MINERALS AND ENERGY RESEARCH INSTITUTE OF WESTERN AUSTRALIA

(MERIWA)

REPORT NO. 273

CYANIDE ECOTOXICITY AT HYPERSALINE GOLD OPERATIONS

Addendum
Volume II – Phase II (Definitive Investigation)
(Curriculum Vitae & Peer Review)

Results of research carried out by [1]Mutis Liber Pty Ltd, [2]Donato Environmental Services and [3]Roger S Schulz (consultant) as MERIWA Project No. M398 I and II

by

[1]M Adams, [2]D Donato, [3]R Schulz and [2]G Smith

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Addenda

Addendum 1 Researchers Curriculum Vitae

Addendum 2 Peer Review Documentation

Addendum 1: Researchers Curriculum Vitae.

Mike Adams BSc (Hons) (Appl. Chem.), MSc, PhD, FAusIMM(CP), FSAIMM

Mike Adams is an experienced metallurgist and applied chemist with some 25 years working in the minerals industry, having experience in management of a variety of bankable-level pilot testwork projects, resource process development projects and metallurgical laboratories. His current role as Consulting Metallurgist and Director of Mutis Liber Pty Ltd is to assist the resource sector with process, flowsheet and testwork design and management, plant assessment and simulation modelling. Mike also sits on the boards of several engineering and resource companies.

Mike completed BSc (hons), MSc and PhD degrees at Wits University, and subsequently held technical leadership and management roles at Mintek in South Africa and SGS Lakefield Oretest in Perth. Mike has been awarded fellow status by the Australian and the South African Institutes of Mining and Metallurgy, and the Raikes gold medal by the South African Chemical Institute. Over the last 25 years he has published about 60 papers, many concerning cyanide management and gold processing, has edited two books, the latest being Advances in Gold Ore Processing, published by Elsevier late 2005. Mike serves on the Editorial Board of the international journal Minerals Engineering.

Mike has project managed several integrated pilot-plant campaigns for definitive feasibility studies on the processing of nickel laterites and sulfides, as well as several international, multi-client, multi-project research programmes and has consulted widely in the area of gold, platinum group and rare metals extractive metallurgy.

Current interests include the development of joint venture companies in the resources and engineering sectors, and the development and techno-economic analysis of process flowsheets incorporating innovative practical technologies, to plant commissioning and operational level.

David Donato BSc, G.Dip.Env.Stud.(Hons)

David is Director of Donato Environmental Service (DES) and has 12 years experience consulting in the resource sector on a wide range of mine environment management issues. Currently DES is completing a three-year industry-wide research project on behalf of ACMER assessing the ecological cyanosis risks associated with gold mine tailings.

David completed his science degree at Adelaide University in 1988 and completed postgraduate studies (ornithology) at the University of Tasmania in 1989. He is currently completing his PhD at the University of Queensland, School of Medicine investigating wildlife cyanosis risks and associated International Cyanide Management Code compliance.

Over the last 12 years he has published relevant papers on ornithology and cyanide management issues as well as more widely on ecology. He project managed the multi-client Northern Territory study on wildlife cyanosis and has developed the current industry understanding of tailings dam ecology.

DES has undertaken numerous industry consults on wildlife and tailings management and has advised and consulted to government regulatory authorities. More recently DES has focused on cyanosis risks and ICMC code compliance protocols to industry in Australia, Africa and New Zealand.

DES has produced near 50 consult reports and presented at 10 international conferences. David is widely regarded as expert by industry peers in matters of wildlife ecology associated with tailings impoundments.

Roger Schulz A(Pure Chem.), Grad.Dip.Nat.Res.(Env), FRACI, CChem, CPChem, MAWA

Roger Schulz is now an independent Environmental Chemist, Consultant and Auditor, trading as Roger S Schulz. Prior to his retirement on July 5, 2002, he was with the Chemistry Centre (WA) where he held the position of Principal Chemist since 1988. With over 30 years of professional experience he headed the Environmental Investigation section of the Natural Resource Chemistry Laboratory.

He has been active in the fields of Environmental and Analytical Chemistry, ultra trace and trace metal analysis, water quality, corrosion of copper components in drinking water supplies, behaviour of metals in the aquatic environment and the relation to sedimentally bound metals, toxicity of algae, behaviour of cyanide and metal-cyanide species in the environment, rehabilitation of tailing structures and assessment of acid rock drainage.

He has been a key member and team leader in many research projects in particular involving cyanide in the environment. Some of the major projects were AMIRA P277, MERIWA M241, AMIRA P497, AMIRA P497A and MERIWA M309.

Mr. Schulz is involved with the practical application of research findings of the behaviour and fate of cyanide species and derived compounds and the resolving of technical issues related to tailings management, decommissioning and rehabilitation. He has been involved with developing chemical models to be used as predictive tools for proposed mine sites.

He is and has been advising and consulting to Local, State and Federal Government Agencies as well as to Industry nationally and internationally, particular in cyanide related issues. He has audited mine sites, assisted in establishing and equipping laboratories and trained environmental staff on sites in Australia, South Africa, Papua New Guinea, Indonesia and Thailand and assisted on projects in the USA, Canada and Greenland.

He has more than 50 major reports (mostly client confidential) and over 100 publications and conference presentations to his credit. He conducted some 16 training courses and conferences.

Greg Smith BEnvSc(Hons)

Greg Smith has 10 years experience with *Donato Environmental Services* consulting to the mining industry on wildlife and tailings management issues, risk assessment and compliance with the International Cyanide Management Code. He has considerable expertise in conducting ecological surveys, wildlife risk assessments, designing monitoring regimes and wildlife management plans. Greg has a Bachelor of Environmental Science with Honours from Adelaide University.

Greg was a key member of ACMER Project 58 which investigated the use of cyanide within the gold-mining industry and its impact on wildlife. He has been involved with many consults to the resource industry in Australia and Africa, including the production of over 20 consultancy reports.

Greg has published papers on the ecology of tailings dams, monitoring protocols for tailings facilities and the assessment of cyanosis risks to wildlife. He is recognized by industry peers as an expert in the design and implementation of monitoring regimes for tailings dams, heap leach pads and other mine site waterbodies.

Addendum 2: Peer Review Documentation.

