Lead Pathways Study
Water Report summary

September 2012

Summary of the report *Sources and Pathways of Contaminants to the Leichhardt River* by:

Barry Noller, Centre for Mined Land Rehabilitation, The University of Queensland
Trang Huynh, Centre for Mined Land Rehabilitation, The University of Queensland
Jack Ng, National Research Centre for Environmental Toxicology, The University of Queensland
Jiajia Zheng, Centre for Mined Land Rehabilitation, The University of Queensland
Hugh Harris, School of Chemistry and Physics, The University of Adelaide

The University of Queensland Australia
SMI CMLR Centre for Mined Land Rehabilitation
entox national research centre for environmental toxicology
Mount Isa Mines
xstrata

The University of Queensland's Centre for Mined Land Rehabilitation (CMLR)

Established in 1993, the Centre for Mined Land Rehabilitation (CMLR) within the Sustainable Minerals Institute (SMI) at The University of Queensland is a collaborative and multi-disciplinary group of research, teaching and support staff and postgraduate students dedicated to delivering excellence in environmental research and education to the Queensland, national, and international minerals industry and associated government sectors.

The Centre is widely recognised as a source of quality research into cutting edge environmental management and sustainability in mining issues. It translates research outcomes into practices that lead to continual improvement of rehabilitation and environmental practices. CMLR focuses on preventing, minimising and remediating mining impacts by providing education and professional development in the sustainability area; engaging industry, government and community; and delivering research solutions developed through science.

CMLR is one of seven research centres at SMI (www.smi.uq.edu.au), which provides knowledge-based solutions to meet sustainability challenges in the global mining industry. The Institute was established in 2001 as a joint initiative of the Queensland Government, University and the minerals industry to provide an overarching framework for progressing minerals industry research and education.

About the authors

Associate Professor Barry Noller

Associate Professor Noller has a PhD (1978) in Environmental Chemistry from the University of Tasmania. He worked as a Research Fellow at the Australian National University (1978-1980), Senior Research Scientist at the Alligator Rivers Region Research Institute, Jabiru, Northern Territory (1980-1990) and then as Principal Environmental Chemist for the Department of Mines and Energy, Darwin, Northern Territory (1990-1998). From 1998-2006 Professor Noller was Deputy Director of the National Research Centre for Environmental Toxicology (Entox) – The University of Queensland, Coopers Plains, Queensland. Entox has a strong involvement with the utilisation of the risk assessment process to deal with toxicological hazards, including in environmental systems. Since November 2006 Professor Noller has been appointed as Honorary Research Consultant and Principal Research Fellow at the Centre for Mined Land Rehabilitation (CMLR) a centre of the University of Queensland based at St Lucia in Brisbane. The CMLR is part of the Sustainable Minerals Institute.

Associate Professor Noller has been working and publishing in the field of environmental chemistry and industrial toxicology for the past 32 years and has presented over 350 conference papers and published more than 170 papers. His professional activities undertaken at four different centres have covered processes and fates of trace substances in the environment, particularly in tropical environmental systems with special reference to risk management associated with their application and studies of the bioavailability of toxic elements in mine wastes, including waters.

Dr Trang Huynh

Dr Trang Huynh has a PhD (2008) in Environmental Science from the University of Melbourne. Her PhD research project was on Bioavailability of heavy metals in soil and biosolids during phytoextraction. She completed her Master of Science Degree majoring in Soil Science at The University of Sydney (2001) with her thesis on Crystallographic and chemical properties of copper and cadmium substituted goethites using X-ray Synchrotron technique. She worked as a researcher and lecturer on soil and environmental chemistry in Vietnam for seven years. During this period, she was involved in several internationally funded projects as a project coordinator, researcher, and project evaluator. Dr Trang Huynh is currently a Postdoctoral Research Fellow with the CMLR at The University of Queensland, working on the Lead Pathways Project at Mount Isa.

Dr Trang Huynh's research interests are principally in biogeochemistry, environmental, and water/soil chemistry, plant-soil interaction, and the behaviour of heavy metals and metalloids in the environment. She is also interested in understanding and applying advanced techniques such as Diffusion Gradients in Thin Films (DGT) and the synchrotron technique to measure heavy metal and metalloid speciation in the environment, especially at mining sites. One of her current research focuses is on the impacts of contaminants from mining activities on human and ecological health.

Independent review process

The Water Report was independently reviewed to verify both the scientific validity of the study and outcomes based on the facts evident in the data.

Dr Graeme Batley

The *Lead Pathways Study* Water Report has been independently reviewed by the Commonwealth Scientific and Industrial Research Organisation's (CSIRO) Chief Research Scientist Dr Graeme Batley BSc (Hons) MSc. DSc. PhD. Dr Batley works as part of CSIRO Land and Water's Environmental Biogeochemistry Research program.

