposure reduction behaviours.
- Exposure reduction by changing daily practices (behaviours) interferes with too many 'normal' caring activities during infancy. Need to provide a safe household environment.

8.2 Strategies for Effective Primary Prevention

8.2.1. Prevent emissions from the smelter

- Aggressive control of fugitive emissions is the primary need.
- Improve dust hygiene, dust management:
  - reduce available dust to reduce re-entrainment,
  - plant sprinkler / washdown during N / NW winds.
- Maximise cost-effective emission control strategies across the smelter site to reduce children's blood lead.
- Investigation: source identification within priority plants, define control strategies, evaluation.
- Develop feedback loop between fugitive losses and process management.

- Cultural change: ownership of emissions and blood lead impacts.

8.2.2. EPA Commitment

- Prime aim is to eliminate all fugitive dust containing bio-available lead.
- Major sources of bio-available lead are understood to be the fumer – kilns plant and the sinter plant.
- The current and future Environment Improvement Programs (EIP) will be primarily aimed at physically eliminating fugitive dust loss from the fumer – kilns and sinter plants.
- Ambient lead monitoring will be used as a licence condition to drive down ambient lead levels in Port Pirie.

8.2.3. Prevent Indoor House Contamination (focus on children under 2 years in high risk areas)

- Control contaminated dust during owner initiated renovation, hasten completion of renovations in high risk areas, temporary relocation during renovation.
- Complete development and trial of new strategies to minimise indoor contaminated dust reservoirs.
- Negotiate with SAHT to modify its building maintenance program to improve dust proofing.
- Provision of lead contamination and renovation advice to home buyers, particularly those under the first Home Owners Grant.
- Compare blood lead history of each house to prioritise the need for modification to reduce dust entry.

8.2.4. Prevent Exposure by Reducing Absorption

- Complete trials using phosphate treatment of carpets and develop intervention program if effective.
- Dietary improvement to reduce the enhanced absorption that occurs during overnight fasting by having early morning snacks / breakfast, adequate iron intake and prudent diet.

8.3 Principles for Minimising the Adverse Impact of Lead Exposure

Families are impacted by environmental contamination outside their control, exacerbated by their circumstances. Victim blaming should not be part of the

PPLIP approach. Services should be delivered in a client-focussed, respectful and sensitive manner, and address family circumstances.

- The focus should be on high exposure children and their families.
- A commitment to social justice and a social health perspective must be a key focus in the future management of high exposure families.
- Families most affected by contamination reside in older housing, are socially, economically and educationally disadvantaged, and have complex needs. Social justice requires provision of individualised, collaborative support strategies and a safer home environment to achieve more equal health outcomes.
- Reduce house contamination rather than depend on personal behaviours to reduce exposure amongst those least able to implement and sustain behaviour change.
- Develop responses based on local service integration and coordination.
- Equity of access to information and services.

8.4 Strategies for Minimising the Adverse Impacts of Lead Exposure

8.4.1. Explore improved approaches

- Improve understanding of client groups, their needs and issues.
- Identify houses causing highest lead exposure to prioritise need.

8.4.2. Individualised family case management in collaboration with local health and social services

- Establish blood lead trend for each infant early in life and intervention in collaboration with “Every Chance for Every Child” program.
- Team work between local services / agencies to reduce household lead sources, enhance homemaking skills, improve diet, advocacy, cooperative problem solving, reduce development delay, group work and linking families to other services. Written plans for each family.
- Exposure reduction packages where needed.
- Culturally sensitive casework for indigenous families through links with existing Aboriginal services.

8.4.3. Provide safer home environments (an effective contribution to social justice).

- Progressively remove or dust proof old timber / iron housing in high contamination areas.
- Assist relocation to low risk area housing, temporary or permanent:
  - Improve financial access to low risk area housing, including rent assistance,
  - Additional low risk area housing (eg. renovated SAHT units) acquired by private agent and made available for rental.
- Minimise indoor dust reservoirs: regular PPLIP cleaning service, washable covers for soft furnishings, installation of vertical blinds, dust proofing building shell.
- Control contaminated dust during owner initiated renovation, hasten completion.
- House modification to reduce dust entry, including ventilation / filtration if shown to be effective.
- Surveillance of rental housing quality, repair / upgrade orders.

8.4.4. Enhance child development and reduce development delay

- Screen for development delay in collaboration with local services.
- Increased use of local childcare and pre-school education services to reduce exposure and enhance education.
- Family centred collaboration of local services to redress development delay, eg. Kids on Track, toy library.
- Minimise contaminated dust in childcare and pre-school facilities in collaboration with the Department for Education and Children's Services.