Addendum 2.1 Peer Reviewers' Statement of No Conflict
Addendum 2.2 Peer Reviewers' Curriculum Vitae
Addendum 2.3 Peer Review Reports
Addendum 2.4 Investigators' Response and Rebuttal

Addendum 2.1 Peer Reviewers' Statement of No Conflict

Statement of No Conflict

This Statement of No Conflict pertains to the Peer Review protocol followed for provision of independent critical Peer Review of MERIWA Project M398 'Cyanide Ecotoxicity at Hypersaline Gold Operations' and culminating in a Final Report (Adams, M.D., Donato, D.B., Schulz, R.S. and Smith, G.B., 2008, Influences of Hypersaline Tailings on Wildlife Cyanide Toxicosis; MERIWA Project M398 'Cyanide Ecotoxicity at Hypersaline Gold Operations' Final Report Volume1 – Preliminary Investigation and Volume 2 – Definitive Investigation).

The Peer Review protocol followed was as follows:

1. Provide critical independent Peer Review of Draft Final Report Volume1 – Preliminary Investigation.
2. Provide Gap Analysis Peer Review of Interim Draft Report – Definitive Investigation.
3. Provide critical independent Peer Review of Final Report.

I certify that I have not been involved as a participant, supervisor, internal technical reviewer or advisor in the work being reviewed. I have not audited or reviewed any component of the facilities covered in the investigation for which I was responsible for design or development; nor have I within the past year been an employee of the facilities, their parent companies, or associated affiliates. Excluding audits and reviews, I have not derived more than 30% of my income within the past five years from the facilities, their parents, or associated affiliates. I have not participated in more than two consecutive Cyanide Code audits or similar review studies of any of the facilities. I have participated in the review of at least three health, safety, technical and/or environmental reports in the past seven years and am familiar with standard Peer Review procedures.

Signed,

Name	Signature	Date
Ray Biehl		
Owen Nichols	O Nichols	26/7/08
Tony Bagshaw		

Statement of No Conflict

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Signed,

Name	Signature	Date
Ray Biehl	R. Biehl	25/07/08
Owen Nichols		
Tony Bagshaw		

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Signed,

Name	**Signature**	**Date**
Ray Biehl		
Owen Nichols		
Tony Bagshaw		25 July 2008

Addendum 2.2 Peer Reviewers' Curriculum Vitae

Curriculum Vitae

Dr. Owen Nichols
Environmental Management and Research Consultants
7 Sarandon Close, McDowall, Qld. 4053
Tel. 07 3353 5224 Mob. 0417 188 321

Qualifications
B. Sc. Hons. (Zoology), UWA
Ph. D (Zoology), UWA

Languages
French Indonesian (basic)
German (basic) Spanish (basic)

Expertise

- Development of mine rehabilitation programs for forest and other ecosystems
- Design and detailed analysis of monitoring and research programs; conducting technical reviews
- Assessing and managing impacts on biodiversity and other conservation values
- Mining environmental management
- Planning and approvals (baseline studies, EIA, management and closure)
- Wetland rehabilitation and management
- Design and presentation of environmental training programs

Career Summary

Dr. Owen Nichols has more than 28 years experience in the environmental management of mining industry projects throughout Australia, South-east Asia and China. He worked for Alcoa's Environmental Department for 11 years and since then has consulted for most major mining companies. He has also studied environmental management and rehabilitation at mines in the UK, USA, Ireland, New Caledonia, Canada and Mongolia. Dr. Nichols specialises in designing and assessing mine rehabilitation programs, evaluating and managing impacts on the natural environment, pre-mining surveys, designing and analysing environmental monitoring programs, mine closure planning, compliance auditing, general project management and the co-ordination of study teams and research programs. Many of his projects have necessitated effective interaction with Government and other key stakeholders. He has published more than 50 papers and 100 consulting reports, and worked in numerous environments including eucalypt forests, woodlands, heathlands, arid regions, rain forests and wetlands. Whilst he was Environmental Research Manager at Alcoa, the company was added to the United Nations Environment Program Global 500 list for the excellence of its rehabilitation, the only mining company in the world to receive this honour. In April 2002, Dr. Nichols was appointed to the position of Research Program Manager by the Australian Centre for Mining Environmental Research, where his role included developing and managing research projects on a range of mining environmental issues, and conducting training programs for industry and Government personnel.

Key Experience

- **Environmental Monitoring Programs**. Developed a rehabilitation monitoring program for Oaky Creek Coal, and vegetation monitoring programs for PT Kaltim Prima Coal in Indonesia, Hamersley Iron (mine rehabilitation, impacts on mulga communities, and rangeland condition), Chevron (islands off WA), RGC Mineral Sands, Consolidated Rutile Ltd., Alcan Gove (with Matrix Consulting), Mt. Arthur Coal and Worsley Alumina. Reviewed water quality monitoring programs for Hamersley Iron in the Pilbara and for Alcoa's Point Henry smelter near Geelong.
- **Mine Rehabilitation**. Extensive experience with Alcoa designing and improving mine rehabilitation techniques. Developed a topsoil handling program for Consolidated Rutile Ltd. Facilitated a workshop and advised on rehabilitation of montane rain forest at Barrick Gold's Porgera mine in PNG. Advised on stabilisation of steep tailings batters for Worsley Alumina. Reviewed the mine rehabilitation programs of Griffin Coal, Tiwest and PT Freeport Indonesia. Jointly conducted a review of good practice post-mining regeneration in Australia for the Eden

project, Cornwall, UK. Jointly wrote the rehabilitation section of international Good Practice Guidance for Mining and Biodiversity, for the ICMM and IUCN. Joint author of the Leading Practice Sustainable Development in Mining handbook on Mine Rehabilitation.