Dr Batley's expertise is in the area of the analytical and environmental chemistry of trace contaminants in natural water systems, with particular emphasis on heavy metals and their chemical forms, fate, transport, bioavailability and ecotoxicology in waters and sediments. Dr Batley is involved in a range of professional activities, including expert and scientific advisory panel membership for large developments. He is author of 393 research papers, book chapters and reports on analytical and environmental chemistry, and author and editor of four books.

Introduction

The health and wellbeing of our employees and communities is paramount. That is why in 2006 we commissioned the most comprehensive study of its kind in Australia, to investigate the natural and industrial pathways of lead into a community and assess the human and ecological health risks.

The *Lead Pathways Study* Water Report is a comprehensive and independent scientific study concluding the risk to human health from water quality in the Leichhardt River Catchment, including Lake Moondarra, is low.

Studies like this are helping us identify further opportunities to improve our environmental performance. We are already acting on the recommendations contained within the report and have achieved significant progress across all five areas.

Since acquiring Mount Isa Mines in 2003, we have invested more than $290 million on over 250 environmental initiatives. Our mining operations have a track record of continuously improving environmental performance and consistently meeting evolving environmental requirements.

Our new *Environmental Authority* was granted in December 2011 and a *Transitional Environmental Program* (TEP) for Water was approved in May 2012. We have developed our action plan for the Water Report to align with our comprehensive Action Plan of environmental improvements in water management as part of our TEP. We have committed approximately $360 million over the next five years to continue improving our environmental performance, with approximately $60 million allocated specifically for water management initiatives.

On behalf of Xstrata Mount Isa Mines, we would like to thank Associate Professor Noller and his team for their work to date in delivering the Land and Water Reports of the *Lead Pathways Study.*

Steve de Kruijff
Chief Operating Officer
Xstrata Copper North Queensland

Brian Hearne
Chief Operating Officer
Xstrata Zinc Australia

Water Report overview

- Four-year study
- Peer reviewed by the CSIRO
- Study area covered sample sites upstream of Mount Isa City to Rifle Creek dam, Mount Isa City and downstream to Lake Moondarra
- Water samples collected over five sampling periods from 11 sites in the Leichhardt River, five tributaries, three tailings seepage ponds and two urban tributaries
- Sediment samples collected over six sampling periods from Leichhardt River between Rifle Creek Dam and Lake Moondarra
- Considered multiple potential metal and metalloid contaminant sources, including current mining operations, urban activities and wastewater discharges, natural mineralisation and historical mine sediment

The Water Report did not examine other forms of contaminants such as chemicals and biological matter.

See study area map fold out on the back page

Background

In 2006, Xstrata Mount Isa Mines commissioned the most comprehensive study of its kind in Australia to investigate the natural and industrial pathways of lead into a community and assess the human and ecological health risk.

The independent and comprehensive study is being conducted by The University of Queensland's Centre for Mined Land Rehabilitation (CMLR) in collaboration with the National Research Centre for Environmental Toxicology (Entox).

The Land Report was released in 2009, concluding the risk to human health from historical mine sediment was low and recommending a number of actions to improve Xstrata's environmental performance. These recommendations were fully adopted and implemented.

The Water Report has been peer reviewed by the CSIRO to ensure both its scientific validity and the accuracy of outcomes based on the facts evident in the data.

This summary presents the key findings of the '*Lead Pathways Study – Water, Sources and Pathways of Contaminants to the Leichhardt River*' and has been developed as a companion document to the scientific report. The full report is available online at ***www.mountisamines.com.au***.

Lead Pathways Study

Land Report	✓	Released July 2009
Water Report	✓	Released September 2012
Air Report	In progress	Expected release in 2013

The Water Report comprised a water quality, sediment quality and aquatic toxicity assessment in water and sediment in line with the National Water Quality Management Strategy.

Purpose

1. Investigate potential sources and pathways of lead and other heavy metals and metalloids in water from a number of tributaries leading into the Leichhardt River Catchment – particularly at and below Mount Isa City and the mine lease.
2. Assess the risk to human, pastoral and ecological health from lead and other heavy metals and metalloids in water.

The broad objectives of the study were to assess the risk of metals and metalloids in water to:

- the health and wellbeing of the Mount Isa community
- pastoral activities
- the continued health of aquatic ecosystems
- minimise impacts of existing mine sediments resulting from historical mining practices, as well as any current discharges.

Results summary

The *Lead Pathways Study* Water Report shows that Leichhardt River water quality, including Lake Moondarra, poses a low risk to human health from metals and metalloids.