8.4.5. Reduce absorption of lead from ingested contaminated dust

- Dietary improvement to minimise overnight fasting, ensure adequate iron intake, promote the prudent diet and provide appropriate referral and support where needed.
- Regular phosphate treatment of carpets if shown to be effective.
- Explore the role of oral chelating agents in highest blood lead children as used in similar programs and occupational settings elsewhere.

9. ENABLING AND SUPPORT STRATEGIES

9.1 Community Planning, Engagement and Promotion

9.1.1. Principles

- Only by invigorated ownership of the lead issue by stakeholders and the Port Pirie community under a common plan can significant change be achieved.
- Need for a whole-of-community approach and ownership, a cultural change that redresses denial and disengagement.
- Greater opportunities for inclusion and community participation.
- Industry, local government and SA Government agencies need to work together in the pursuit of improved, creative approaches.
- The demand for bold targets creates an imperative for innovation and change.
- A commitment to consultation in developing an understanding of issues and strategies for their resolution.
- Strategies should avoid blaming the victims of smelter contamination and offer services as compensation from a grateful Port Pirie and wider SA community.
- Honesty as to what the system can reasonably provide.

9.1.2. Strategies

- The development of a bold plan to substantially reduce children's blood lead levels is central to future directions. The plan should be sponsored by the principal stakeholders and secured by their public commitment. The plan should be developed in consultation with all stakeholders and the Port Pirie community and then actively promoted to secure broad ownership.
- Identify opinion leaders and lobbyists.
- Celebrate Zinifex emission reduction achievements and economic contribution.
- Implement mechanisms for community and client feedback.

9.2 Community Education

9.2.1. Principles

- Community-wide communication and education on priority lead effects and protection messages. Engage the community, don't overload or scare people. Honesty and accuracy. Re-enforce messages.
- Tackle Port Pirie historical/cultural views eg: denial and apathy.
- Lead education part of a positive, broader focus on healthy living although lead messages should be obvious and important.
- Messages should be positive. Avoid fear, guilt, disapproval and blaming of the victims.

9.2.2. Strategies

- Review investigation results, identify key protective behaviours and messages.
- Improve education for all groups involved with children: better understanding of important protective behaviours.
- Consultants to help develop marketing of the program and audience segmentation.
- Public information campaign repackaged, planned and scheduled.
- Explain and market PPLIP goals, strategies, services, current research on the adverse impacts of lead.
- Use all media.
- Inform key stakeholders and collaborators.
- Improve awareness re house dust.
- Inform, market and report achievements to maintain motivation. Achieve and promote some immediate gains. Champion success stories.
- Expand Pea-Bee role plus artistic props such as puppetry, visual aids, mime and music.
- Involve older children through visual arts studies etc.
- Involve parents, volunteers, health professionals. Lead cannot be an EHC issue alone.
- Well-coordinated, multi-faceted, sustained program.

9.3 Strategy Development, Evaluation and Monitoring

9.3.1. Principles

- Improving the effectiveness and equity of Program services / strategies.
- Sustainability in delivery through ensuring efficiency and evaluation.
- The need for a continuing commitment to strategy development and evaluation in the absence at this time of:

  precisely defined, affordable and effective engineering and maintenance solutions to adequately control ongoing fugitive emissions,

  demonstrably effective and affordable strategies for adequately minimising the entry of contaminated dust into houses

  so as to achieve target blood lead levels.
- Blood lead monitoring is the only acceptable index of personal exposure currently available and fulfils several essential roles.
- The level of environmental and household contamination can only be assessed by appropriate measurement which must be an essential component of the future program.

9.3.2. Strategies

- Contribute to precise delineation of sources within priority plants, support control strategy development, and evaluate impact of plant emission control programs.
- Blood lead monitoring: identify interventions for each individual, evaluate overall progress of PPLIP, including the effect of emission control, and evaluate interventions for high-risk individuals.
- Develop and evaluate the effectiveness of house contamination reduction and avoidance strategies. Incorporate findings into PPLIP programs. Eg air filtration, building modifications, exterior wind barriers including trees and shrubs.
- Monitor smelter emissions, environmental and household contamination.
- Evaluate experience, strategy development, investigation findings and evaluation feedback from other similar contamination settings.

- Develop mechanisms for community and client feedback.
- Explore the need for investigation of sulphur dioxide and non-lead heavy metal impacts, iron deficiency and children's development delay assessment.