- **Environmental Research**. Managed Alcoa's Environmental Research Program. Conducted numerous research projects on assessing and managing environmental impacts, and post disturbance recovery of flora and fauna. As Research Program Manager for the Australian Centre for Mining Environmental Research, managed inter-disciplinary teams working on a range of projects addressing issues such as improving seeding success, monitoring and managing impacts of cyanide storage facilities on wildlife, management of dispersive mine spoils, and water quality assessment of ephemeral stream and lake systems.
- **Wetland Rehabilitation**. Designed several wetland offset ecosystems for Alcoa following clay mining, and co-ordinated ongoing management and monitoring. Designed and reviewed wetland systems for Alcoa at smelters near Portland and Point Henry in Victoria. Reviewed Southern Pacific Petroleum's wetland management proposal, incorporating a biological filtration system, for SKM. Developed wetland function replacement procedures for Main Roads Western Australia. Joint author of a wetland rehabilitation manual for the WA Wetland Conservation Society.
- **Managing Conservation Values**. Consulted on numerous projects related to the assessment and management of impacts on biodiversity for clients such as Ok Tedi Mining Ltd. (rainforest and wetlands in PNG), Alcoa (forests), Hamersley Iron (rangeland, mulga and woodland) and Iluka Resources (heathland). Projects for Government have included preparing a management plan for the 54,000ha Lane-Poole Reserve, chairing the Ministerial appointed Dieback Advisory Council, and serving on the WA Ministerial Fire Review Panel. Principal author of the Leading Practice Sustainable Development in Mining booklet on Biodiversity Management. Conducted a detailed review of offsets used in Australia and elsewhere for Queensland EPA; assisted Queensland Resources Council in its dialogue with EPA on matters relating to the development of offsets policies. Reviewed monitoring programs and strategies for minimising impacts of cyanide tailings storage facilities on wildlife at a range of mines in Australia, Mali and New Zealand.
- **EIA & EMP's**. Co-ordinated and contributed to various EIA's including the Hedges Gold ERMP. Conducted an environmental risk assessment of Ashton's Mt. Weld Rare Earth project. Co-ordinated preparation of the Delta Electricity cogen. power project EIS in NSW. Prepared an EMP for Alcoa's Portland aluminium smelter.
- **Government Liaison**. Prepared mining company contributions to Government initiatives such as the Ecologically Sustainable Development Report, and reviewed legislation inc. the WA EPA Act and the Wildlife Conservation Bill. Reviewed offset policies and strategies for Queensland EPA.
- **Mine Closure & Developing Sustainable Ecosystems**. Developed a mine closure accounting checklist for WMC Resources, and ecological success criteria for Worsley Alumina, RGC, Oaky Creek Coal, CRL and Placer Dome's Misima Mine (Papua New Guinea). Joint author of the Mining Minerals and Sustainable Development Biodiversity Project for ACMER. Developed a process coal mines in Queensland's Bowen Basin and NSW's Hunter Valley can use to establish completion criteria for native ecosystem rehabilitation, in consultation with key stakeholders.
- **Environmental Management Systems**. Developed major components of the Hamersley Iron Exploration EMS, and contributed to those for other companies.
- **Environmental Auditing**. Conducted audits of environmental compliance for mining companies such as Alcoa and WMC Resources Ltd. Conducted a due diligence audit of environmental performance of six alumina refineries and smelters for CHINALCO in China, and an environmental review of QAL's Alumina Refinery in Gladstone, Queensland. Conducted rehabilitation audits of ten Xstrata Coal NSW mines jointly with Umwelt Consulting.
- **Training**. Developed and presented numerous environmental training programs for ACMER on a range of mine environmental management and monitoring topics for industry and Government personnel in Australia and South Africa. Other courses conducted for Alcoa, Hamersley Iron, NSW Minerals Council and Murdoch University (for Indonesian Highway Engineers).

Professional History – Owen Nichols		
Company	**Position**	**Duration**
Environmental Management and Research Consultants	Manager (own company)	1991 to present
ACMER	Research Program Manager (part time)	April 2002 to present
Worley Astron	Environmental Manager (Perth Office)	June 1999-January 2001
Alcoa of Australia Ltd.	Environmental Research Manager	1989-1991
Alcoa of Australia Ltd.	Senior Environmental Scientist	1982-1989
WA Dept. of Conservation and Land Management	Planning Co-ordinator (Secondment)	1985
Alcoa of Australia	Biologist	1980-1982

INDEPENDENT METALLURGICAL OPERATIONS PTY LTD
ABN: 33 084 725 557
Perth Office: 88 Thomas Street, West Perth, Western Australia, 6005
Telephone +61 1300 724 271 Fax + 61 8 9322 1808
imo@indmetops.com.au

RESUME OF RAYMOND BIEHL

EXPERIENCE

DEC 05 – PRES **INDEPENDENT METALLURGICAL OPERATIONS PTY LTD**
Consultant Metallurgist

- Responsible for organisation of audits and gap analyses based on the International Cyanide Management Institute (ICMI) code
- Audits completed to date for gold mining operations at Sunrise Dam and Chatree (Thailand), a transportation chain for Australian Gold Reagents and a manufacturing facility for Australian Gold Reagents.
- Gap analyses completed for gold mining operations at Gidji and Fimiston for KCGM.
- Completed OHSA Auditor accreditation with RABQSA.
- Represented Auditors on AGC Cyanide Management sub committee.
- Completed 3 month project with Barrick Gold of Australia Limited on roasting of pyritic concentrates available from the Eastern Goldfields district of WA.
- Completed 2 month review of Union Reefs gold production facility at Pine Creek (NT) for GBS Gold.

SEPT 01 – AUG O5 **NEWCREST MINING LTD, TELFER PROJECT, WA**
Principals Representative – Ore Treatment / Manager Ore Processing

- Responsible to the Telfer Study Manager for operational matters concerned with the feasibility study for the new Telfer treatment plant and associated facilities.
- The new treatment plant capacity was designed to process 17-19 Mtpa using a conventional SABC and flotation circuit to recover a gravity gold concentrate, a copper concentrate and a cyanidation circuit to recover gold from a pyrite concentrate.
- Plant commissioning commenced in November 2004 with a plan to produce in excess of 800,000 fine ozs gold and 30,000 tonnes of copper in concentrate per annum over a 25 year mine life.
- Participated in monthly process plant inspections and annual departmental OHS&E audits prior to and following the commencement of plant commissioning.

RESUME OF RAYMOND BIEHL (contd)

FEB 99 – SEPT 01 P.T.NUSA HALMAHERA MINERALS, INDONESIA
Mill Manager

- Responsible to the General Manager for ensuring that plant operations performed according to agreed targets for production, safety, costs and the environment.
- Development and implementation of an expatriate replacement program which formed part of an ongoing agreement with the Indonesian government.
- The plant was designed to produce in excess of 210,000 fine ozs of gold per annum from a throughput of 220,000 tpa.
- Participated in the annual site OHS&E audit involving all operational departments.

JUN 97 – FEB 99 NORMANDY MT LEYSHON LIMITED, QLD
Mill Superintendent

Responsible to the Resident Manager for the:

- Safe and efficient operation of the 4.5Mtpa CIP Plant and associated systems.
- Achieving production and cost targets, setting of budgets and cost control.
- Developing capital projects and plant modifications as required.
- Preparing periodic financial, physical and technical reports for all treatment plant areas and fulfilling all statutory requirements in the role of Registered Manager - Processing Area.
- Ensuring production personnel were effectively utilised throughout the processing area.
- Supervising Plant Metallurgists.
- Overseeing the site assay laboratory function.