- Mount Isa's drinking water supply meets *Australian Drinking Water Guidelines* (ADWGs)
- Eating the flesh of fish caught in Lake Moondarra presents a low risk to human health. People should avoid eating fish livers in general as they may have higher concentrations of heavy metals and other toxicants
- Recreational activities, such as swimming and boating in the Leichhardt River and Lake Moondarra, pose a low risk to human health
- The Leichhardt River meets national livestock watering guidelines for metals and metalloids
- Further investigation is required to assess the ecological health of the Leichhardt River Catchment between Star Gully and Moondarra Crossing to determine if any additional remediation work is required

Study methodology

The Water Report considered all sources of potential heavy metal contaminants, including mining activities, urban waste, natural mineralisation and historical mining in Mount Isa. It determined the distribution of metal and metalloid concentrations within the study area, assessing the potential risks of these concentrations for human, pastoral and ecological health.

The Water Report comprised a water quality, sediment quality and aquatic toxicity assessment in water and sediment in line with the National Water Quality Management Strategy (NWQMS). The NWQMS is a joint national approach to improving water quality in Australian and New Zealand waterways, developed in cooperation with state and territory governments. Specifically, the Water Report used a number of guidelines, including:

- *Australia and New Zealand Environment and Conservation Council/ Agriculture and Resource Management Council of Australia and New Zealand (ANZECC/ARMCANZ) Water Quality Guidelines*
- *Australian Drinking Water Quality Guidelines*
- *Food Standards Australia New Zealand (FSANZ)*
- *Guidelines for Managing Risks in Recreational Water*
- *National Environmental Protection Measure Health Investigation Level E (NEPM HIL Level E)*
- *Queensland Water Quality Guidelines*

These guidelines outline biological, water, and sediment quality criteria for protecting human, livestock and aquatic ecosystem health. Where contaminants were identified at concentrations above thresholds set out in these guidelines, site-specific risk assessments were conducted according to the investigation processes outlined in the guidelines to identify potential human health, pastoral, and ecological risks.

Water Report risk assessments

1	Human health risk	People occasionally drinking raw river water
		People using the river for recreational activities, such as swimming and boating
		People occasionally eating fish caught in the Leichhardt River, including Lake Moondarra
2	Pastoral risk	Using river water for irrigation and livestock watering
3	Ecological risk	Effects of metals and metalloids to the health of freshwater life in the study area

The water and sediment quality sampling process took into account the fact that metal and metalloid concentrations vary between seasons. For example, during dry periods, concentrations of contaminants such as heavy metals and biological matter can be higher in river pools and are subsequently naturally diluted during the wet season.

Human health risk assessment

The Water Report identified and assessed the significance of all potential water exposure pathways of metals and metalloids for members of the population who may have contact with the Leichhardt River. People's contact with water at the study sites ranges from direct contact through sport and recreation activities to indirect contact through the consumption of drinking (potable) water, treated at Clear Water Lagoon. Other study sites include tailings dams and other areas on the Xstrata Mount Isa Mines lease that are not accessible to the public and bound by strict health and safety procedures for employees and visitors.

Definitions

Acute toxicity: Toxicity experienced during or immediately after short-term exposure to a toxicant or stimulus severe enough to induce an adverse reaction rapidly, relative to the lifespan of the organism.

Bioaccessibility: The fraction of a compound that is soluble following gastrointestinal extraction and is therefore available for absorption. It is specifically referred to when in vitro (i.e. in a test tube) assessment models are used, for example, using laboratory equipment to simulate the gastro-intestinal tract. Bioaccessibility is a scientifically recognised method of predicting bioavailability.

Bioavailability: The fraction or percentage of a compound which is ingested, inhaled or applied to the skin that actually is absorbed and reaches systemic circulation.

Metalloid: A non-metallic element that has some of the same properties as a metal. Arsenic is an example of a metalloid.

Toxicity: The inherent potential or capacity of a material to cause adverse effects in a living organism.

The human health risk assessment was undertaken according to guidelines set by the National Health and Medical Research Council (NHMRC), the *Australian Drinking Water Guidelines (ADWGs)* and the *Guidelines for Managing Risks in Recreational Water*, and the National Environmental Protection Council (NEPC).

In assessing the human health risk from heavy metals in sediment samples, the Water Report treated sediment as soil and then considered the bioaccessibility and bioavailability of metals and metalloids in the soil. This is important, as the risk to human health is not directly related to the total amount of contaminant ingested, but rather the amount that is available to be absorbed by the body as it passes through the stomach and gastrointestinal tract (bioaccessibility) and the amount that is actually absorbed by the body (bioavailability).

Drinking water

The Water Report confirmed that Mount Isa's drinking water (potable) supply, treated at Clear Water Lagoon, was safe for human consumption and met the *Australian Drinking Water Guidelines*. Clear Water Lagoon was constructed as a protected reservoir, which acts as a biological filter for treating water drawn from Lake Moondarra and Lake Julius.