9.4 Collaboration Between Local Services

9.4.1. Principles

- The need to collaborate with and contribute to other Port Pirie health, education, social and GP services to maximise the effective use of resources to promote the community plan, to educate and to minimise the impacts of lead amongst those most affected.
- The Government's commitment to strengthen communities and services by bringing together its resources in partnerships with local government, local providers and local communities themselves.

9.4.2. Strategies

- Engage with local health, social and education services to develop cooperative programs:
  - Early childhood intervention with Every Chance for Every Child program and explore the use of elevated blood lead as a trigger for intensive visiting,
  - Case management,
  - Develop and implement the community plan,
  - Nutrition improvement,
  - Child development and development delay,
  - Health promotion and community education,
  - General practitioner referrals.
- Share administrative arrangements, infrastructure and support systems (conditional on benefit to children's lead goals).
- Share information, policies, responsibilities, skills, referrals.
- Reinforce lead (Pb) messages within broader health promotion.
- Parenting skills development eg: with Child Youth and Women's Health Service.

- Workshops for health and community workers:
  - Correct information for clients,
  - Identify common purposes, strategies, services,
  - Promote work of PPLIP.
- Synergy with external initiatives and government policies / programs.
- Encourage other agencies to include lead (Pb) messages in their strategic planning and everyday activities.
- Interaction with local general practitioners and other medical specialties.

9.5 Workforce Training and Development

9.5.1. Principles

- Staff of the principal partners need high level understanding to maximise the benefits of future directions.
- Improve the quality and equity of services.
- Dignity and autonomy of health service users – respectful communications and service provision.
- Leadership – quality leadership that recognises and enhances the skills of staff.
- Improve understanding and contribution to the lead (Pb) issue amongst other service providers.

9.5.2. Strategies

- Measures to improve PPLIP (EHC) morale and recruitment. Engage HR consultant.
- Targeted training to improve client interaction and service quality.
- Develop management team.
- Develop whole-of-agency staff team.
- Develop the ethos and culture of PPLIP.
- Explore strategies to collaborate with smelter workforce:

- Improve understanding of lead effects on health, of process control impacts on emission performance and environmental contamination,
- Improve understanding of personal lead avoidance strategies,
- Workforce as community leaders, lead (Pb) educators,
- Minimise take-home lead (Pb),
- Urgent attention to uncontrolled emissions,
- Explore selective use of oral lead chelator, succimer.

9.6 Collaboration with Port Pirie Regional Council

9.6.1. Principles

- Council is recognised as the only acknowledged single point of contact for the whole community and provides direct representation.
- Council is a key tier of Government, and as the elected representative of the local community, plays a valuable role in the political process.
- Council is responsible for several strategy components that are critical to future directions, eg. land use planning, site contamination.

9.6.2. Strategies

- Encourage development of a City plan that includes health eg: Healthy Cities model.
- Land management plans for the most contaminated allotments, including public land, to set limits on development and enforce Development Act.
- Control / reduce residential development in high contamination areas:
  - Section 7 advisories,
  - Title encumbrances,
  - Land management plans,
  - Consider further buffer zone policy.

- Complete North of Frederick Rd withdrawal and conversion to inactive care scrubland. Ensure no further development.
- Improve Council staff understanding of the lead issue and PPLIP programs, increase cooperation.
- Disposal of PPLIP post-demolition vacant allotments (about 38) eg: neighbours, SA Housing Trust for elderly homes development.
- Develop an MOU with Council to define responsibilities, limit Council liability over vacant allotments.

10. DELIVERING THE STRATEGIES

10.1 Developing the Bold 10 by 10 Initiative

The review panel acknowledges with pleasure the rapid progress that has been made in recent months toward joint and bold action to reduce blood lead levels. Under Zinifex leadership and energetic commitment, an innovative project – 10 by 10 – is taking shape (ie, blood lead levels of 95% of children, 0-4 years, below 10µg / dL by the end of 2010):

- An executive board for 10 by 10 of chief executive level officers of the principal partners has formed to provide strategic direction;
- A working party of senior officers from principal partners has been meeting regularly to develop implementation plans;
- Zinifex has committed, as a company, to controlling its emissions to achieve 10 by 10 and to achieve a sustainable smelter and community;
- Zinifex has identified key emission control strategies, has approved $18m over the next 3 years and is developing proposals for additional initiatives;
- Zinifex is leading 10 by 10 community consultation, discussions with smelter staff, exploration of interventions to reduce take-home lead by staff and other supportive projects; and
- A public commitment to 10 by 10 and launch is being planned.

10.2 Supporting 10 by 10

The following recommendations outline other initial components of a detailed implementation plan which will be needed to support the 10 by 10 vision of the future.