APR 95 – JUN 97 PORGERA JOINT VENTURE, PAPUA NEW GUINEA
Assistant Mill Superintendent

- Responsible to the Mill Superintendent for ensuring that the site operations performed according to agreed targets for production, safety, costs and the environment.
- The treatment plant facility produced in excess of 850,000 fine ozs of gold per annum with an ore throughput of approximately 5.6 Mtpa.

RESUME OF RAYMOND BIEHL (contd)

MAY 89 – APR 95 KALGOORLIE CONSOLIDATED GOLD MINES PTY LTD
Superintendent - Fimiston Mill Expansion/Superintendent - Central Metallurgical Group/Principal Metallurgist

- Responsible initially to the Chief Executive Officer for a feasibility study based on the original Fimiston expansion proposal and then to the Project Manager for the technical and commissioning aspects of a processing expansion to 4.2 Mtpa. The project involved upgrades to the crushing, grinding, flotation, roasting and CIL sections of the Fimiston and Gidji plants.
- Responsible to the Manager - Metallurgy for the operation of the Central Metallurgical Group. This group provided technical support for the operating superintendents through assistance in plant optimization projects and provision of status reports from external research projects.
- Responsible to the Manager - Mineral Processing for ensuring that operations at all sites were undertaken in line with the agreed targets for production, safety and costs. In association with the plant superintendents continued metallurgical development work with a view to increasing plant efficiencies and keeping abreast of the latest gold technology.

DEC 86 – APR 89 NORTH KALGURLI MINES LIMITED, WA
Metallurgical Superintendent

- Responsible to the Resident Manager for the site metallurgical activities, with emphasis on improving gold recoveries and maintaining low cost milling facilities.
- NKML operated the Croesus and Paringa gold treatment plants containing both free milling and refractory gold circuits with a total capacity in excess of 1 Mtpa and a gold production budget of 120,000 fine ozs per annum.

MAY 85 – DEC 86 MT PERCY MINING SERVICES PTY LTD, KALGOORLIE, WA
Mill Superintendent

- Responsible to the Resident Mine Manager for the staffing and commissioning aspects of the greenfield CIP plant followed by the day to day technical and operational control aspects of the commissioned gold treatment plant. The installed plant capacity was 330,000 tpa with an annual gold production of 40,000 fine ozs.

RESUME OF RAYMOND BIEHL (contd)

OCT 83 – APR 85 ARROWVILLE PTY LTD, KALGOORLIE, WA
Operations Metallurgist

- Responsible to the Managing Director for the metallurgical performance of the Fimiston and Ora Banda gold processing plants. Unit operations included cyanide leaching, carbon adsorption, carbon desorption, electrowinning and smelting.

MAR 80 – SEPT 83 ABERFOYLE LTD, MELBOURNE VIC
Project Metallurgist (Matte Fuming) / Plant Metallurgist (Cleveland Tin)
Project Metallurgist (Central Metallurgical Services)

- The Matte Fuming project involved over 2 years smelting experimentation with complex tin ores and concentrates at the Kalgoorlie Nickel Smelter. Responsibilities varied, but the main duties involved supervision of planned groups of experiments and subsequent reporting to the Site Superintendent.
- Experience at Cleveland Tin involved a 3 month stint as Plant Metallurgist. Responsibilities were to the Metallurgical Superintendent for the metallurgical performance of the tin concentrator. Unit processes included crushing, grinding, heavy media separation, gravity concentration and flotation.
- A years experience was gained at the Group's central metallurgical laboratory where various testwork was performed for companies within the Aberfoyle group. Most time was spent on metallurgical testwork associated with copper, lead, zinc resource at Que River.

APR 74 – APR 78 WESTERN MINING CORP - KALGOORLIE NICKEL SMELTER
Operations Metallurgist

- Responsible to the Metallurgical Superintendent for the metallurgical performance of the slag cleaning furnaces and the converting operations.
- Minor project work was undertaken involving the flash smelting of nickel concentrates.

RESUME OF RAYMOND BIEHL (contd)

QUALIFICATIONS

- Bachelor of Engineering (Metallurgy) 1970 – 1973, University of Melbourne, VIC

- Registered Manager (Works) - Process, PNG
- St. Johns First Aid Certificate
- Lead Auditor Accreditation - RABQSA

PROFESSIONAL AFFILIATION

- Member of the Australasian Institute of Mining and Metallurgy

PUBLICATIONS

Design, construction and commissioning of a 4 tonne/hour Matte Fuming Pilot Plant.
- Aus IMM, Melbourne Branch, Symposium on “Extractive Metallurgy”, November 1984

Roasting at Kalgoorlie Consolidated Gold Mines Pty Ltd
- Pyrometallurgy Seminar - Murdoch University, 9 November 1990

Tailings Dam Management at KCGM
- Fifth Mill Operator’s Conference, Roxby Downs, October 1994

An Auditor’s Perspective of a Recent Cyanide Code Audit
- ACMER Workshop, Perth, May 2006

BIOGRAPHCAL DETAILS:

FULL NAME:	Anthony Nicholas BAGSHAW
DATE OF BIRTH:	28 July 1944
PLACE OF BIRTH:	Reading, Berks. England
NATIONALITY:	Australian and U K
TERTIARY EDUCATION:	B.A.(Honours, 1967), D.Phil.(1970), and M.A.(1971), all in inorganic chemistry, metallurgy and materials science, from the University of Oxford, England.

PROFESSIONAL ACTIVITIES

Member of the Australasian Institute of Mining and Metallurgy. Past member of Perth Branch Committee (Hon. Treasurer).

Member of the organising committees for various international and national conferences.

PUBLICATIONS, PRESENTATIONS:

Some 20 publications in international journals and magazines. Numerous internal reports of a confidential nature.

Talks presented at state, national and international conferences, including invited lectures at international meetings and workshop presentations at industry forums.

Many lectures and talks of a more general content presented on various occasions to a wide cross-section of audiences.

EMPLOYMENT RECORD:

Chemical Systems Pty Ltd

Proprietor, 11/2005-present

Established my own consultancy business to pursue a number of specific opportunities that I had identified. Consulting to a range of international mining companies, especially in the alumina and aluminium sectors, universities and cooperative research centres.

AMIRA International

Research Director, Manager of Perth Office, 11/1997-11/2005

Opened the Perth office: a substantial expansion move for AMIRA at that time.

My focus was on major projects for the alumina, base metals (especially copper, nickel and zinc) and gold commodity sectors worldwide. I travelled extensively in Australasia, Europe, Southern Africa North and South America in dealings with commodity producers, suppliers, engineering companies and public research organisations.