The Water Report confirmed that Mount Isa's drinking water (potable) supply, treated at Clear Water Lagoon, was safe for human consumption and met the *Australian Drinking Water Guidelines*.

Raw river water

In addition to the potable water supply, the study assessed the quality of the water in the remainder of the Leichhardt River Catchment. The study adopted the conservative assumption that the Leichhardt River (raw river water) was the only source of drinking water and assessed water samples against the ADWGs even though the river water is not treated.

Water samples were collected from the Leichhardt River, tributaries from the mine lease and Xstrata Mount Isa Mines' seepage ponds (not accessible by the general public or livestock) over five sampling periods between October 2008 and June 2010. The sampling periods took into account pre-wet, wet, and post-wet season conditions.

Across the five sampling periods, six sites from the Leichhardt River, five sites at tributaries from the mine lease and two of Xstrata Mount Isa Mines' seepage ponds exceeded the ADWGs for arsenic, cadmium, and lead on at least one occasion.

To assess the potential risk to human health of drinking raw river water, the study took a conservative approach and investigated the risk from drinking two litres of raw river water per day. The results showed that even if two litres of raw river water is consumed every day, the total intake of lead would still be below the acceptable daily intake of 0.25 milligrams per day (mg/d) for adults and 0.05 mg/d for children, when adjusted for 10% bioavailability and normal food lead intake. However, a number of Leichhardt River water samples could pose a risk if soil lead is included in this calculation (only water samples where lead concentration was higher than ADWGs were considered).

It should be noted that the health risk from heavy metals and metalloids in drinking raw river water every day is very low compared to the potential adverse impacts from biological contaminants such as bacteria, viruses and parasites. The public is advised not to drink raw river water from tributary creeks, which exceeded the ADWGs on the Xstrata mine lease.

Water samples within the study area also met the *Guidelines for Managing Risks in Recreational Water*, which allow for consumption of 100–200mL of raw river water per day during recreational activities.

Sediment

Sediment is the matter that settles at the bottom of a liquid, such as sand in a river. Sediments are a 'sink' for heavy metals and metalloids and can also influence water quality. They can be absorbed by organisms and then transfer metals and metalloids through the aquatic food chain. Sediment contamination can come from a number of sources such as natural mineralisation, historic mining activities, urban discharge and mining discharges.

The human health risk from sediment was assessed by comparing total concentration levels of metals and metalloids found in sediment samples with the *National Environmental Protection Measure Health Investigation Level E (NEPM HIL Level E)* for soil. This is a national guideline for the recreational use of "land" including dried river sediment for parks, recreational open space and playing fields. This criterion is used to assess any potential existing contamination and is intended to prompt an appropriate site-specific investigation where this investigation level is exceeded. Where the need for further investigation was identified, the assessment also considered the bioaccessibility of the metal to predict bioavailability.

All sediment samples (when considered as a soil) within the study area, except for one, met the *NEPM HIL Level E* guideline for metals and metalloids tested.

One sample located at the Star Gully exit study site on the Leichhardt River exceeded the *NEPM HIL Level E* criteria for human health risk for cadmium and lead, when the total concentration was adjusted for bioaccessibility. Exceeding this guideline means further investigation should be undertaken to determine if remediation is required at this site, and to what extent (see Recommendations).

Fish

A study of the bioaccumulation of heavy metals and metalloid concentration in fish and aquatic macroinvertebrates in the Leichhardt River Catchment was undertaken from upstream of Lake Moondarra, extending downstream to Lake Julius. The study assessed the potential human health risk of consuming fish from the study area in accordance with the *Food Standards Code Australia New Zealand (FSANZ)* for fish consumption by children and adults. The assessment concluded that acute toxicity from the consumption of fish caught in the Leichhardt River is unlikely.

Eating the flesh of fish caught in Lake Moondarra presents a low risk to human health from metals and metalloids. People should avoid eating fish livers generally as they may have higher concentrations of heavy metals and other toxicants. Further, people should avoid eating fish caught in pooled areas of the Leichhardt River between Mount Isa and Lake Moondarra during the dry season, as substances such as heavy metals and metalloids, and biological matter are more concentrated in these smaller bodies of water. These substances are naturally diluted during the wet season.

The NHMRC *Australian Dietary Guidelines* recommend eating two to three serves of fish per week (one serving size is equal to 80–120g of cooked fish fillet for children and adults).

Based on the median (and even the 75th percentile) results from fish caught in Lake Moondarra, the Water Report concluded that consuming even three times the standard serving size of fish fillets (300g) per day poses a low risk to human health. In fact, median results showed that an adult could consume up to five kilograms of fish fillets every day from fish caught at Lake Moondarra and still remain within the guideline thresholds for heavy metals exposure. A child could eat up to one kilogram of fish fillets from Lake Moondarra daily.