- Implement the proposed prevention, impact minimisation and enabling strategies:
  - Review current PPLIP budget and identify re-allocation needs,
  - Review PPLIP staff roles and skills and identify training / development and changes needed,
  - Identify opportunities and develop enhanced effective collaboration with other Port Pirie health, education and social services.
- Strategic planning and direction supervision:
  - Appropriate management structures and lines of responsibility within the Public Health group of the Department of Health,

- Quality leadership that is committed to implementing the future foci and directions and to recognising and enhancing staff skills,
- Develop mechanisms for community and client feedback,
- Strategic leadership from the wider Environmental Health Service: EIP negotiations with EPA and Zinifex, development of agreed review strategies, strategy development, evaluation and monitoring.

- An external consultant should review PPLIP human resource management to improve staff issues: morale, recruitment and retention, supervision and communication.
- Establish local interagency working groups to:
  - Develop early childhood services,
  - Define key lead messages,
  - Develop nutrition programs,
  - Identify opportunities for collaboration and sharing,
  - Develop teamwork approaches for family centred case management,
  - Plan and develop community education and health promotion strategies.
- Explore the benefits of selected consultancies to:
  - Segment the community for communication and education strategies,
  - Identify the needs and issues of high risk / exposure client groups,
  - Develop community education materials,
  - Develop a targeted staff training plan,
  - Identify acceptable relocation options for residents north of Frederick Road.
- Consider some current PPLIP services:
  - Individual intervention for moderate risk families (10-19µg / dL),
  - Greening, plant replacement, irrigation needs,
  - PPLIP asset maintenance,
  - Blood lead testing to improve cost effectiveness.

- Implement strategy development and evaluation program and explore further short-term contracts to provide critical new understanding to support further emission reductions.

10.3 Additional Funding for Blood Lead Effective Strategies

10.3.1. Principles

- Recognising that:
  - the dependence on behavioural change strategies during the current Lead Program has not achieved adequate reductions in blood lead levels,
  - currently available, demonstrably effective strategies involving relocation of residents, house modification and indoor dust control are relatively expensive, and
  - 95 children are still at high risk (above 20µg / dL), another 101 children are at moderate risk (between 15-19µg / dL), and 174 children are still between 10-14µg / dL,

  the review panel concludes that even by maximising the budget allocated to these effective strategies, e.g. approximately 50% or $0.9m per annum, substantial reductions in blood lead levels will be delayed unless smelter emissions can be concurrently substantially reduced.

- Short term additional funding may be strategically justifiable to gain necessary long-term improvements and allow re-allocation of current resources.

- Significant numbers of children who are above 20µg / dL is quite unacceptable.

- Achievement of substantial reductions in blood lead must take full advantage of the unique partnership opportunity that is emerging.

10.3.2. Strategies

- Encourage Zinifex to contribute to community strategies provided that is the most effective use of their resources towards achieving 10 by 10.

- Explore opportunities for additional funding for:
  - Increasing the availability of low risk area housing,

- Housing modifications to reduce dust entry including installation of positive pressure ventilation / air filtration equipment,
- Clearing residual houses from buffer zones eg. North of Frederick Road will also allow re-allocation of current resources used for maintaining that area,
- Bridging the financial gap between high and low risk houses.

- Explore collaboration opportunities to support investigation and strategy development.
- Develop multi-agency proposals for innovative solutions to SA Government, Commonwealth Government, Local Government Association, industry associations and other funding bodies.

10.4 Government Agency Consultation

Negotiated whole-of-Government agreed target and strategies with roles for DH, EPA, SAHT and DECS agreed. Strategies envisaged are outlined below.

- Negotiations with EPA Chief Executive to include conditions in any future EIP negotiated with the Zinifex Port Pirie Smelter. Potential future EIP conditions may include:
  - Programs that will reduce relevant sources of emission from the sinter plant,
  - Programs that will identify and reduce fugitive loss of bio-available lead from elsewhere in the smelter,
  - Programs that reduce the impacts of ambient sulphur dioxide if health risk assessment shows this to be justified relative to reducing infant blood lead levels,
  - Programs that consider the elimination of other pollutants in fugitive material that are found to have a health impact on the Port Pirie community.
- Negotiations with the SA Housing Trust to identify strategies to facilitate relocation of high risk families, to modify recurrent programs to improve contaminated dust management in public housing and rental accommodation, and to use rental accommodation for temporary relocation.
- Negotiations with the Department of Education and Children's Services (DECS) to reduce exposure to contaminated dust in pre-school facilities and to improve the identification and management of children with delayed development.

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