Of the commodity areas managed in AMIRA projects my main emphasis was on alumina. I recognised a need for the alumina industry to develop a technology roadmap to chart its development course over the

next two decades, and put in place an intensive workshop of senior industry personnel seven years ago to produce such a roadmap. This exercise was also supported by the Australian and U S governments. Since the roadmap was produced in late 2001 I managed the resulting collaborative projects required to meet the 20-year technology vision. As such I had unique constant interactions with the senior staff (Vice Presidents, Technology) of all the major world alumina producers.

I was also responsible for the largest gold project on AMIRA's books. This project continues to be supported by the world's major gold producers including AngloGold Ashanti, Barrick and Newmont.

On AMIRA's behalf I was involved in key industry activities:

> Member of the Minerals Research Advisory Committee (nominated by the WA Minister for State Development) of the Minerals and Energy Research Institute of WA (MERIWA).
>
> Member of the Exploration Technical Committee of the Association of Mining & Exploration Companies (AMEC).

Mineral Processing Laboratory, W A Department of Minerals and Energy
General Manager, 7/1995-9/1997
Located at Waterford (southern end of the Curtin University campus). Direct responsibility for the commercial business of the Mineral Processing Laboratory and to act as the State Government's representative on the site.

In the former role, I managed a commercial team of technical consultants. Most of the activity was fee for service metallurgical testwork for the industry; the client base comprises more than 200 organisations from multinationals through engineering contractors to consultants, with work being conducted at bench and especially pilot plant scale in a purpose-designed building. Major commodities under test included precious metals (especially gold), base metals, mineral sands, alumina, industrial minerals and iron ore.

Project Manager for a major iron ore project involving existing and potential producers in WA, evaluating processing options for new ore bodies and feedstock for direct reduced iron. Collaborated with iron ore researchers based in Beijing with a view to providing iron ore from WA to China. Involved visits to Chinese operations.

Carried out all the commercial negotiations to transfer the Laboratory to CSIRO Minerals during 1997.

Chemistry Centre (WA), W A Department of Minerals and Energy
Deputy Director, 7/1988-6/1995
Prime responsibility for the business operation of the three minerals-based Laboratories (Mineral Science and Mineral Processing in Perth and the Metallurgical Laboratory at Kalgoorlie; total staff 65), involved across the whole industry spectrum from exploration, mining, mineral processing and environmental monitoring, for delivering services to clients, primarily to industry.

Closely involved with feasibility studies for new resource developments. Interaction with a wide range of commercial and government clients as well as engineering companies and consultants.

In 1991 nominated as the inaugural Director of the A J Parker Cooperative Research Centre for Hydrometallurgy in its application in the first round of funding from the federal government. Served as Department's representative on the Centre's governing body.

Acting Assistant Director General of Minerals and Energy during 1993, with 350 staff reporting to me and constant dealings with MD's of companies, State and Federal Ministers and senior bureaucrats.

W A Department of Resources Development
Project Manager, Minerals and Mineral Processing Division. 9/1987-7/1988
Responsible for project management on a wide range of developments including ICI's zirconia plant, SCM's titanium dioxide plant at Kemerton and the Rhone-Poulenc rare earths plant at Pinjarra. Contributed to other mineral sands projects, and those involving lithium, copper, uranium and industrial minerals.

Liaison at the most senior levels with a wide range of companies as well as state, federal and local government agencies, including regulatory agencies.

Alcoa of Australia Ltd
Technical Development Scientist, 1/1978-3/1982
Located in the R&D Department located at the Kwinana alumina refinery. Involved with improvements to all aspects of the Bayer process for refining bauxite to alumina.

Research Supervisor and acting R&D Superintendent, 4/1982-9/1987
Responsible for managing projects on behalf of operating divisions across three alumina refineries. Close liaison with technical and engineering staff within refineries, with external consultants and contractors, and with providers of R&D project services such as CSIRO and the universities.

Spent two months during 1982 as Technical Specialist at the Alcoa Technical Centre, Pittsburgh, U.S.A.

As a key part of examining alumina product quality and performance of aluminas in smelters, and resulting from a proposal put forward by myself, I was seconded to work with Professor Barry Welch at the University of Auckland from 8/1984 to 3/1985, to conduct a project on behalf of Alcoa (U.S.A.) and Alcoa of Australia. Work was reported in a number of papers to the Light Metals meetings in the U.S.A. In late 1985, spent two months as project manager for a plant trial at the Goldendale aluminium smelter, Washington State, U.S.A., on behalf of Alcoa (U.S.A.) and Comalco, evaluating the concepts and results developed in the Auckland work.

During 1986, conducted design and technical evaluations (on behalf of the French company Rhone-Poulenc as a client of Alcoa) for a gallium metal refinery. Project managed an evaluation on the refining of zircon to high purity zirconia as a potential subsidiary business for Alcoa.

Mineral Sands Industry
Various positions, 2/1970-12/1977
Working with Tioxide Australia and Western Titanium on pyro- and hydrometallurgical projects involving the upgrading of ilmenite to synthetic rutile.

Addendum 2.3 Peer Review Reports

A REVIEW OF THE FINDINGS OF MERIWA PROJECT M398: INFLUENCES OF HYPERSALINE TAILINGS ON WILDLIFE CYANIDE TOXICOSIS

Environmental Management & Research Consultants

August 2008

1 Introduction

In January 2008 Environmental Management and Research Consultant's Dr. Owen Nichols was approached by Dr. Mike Adams of Mutis Liber Pty. Ltd. and asked to review the following document 'MERIWA, 2007. Preliminary Review: Influences of Hypersaline Tailings on Wildlife Cyanide Toxicosis, MERIWA M398 Phase 1 Report, Mutis Liber Pty Ltd, Roger S Schulz, Donato Environmental Services.' A review was submitted to MERIWA (EMRC 2008) and, together with feedback from other peer reviewers, was discussed at a meeting with the mining companies (Barrick Gold and Goldfields), MERIWA staff and the project team on 15th April 2008.

The overall objective of Phase 1 of the MERIWA project was to compile and review available data, to assist stakeholders to develop a 'hypersaline cyanide hypotheses' and establish on a preliminary basis whether hypotheses can be identified as valid or invalid and if valid, the broad nature and extent of the effect. The review of Phase 1 identified a number of gaps and areas requiring further information, and concluded that several hypotheses that would explain the apparent lack of wildlife deaths in hypersaline TSF's were worthy of further investigation in Phase 2 of the Project.