Pastoral health risk assessment

The water samples, collected over five sampling periods, used for the human health risk assessment were also compared to the *Australia and New Zealand Environment and Conservation Council/ Agriculture and Resource Management Council of Australia and New Zealand (ANZECC/ARMCANZ)* irrigation or livestock watering guidelines. Analysis found that all study sites were within these guidelines for metals and metalloids measured.

Ecological health risk assessment

Aquatic ecosystems are communities of living organisms such as plants, animals and microbes in a body of water. The report assessed the effects of metals and metalloids to the health of freshwater life in the Leichhardt River Catchment. These findings are not applicable to human health.

Concentrations of metals and metalloids in water and sediment samples were compared against the *ANZECC/ARMCANZ Water Quality Guidelines* for protecting aquatic ecosystems in both freshwater and sediment. This involved a comprehensive multi-stepped testing process in which the results of each test determined the direction of the investigation. Where the specific guideline threshold was exceeded, an assessment of aquatic toxicity and the bioavailability of lead and other metals and metalloids to aquatic species was undertaken.

Ecological health risk assessment methodology

The *ANZECC/ARMCANZ Water Quality Guidelines* are a multi-stepped testing process in which results of each test determine direction of investigation.

Guideline

Water

ANZECC/ARMCANZ Water Quality Guidelines 90% and 95% trigger values.

Sediment

ANZECC/ARMCANZ Interim Sediment Quality Guidelines (ISQGs) High and Low.

Bioavailability

When guideline exceeded, study considered bioavailability.

Definition

The fraction or percentage of a compound which is ingested, inhaled or applied to the skin that actually is absorbed and reaches systemic circulation.

Aquatic toxicity

If guideline still exceeded when bioavailability is considered, study undertook an aquatic toxicity assessment.

- Assessed using range of test organisms
- Study limited by availability of suitable local aquatic species

The aquatic toxicity of both water and sediment samples from the Leichhardt River was assessed using a range of test organisms according to the *ANZECC/ARMCANZ* guidelines investigation process. Aquatic test organisms are microscopic organisms that live in river sediment, which are sensitive to changes in water quality and therefore could provide an indication of potential contamination in aquatic systems.

Water

Total concentrations and bioavailability of metals and metalloids in the water were compared with the *ANZECC/ARMCANZ Water Quality Guidelines* trigger values for fresh water species at two levels: to protect 90% of all freshwater species and to protect 95% of all freshwater species. The trigger values were also adjusted for site-specific water hardness, as stipulated by the *ANZECC/ARMCANZ* guidelines investigation process.

A number of sites exceeded the *ANZECC/ARMCANZ Water Quality Guidelines* 90% and 95% trigger values for fresh water species for arsenic, cadmium, copper and lead. These results indicate that further investigation needs to be undertaken to assess potential impacts on ecological health at these sites according to the *ANZECC/ARMCANZ* guidelines investigation process.

As such, a toxicity assessment of water samples was undertaken using a range of test organisms. Samples taken both before and after Xstrata's Leichhardt River Remediation Project were assessed and showed acute toxicity at Davis Crossing, and to a lesser extent, at the junction of Breakaway Creek and Leichhardt River. Other sites showed no toxicity following the remediation works undertaken in 2008.

The findings indicate that, overall, only limited toxicity was observed in the Leichhardt River water for a range of aquatic species across different levels of the food chain.

Sediment

The sediment sample results were compared against *ANZECC/ARMCANZ Interim Sediment Quality Guidelines (ISQGs)*, which are trigger values that, if exceeded, prompt further action in line with the guideline investigation process.

Definitions

There are two kinds of trigger levels: ISQG-Low and ISQG-High

ISQG-Low: sites that exceed this guideline level indicate a low probability of biological effects.

ISQG-High: Sites that exceed this guideline level indicate a high probability of biological effects.

Where Leichhardt River sediment samples exceeded ISQG-Low and ISQG-High values, the bioavailability of metals and metalloids was assessed. If the sediment samples still exceeded the guideline levels when adjusted for bioavailability, further aquatic toxicity testing was undertaken in line with the *ANZECC/ARMCANZ* investigation process, although this assessment was restricted due to the limited availability of suitable test organisms.

Samples taken both before and after the Leichhardt River Remediation Project were assessed. The results indicated that the majority of sites from the Leichhardt River (including those upstream of Mount Isa) exceeded the ISQG-Low level for different heavy metals and metalloids, including arsenic, cadmium, copper, lead and zinc, when adjusted for bioavailability.

A smaller number of samples also exceeded the ISQG-High level. These sites may require remediation depending on the outcome of further aquatic toxicity testing for sediments, which is recommended given the limitations of the toxicity assessment undertaken as part of this study for both water and sediment (see Recommendations).

Recommendations

Recommendations based on findings and observations from the study are outlined below. Xstrata Mount Isa Mines has committed to act on all the recommendations and is already making progress in all five areas.

Recommendations	Actions
Identify the specific source of toxicity observed in water from the lower part of the Leichhardt River, adjacent to Mount Isa City and the mine lease. Continue to identify aquatic species that may be suitable for testing whole sediment for effects from metals and metalloids.	Xstrata Mount Isa Mines has engaged a leading environmental consultant to further assess areas in the Leichhardt River to identify specific sources of ecological toxicity. This will provide a better understanding of the impacts of metals and other contaminating substances on microorganisms living in the waterways. This will include identifying local aquatic species that may be suitable for testing whole sediment for effects from metals and metalloids.
Investigate the section of the Leichhardt River and tributaries from the mine lease with sediment metal and metalloid concentrations exceeding ISQGs that may show potential ecological effects and may require remedial attention. Investigate the section of the Leichhardt River at the exit from Star Gully where contaminated sediment exceeds *NEPM HIL Level E* and could impact on human health. This area has been identified for possible remedial attention. The link with sediment and elevated levels of cadmium and lead in fish needs to be better understood.	Xstrata Mount Isa Mines will continue to regularly monitor these and other sites as part of their *Environmental Authority*, granted in December 2011 and *Transitional Environmental Program* for Water approved in May 2012. Assessment of remediation requirements will be carried out following the identification of specific sources of ecological toxicity and testing with local aquatic species. The elevated result for the site along the Leichhardt River at the Star Gully exit triggered a requirement for further investigation, which Xstrata completed throughout 2011. This was only one of 79 sites assessed as part of the Mount Isa Mines Verification Program that exceeded the *NEPM HIL Level E* national guidelines. An additional 10 samples were taken at this site. Analysis showed sediment quality was in compliance with all regulatory and environmental standards and posed a low risk to human health.
Consider changing the frequency of water and sediment monitoring programs to enable collection of sufficient data for developing adequate site-specific guidelines undertaken according to the *Queensland Water Quality Guideline* procedure.	Xstrata Mount Isa Mines have already amended their water and sediment monitoring programs to address the recommendations of this report and align with their *Environmental Authority.* This includes a greater frequency of monitoring, as well as the development of a results database, which is an important step to developing site-specific water quality guidelines according to the *Queensland Water Quality Guideline* procedure. Since 2006, Xstrata has invested around $11 million on stormwater management improvements at Xstrata Mount Isa Mines. As part of their *Transitional Environmental Program* Xstrata are investing approximately $60 million over five years to improve water management practices and ensure compliance with their new *Environmental Authority.* This includes improvements to the operation's site-based capture of contaminated waters and sediment, further minimising the risk of releasing contaminated water from site.

About the authors continued

Professor Jack Ng

Professor Ng is a certified toxicologist (DABT – Diplomate of the American Board of Toxicology) and is the Program Manager for Risk Assessment and Intervention Research at the National Research Centre for Environmental Toxicology (Entox). His major research themes include chemical speciation of arsenic species in environmental and biological media, bioavailability in relationship to toxicities using various animal models, carcinogenicity and mechanistic studies of chronic arsenic toxicity in both humans and animals. Other research interests include toxicity of mixed metals, the transfer of heavy metals via the food chain from mine tailings and other mining wastes in addition to study on natural toxins in plants relevant to human health. Jack's projects represent a combination of independent effort as well as linkages through national and international collaboration.

Professor Ng is also the Program Leader for Minimising Uncertainty in Risk Assessment of CRC-CARE (Contamination Assessment and Remediation of the Environment). Professor Ng has over 300 publications including journal papers, book chapters and technical reports.