It was therefore agreed that the project should proceed to Phase 2. This involved the compilation and review of additional data, testwork, and modeling designed to quantify the nature and to establish the scientific validity of the 'hypersaline cyanide ecotoxicity' hypotheses that were supported by the Phase 1 field data and literature review, viz:

- Saline (>14,000 mg/L total dissolved solids – TDS) and hypersaline (>50,000 mg/L) tailings solutions provide a natural barrier for wildlife exposure to contained weak-acid dissociable (WAD) cyanide.
- WAD cyanide in hypersaline waters is lost at rates sufficient to have a substantial impact on the area of wildlife inhabitation to contained WAD cyanide (levels and profiles to be determined on a site-specific basis).

The investigation aims to identify these protective mechanisms in a manner consistent with the requirements of the International Cyanide Management Code.

The purpose of this report is to assess whether, in conjunction with the work carried out in Phase 1, this objective has been met, or if not, identify any gaps, flaws or inconsistencies in the conclusions regarding the hypotheses and provide recommendations for further investigations.

The report is divided into three sections:

- Specific comments and questions on the Phase 2 report
- Questions raised in Phase 1
- Discussion and conclusions.

2 Specific Comments and Questions on the Phase 2 Report

xiii Para2: Last sentence needs clarification.

P5: Text says Figs 2 and 3 show BGS and GSI, but the figures actually show BGS and BKB.

P20: Second last para is a repeat of an earlier one

P40 Para 4: Re the sentence 'Indications are that despite lower salinity, wildlife are drinking elsewhere' it may be worth mentioning that other factors are likely to be involved e.g. visual 'unattractiveness' – looks unnatural to wildlife (this is touched on elsewhere but could be mentioned here.

P40 last line: Water chemistry may not have been the reason – they may have just drowned

P42 Para 2 Sentence 1: Check the figure for BGS in text vs Table 14 for Active Cell – Buzz ratio 0.16 is quoted, should be calls/hr of 0.9

P43 Section 5.2: Table x?

P44 Table 15: Diversity is actually the number of species so technically it should be called either Species Richness or Number of Species

P45: Check table number reference, it should be 15, not 14

P46 Last Para: Should 'At times all sites discharge below 50mg/L' be above 50mg/L? Note units also should be mg/l, not m/l

P47: Table 16 Generally more conventional to quote Standard Errors, not Std Deviations

P47: Sentence beginning 'As a comparison…' needs checking

P49 S5.5 Para1: Add that wildlife may also find TSF's unattractive due to the lack of other wildlife there.

P54: Have you got the Findings for 6.3.1 and 6.3.2 around the wrong way?

P55 Para 3: Nevertheless, a specific data set from CSD has…

P55 Para 4: spelling of Wether

P62 Table 19: There is no # in the table

P66 S9.3: Particularly organic waste

P66 S9.4: Mention that vegetation provides bird shelter, food and invertebrates

App6 P2: Check dates e.g. BGS on-site monitoring

3 Questions Raised in Phase 1

The following key points were raised in the review of Phase 1 because they were considered to be gaps requiring further investigation, or flaws or inconsistencies in the conclusions regarding the hypotheses. The extent to which they have been addressed in Phase 2, or require further information, is noted with each.

1. Species that can drink saline water. In Phase 1 it was noted that Zebra Finches can drink water up to 47,000 mg/l TDS, and this could remove one of the 'protective mechanisms' i.e. total avoidance. At one of the sites (BGS), salinities are well below this value, and within the ranges of tolerance of some other species. However, ongoing monitoring has shown no mortalities of this or any other species, and only one record (a Red-capped Plover) drinking at this site, following rain. The evidence suggests that other factors such as drinking of freshwater sources in preference to the saline TSF water (Hypothesis 7B), the (albeit lower) salinity increasing the rate WAD CN is lost (Hypothesis 8), management of CN levels, and design of the TSF facility (making it unattractive to wildlife) combine to offer protection. Nevertheless, it is recognised in Section 8 Limitations that operational controls will be required at BGS to maintain salinities >14,000 where possible, and monitoring in other seasons and during drought, when freshwater sources are largely unavailable, will be necessary to determine whether species do not attempt to drink when their need is greatest. It would be of interest to know whether Zebra Finches were one of the species that suffered mortalities at the freshwater CSD mine (see point 10). The species was recorded within the TSF at the GSI mine (Volume 1 report, Appendix 5), although it was not interacting with tailings; it is likely that the species occurs locally at all three mines.
2. Can wildlife detect salinity – what is the avoidance mechanism? In the Phase 1 review it was noted that this is a key to understanding the proposed avoidance mechanism and needs to be determined. This has only been done to a limited extent, e.g. in Section 6.5 which suggests that visual factors such as the lack of vegetation and physical cover, height, and general unsuitability of the habitat as well as the saline or hypersaline solutions and lack of food combine to result in a lack of utilisation by wildlife, and therefore others are not attracted; rather, they utilise water bodies where wildlife are already present (and which, by inference, are suitable). Together, this results in very little interaction of wildlife and the TSF water bodies or tailings. Although the study did not determine whether tasting or ingestion is necessary for some individuals, in combination the above reasons appear to largely explain why avoidance happens in practice; however it should be noted that freshwater systems also have most of these characteristics and clearly birds do interact with them, so they alone are not the whole reason why utilisation is low.

3. Do wildlife limit the amount of saline solution ingested? The study demonstrates that wildlife activities such as drinking and inadvertent ingestion of tailings while feeding by pecking on mud flats are low in saline and hypersaline tailings solutions. This greatly reduces or eliminates dosages received, compared with what might be the case in comparable freshwater systems. However, it is noted in Section 8 that calculation of actual quantities ingested is very difficult and at best, only inferred dosages can be calculated from SP3 and toxicity data. Also the Literature review of Phase 1 notes that a number of species do forage on hypersaline lakes from time to time, so it would strengthen the argument if the authors were able to quote data on species such as Red-capped Plovers feeding in nearby natural freshwater sites and compare this with numbers feeding on TSFs. For example, in Volume 2 Appendix 6, results show that Red-capped Plovers are present on both fresh water bodies and TSFs; however, calculations show that, of the total recorded, the percentage foraging is 36% on TSFs (Table 12) but more than 50% on the BGS Saline Wash and the Kambalda Wetlands (Table 16). This suggests that although the species visits both sites, it forages more on the 'natural' sites. It is suggested that the authors consider whether more analysis of the data could be done to compare foraging rates of individual species in TSFs and natural wetlands.

4. Chain of custody and time delay in getting samples to NATA Labs mentioned in the review of Phase 1 have been resolved.