Ms Jiajia Zheng

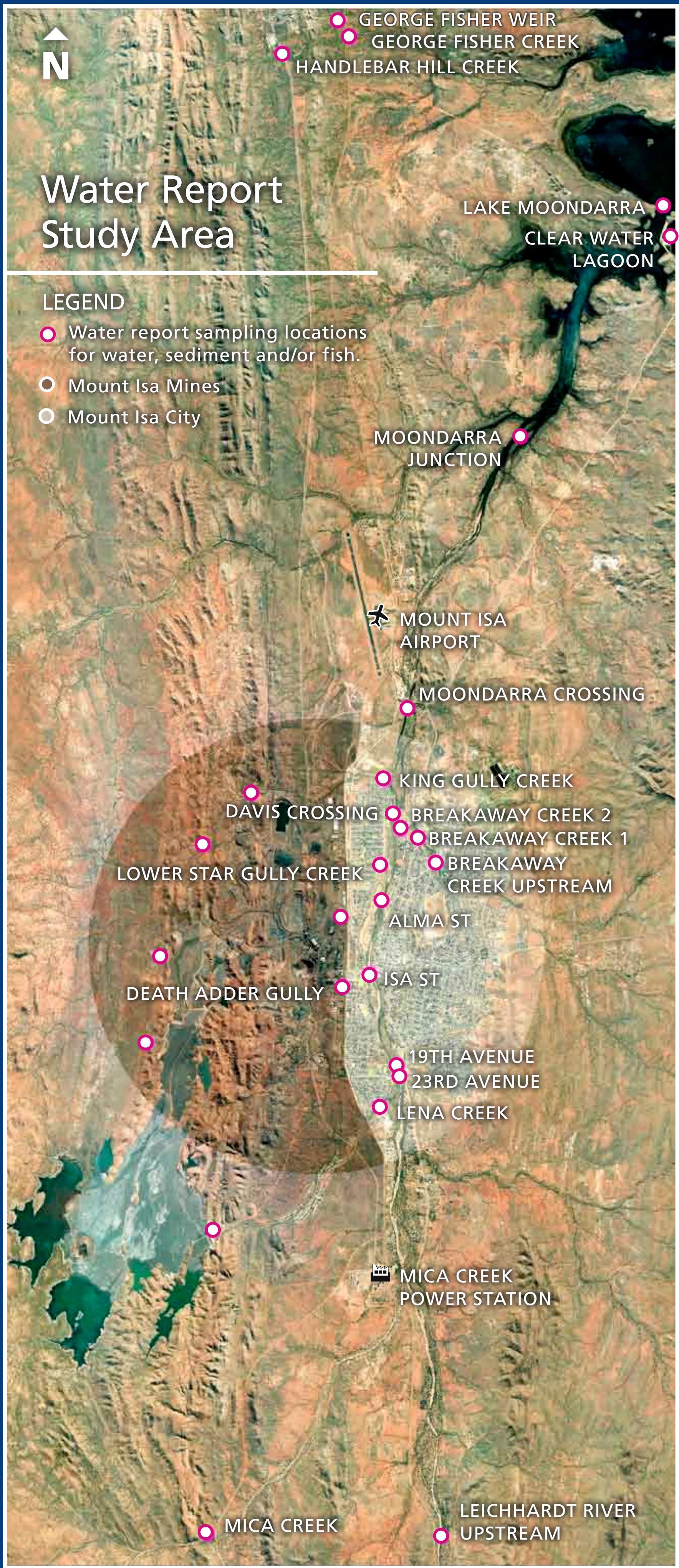
Ms Jiajia Zheng is currently doing a PhD with the CMLR at The University of Queensland, and is working on the Lead Pathways Project at Mount Isa. Ms Zheng has a Masters Degree in Environmental Geochemistry (2010) from The University of Queensland. Her Masters research project was on Peat Deposits of Moreton Bay: Natural Archives of Environmental Pollution. Before studying in Australia, Ms Zheng studied at the China University of Geosciences (Wuhan), majoring in Economic Geology.

Ms Zheng's research interests are principally in environmental risk assessment and the mining and minerals industry, using various techniques such as synchrotron technique and isotope measurement, air/soil pollutions, to determine the impacts of contaminants from mining activities on humans.

Associate Professor Hugh Harris

Dr Hugh Harris is an Australian Research Council Queen Elizabeth II Fellow in the School of Chemistry and Physics at the University of Adelaide. He has a PhD in Chemistry (2000) from the University of New South Wales, and has worked as a postdoctoral fellow at Stanford University and the University of Sydney. His main research focus is on using synchrotron-based techniques, such as x-ray absorption spectroscopy and x-ray fluorescence imaging, to understand the roles that metals play in biological systems. This focus spans work on fundamental biochemical and structural studies of metalloproteins, deciphering modes of action of metal-based pharmaceuticals, and the relationship between intake of essential or toxic heavy elements and the development and progression of a range of diseases. He has demonstrated the advantages of x-ray techniques in the area by determining the chemical form of mercury in fish for human consumption, showing that mercury from dental amalgams can migrate through teeth to the bloodstream and by mapping intracellular targets for elements, such as selenium and arsenic.

Dr Harris is the author of nearly forty journal publications, including papers in highly regarded journals such as Science, Environmental Science and Technology and Chemical Research in Toxicology. He serves on a number of committees for the Australian Synchrotron including the X-ray Fluorescence Microscopy Proposal Advisory Committee (chair), the User Advisory Committee and the National Science Consultative Group.