5. Cyanide degradation under different weather conditions is briefly discussed in Volume 1 Section 5.1.4, in relation to the effects of UV irradiation and wind. However insufficient data are available to understand what processes occur under different weather, sunlight, dark etc. conditions. It is therefore suggested that monitoring continue, as described in point 11 below, to improve the sites understanding of the links between WAD CN levels, weather patterns, and any impacts on wildlife.

6. Carcass detection issues have been resolved through the use of decoy balloons at all three mines. The vast majority of these were detected during routine wildlife monitoring, suggesting that at all of the mines, any significant wildlife mortality events would be detected.

7. Wildlife tracks were noted (Sections 7.5 and 4.2.4 of the revised Volume 1 report) and these showed that apart from the occasional tracks of scavengers such as the dingo, fox, feral cat and feral dog, no other tracks were recorded suggesting that visitations by terrestrial wildlife are few. However, the situation with regards to fencing to exclude terrestrial wildlife at the three TSF's needs to be clarified.

8. Rainwater on the supernatant – what risk does it pose? In the Phase 1 review, it was stated that at some stage there will need to be a clearer assessment of the risk associated with drinking rainwater sitting on top of the saline supernatant – does this commonly happen, does the risk of cyanide deaths increase under certain scenarios e.g. when strong winds result in greater mixing, or when the overlaying layer of freshwater becomes shallower? This is only addressed to a limited extent. As well as the few observations of drinking by Welcome Swallows and Red-

capped Plovers, it is recognised (in Section 9.2.1) that significant rainfall events may result in a decrease in the salinity of tailings discharged to the TSF, and a decrease in the salinity of spigot-derived supernatant (which in turn would become less saline through direct rainfall). This would decrease the effects of salinity on WAD CN loss, potentially increasing risks to wildlife. This is acknowledged and the proposed solution involves rigorous sampling of salinity in the process and make-up water, spigot discharge and spigot-derived supernatant. Linking these data to rainfall events and wind (resulting in greater mixing) over a range of weather patterns and seasons will increase TSF operators understanding of the risks to wildlife, and management options. The study also notes the much of the BKB monitoring took place after rainfall events; monitoring of wildlife utilisation and CN levels during drier periods, as proposed, is needed.

9. In the review of Phase 1 it was suggested that more detailed evidence was needed to show that wildlife are really exposed to WAD CN levels >50 mg/L. The use of the radio controlled sampling boat was suggested as one means of doing this. Volume 2 of the report provides good evidence that wildlife utilise TSF's at times when WAD CN levels exceed 50 mg/l. For example, photographs in Appendix 8.1 show water birds present on a number of the TSF's, near points where tailings solution samples were taken for analysis. Supernatant samples taken on the same day Black-winged Stilts were observed foraging at GSI showed a mean WAD CN concentration of 114 ppm (Appendix 6 P22); see also P23. Other data (Appendix 6, Figures 1-3) show that wildlife visitations occurred at all three mines on days when spigot discharge concentrations exceeded 50 mg/L WAD CN, although the details of exactly what interaction took place are not given. Nevertheless, the combined information presented provides more substantial evidence that the absence of wildlife deaths is not because WAD CN concentrations are never high enough; they are, and it can be concluded that some protective mechanism exists.

10. Do similar sites with fresh water experience mortalities? In the Phase 1 review it was noted that for Hypothesis 7 to correctly explain why no deaths occur, it must be established that under non-saline conditions, wildlife deaths *would* occur at this site, i.e. is there the right combinations of species, Cyanide concentrations >50mg/l, habitats, species behaviour in habitats that pose a risk, etc. Data obtained during Phase 2 from studies conducted at the CSD Gold Mine in 1997 (Section 5.3 and Appendix 7), where the TSF was relatively fresh (<1,500 mg/L), show that considerable bird mortalities occur at WAD CN concentrations above 50 mg/L, and comparable to those recorded at the three goldfields study sites. These data were recorded during the wetter months of the year – during dry months, it is likely that mortalities would be even higher. Overall, this is quite convincing evidence that saline and hypersaline TSF's have some protective mechanism that results in few or no bird deaths. However, the actual species dying at CSD, which is a considerable distance from the three study sites, are not mentioned; it needs to be established that they are the same species that occur in the region of the three mines, and have been recorded in adjacent freshwater sites and/or in the TSF's themselves. This would add convincing evidence that the species suffer mortalities at fresh water sites but not at saline and hypersaline sites.

11. The full range of seasons and a broader range of climatic cycles need to be assessed; The Phase 1 review posed the question - could low frequency high consequence events occur? i.e. consideration needs to be given to whether wildlife deaths could happen under unlikely scenarios or particular circumstances not encountered during the study period, e.g. during severe drought, after a big rainfall event, at a time when migratory waders are present in bigger numbers. The present study has added data from an important time of the year, i.e. March/April, when migratory birds are present. However, semi-arid regions experience wide variability between seasons and this needs to be taken into account by ongoing monitoring of wildlife and key process parameters. Thus, while the present study has provided sufficient data to have a relatively high level of confidence that the protective mechanisms exist and are understood, it is important that routine chemistry and wildlife monitoring take place as described in Section 9, data are regularly analysed to increase the sites understanding of links between ore feed characteristics, process controls and seasonal climatic variability; and if mortalities are observed intensive monitoring by external experts is conducted as soon as possible.
12. Hypothesis 8 proposes that in hypersaline tailings solutions, CN is lost at rates sufficient to result in concentrations that are not a problem to wildlife – or, to result in a reduced area where impacts are likely (i.e. where WAD CN levels are >50 mg/L). In the review of Phase 1 it was suggested that there may be some confounding in the design, making determination of specific causal factors difficult; i.e. salinity results in less drinking, whilst at the same time reducing WAD CN concentrations to the point where the solution may not be toxic; aspects relating to effects on ingestion amounts or avoidance also influence the overall picture. Data obtained and analysed during Phase 2 of the project produces a much clearer picture of the effects of hypersalinity on WAD CN loss, concentrations of WAD CN in relation to wildlife utilisation of TSF's, feeding and drinking patterns and other aspects related to risk to wildlife. These are summarised in Sections 6 and 7.
13. In Phase 1, the issue of nocturnal wildlife was raised. Monitoring of bat activities has been carried out and in Phase 2 further analyses were carried out. Overall results clearly show that bats utilise freshwater sites to a much greater extent than saline sites (both natural and TSFs). The ratio of feeding, drinking and social 'buzz' calls to total calls was much higher in freshwater sites than in hypersaline water bodies. There is no evidence that the TSF's studied pose a significant risk to Bats.