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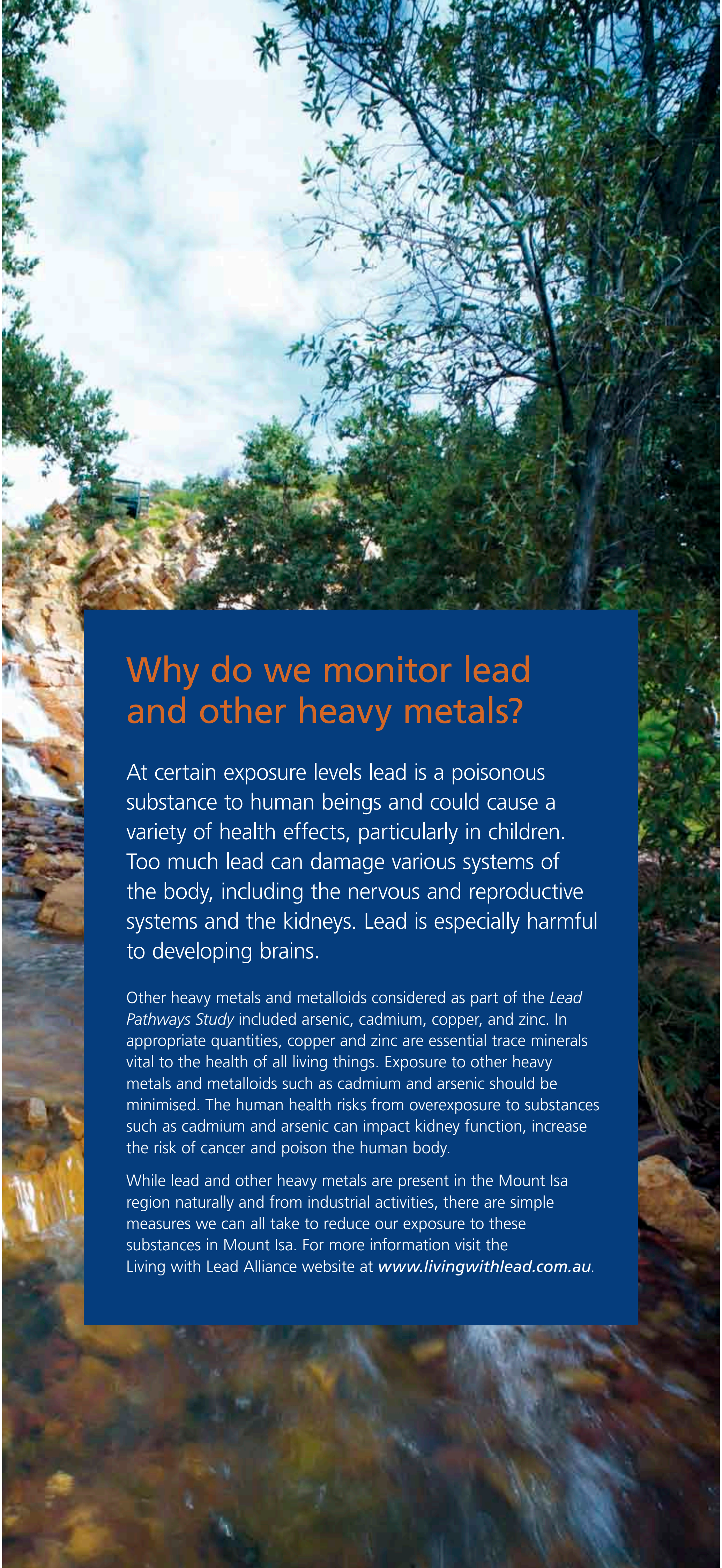
Additional sampling locations at Sybella Creek (approximately 6 km south), Rifle Creek and Rifle Creek Dam (approximately 18 km south).



Why do we monitor lead and other heavy metals?

At certain exposure levels lead is a poisonous substance to human beings and could cause a variety of health effects, particularly in children. Too much lead can damage various systems of the body, including the nervous and reproductive systems and the kidneys. Lead is especially harmful to developing brains.

Other heavy metals and metalloids considered as part of the *Lead Pathways Study* included arsenic, cadmium, copper, and zinc. In appropriate quantities, copper and zinc are essential trace minerals vital to the health of all living things. Exposure to other heavy metals and metalloids such as cadmium and arsenic should be minimised. The human health risks from overexposure to substances such as cadmium and arsenic can impact kidney function, increase the risk of cancer and poison the human body.

While lead and other heavy metals are present in the Mount Isa region naturally and from industrial activities, there are simple measures we can all take to reduce our exposure to these substances in Mount Isa. For more information visit the Living with Lead Alliance website at ***www.livingwithlead.com.au***.

Mount Isa Mines Limited ABN: 87 009 661 447

For more information

Call our Community Feedback Hotline
1800 982 982

Email our team
mountisamines@xstrata.com.au

Write to us at
Xstrata Mount Isa Mines, Central Office
Private Mail Bag 6, Mount Isa Qld 4825

www.mountisamines.com.au

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