4 Discussions and Conclusions

Phase 2 of the project focused principally on determining the validity of Hypotheses 7 and 8, however aspects relevant to other hypotheses were also considered.

Hypothesis 7 was reworded to take account of the fact that BKB and GSI are hypersaline sites, while BGS is saline. The rewording is:

Hypothesis 7A: *Hypersalinity (>50,000 mg/L) provides a natural barrier for wildlife exposure to WAD cyanide contained in tailings solutions because at this salinity the solutions are outside the physiologically safe drinking range of wildlife and wildlife seek to avoid its ingestion while foraging*

Hypothesis 7B: *Salinity (>14,000 mg/L) provides a partial barrier for wildlife exposure to WAD cyanide contained in tailings solutions because at this salinity wildlife are either unable to drink solutions or preferentially drink fresh water if it is available*

Phase 2 of the project adds support to the validity of this hypothesis by confirming that wildlife utilisation of hypersaline TSFs is very low compared to adjacent fresh water bodies, some of which are structurally similar to the TSFs. In the case of the saline TSF (BGS), it is acknowledged that at times, salinity may decline to levels where, theoretically, some wildlife are capable of drinking it. However, visitations and behaviour still indicate low visitation rates, and the report recommends that monitoring of both salinity levels and process water chemistry continue to ensure that protective mechanisms remain effective. Other new data added includes information on bats that demonstrate that, as well as bat visitations being much higher on fresh water bodies, the proportion of calls that indicate feeding, drinking and social behaviour (as opposed to general exploration) is also much higher on fresh systems.

It is acknowledged that calculating actual doses is very difficult, as is determining the mechanism that individual birds use to detect and avoid hypersaline water bodies. Nevertheless, behavioural studies and mortality data indicate that they are not ingesting toxic amounts of tailings solutions, and are generally avoiding the hypersaline sites.

Establishing that deaths occur in fresh water TSF's (CSD) that discharge at similar WAD CN levels provides good evidence that saline and hypersaline sites provide a barrier, although it should be confirmed that in each case the same bird species are involved.

Whilst the barrier appears to be effective during the period over which the study was conducted, it is recognised that both process and wildlife monitoring need to continue in order to ensure that the management systems work under the full range of weather conditions likely to be experienced in this region.

Provided the limitations noted above are addressed, Hypotheses 7A and 7B can be considered valid.

Hypothesis 8 states that *WAD cyanide in hypersaline waters is lost at rates sufficient to have a substantial impact on the area of wildlife inhabitation to contained WAD cyanide (levels and profiles to be determined on a site-specific basis)*. Data obtained and analysed during Phase 2 of the project produces a much clearer picture of the effects of salinity and hypersalinity on WAD CN loss and the resulting concentrations of WAD CN in relation to wildlife utilisation of TSF's. In combination with data on feeding and drinking patterns, this helps clarify the risk to wildlife. As with Hypothesis 7, further monitoring is

needed over a range of seasons, and if different ore feed is utilised, to ensure that protective mechanisms remain in place. However, at this stage, there is sufficient information available to conclude that Hypothesis 8 is also valid.

The conclusions regarding Hypothesis 9 (Hypersaline tailings solutions have sufficient buffering capacity to inhibit free cyanide liberation on ingestion) appear to be correct, i.e. the Hypothesis can not be considered valid under all potential scenarios.

The remaining Hypotheses were mainly addressed in Phase 1/Volume 1, although for some the findings of Phase 2 provide additional evidence for the conclusions as noted in the Table below.

Hypothesis	**Comment**
Hypothesis 1: *Wildlife deaths occurred but the monitoring regime failed to record any carcasses*	Using balloons, and the same training and monitoring techniques that prove effective in detecting wildlife deaths at other sites, the project correctly concludes that if substantial mortalities occurred, they would be recorded.
Hypothesis 2: *Wildlife did not die in situ but flew away and died elsewhere*	Volume 1 notes that although the possibility of wildlife leaving the system and dying elsewhere cannot be discounted, were this to occur other deaths would be noted *in situ*. Therefore the hypothesis does not explain the lack of wildlife deaths.
Hypothesis 3: *Wildlife deaths did not occur during the monitoring period due to seasonal or other environmental influences, resulting in at-risk species not being present during the monitoring period*.	This was raised as a possible issue during the review of Phase 1. Since then a broader range of seasons have been surveyed, and it is recommended that monitoring continue in order to encompass unusual events such as prolonged drought and extreme rainfall events. On the basis of the findings to date, it is not considered likely that the absence of deaths is due to species not being present – further data from adjacent fresh water bodies clearly shows that at-risk species are in the area at the time of monitoring. It is recommended that lists of species suffering mortality at CSD (a fresh water site) be provided to demonstrate that many of the same species are present at both sites and die when protective mechanisms are not present.
Hypothesis 4: *Wildlife deaths do not occur due to the physical attributes of the TSF's, resulting in no wildlife interaction with the hazard*	Although the physical attributes of the TSFs can and do reduce the numbers of wildlife interactions, photographs and monitoring data clearly show that wildlife do interact with the hazard, at times when tailings are being discharged at WAD CN concentrations that result in mortalities at fresh water TSFs
Hypothesis 5: *Wildlife*	Listing of species suffering mortality at CSD, and

deaths do not occur at any of the sites because at-risk species are not found in the region or on any of the sites.	confirmation that the same species occur in fresh water bodies adjacent to BGS, BKB and GSI, and in many instances on the TSFs themselves, would demonstrate that this hypothesis is not the reason for the absence of mortalities. Other data show that considerable numbers of species known from their behaviour and other studies to be 'at risk' are frequently recorded as visiting the TSF's studied.
Hypothesis 6: *Wildlife deaths are below detectable levels or non-existent due to a lack of aquatic food within the TSFs resulting in little of no wildlife exposure to the hazard*.	Whilst the studies have shown that there is a lack of aquatic macroinvertebrates in TSF solutions at the sites, the same is true in fresh water sites where there are wildlife deaths. Therefore, absence of aquatic invertebrates is not a primary reason for the lack of wildlife deaths at the TSFs studied. However, it is likely to be a factor contributing to lower numbers feeding on supernatant, and therefore at risk. Small numbers of birds attempt to feed on TSFs due to the presence of some terrestrial macroinvertebrates, and the chance of food being present.

The Phase 2 report recognises that the lack of actual mortalities makes the establishment of specific recommended cyanide and salinity limits difficult. Data from CSD suggest that in fresh water systems, the 50 mg/L WAD CN discharge limit is probably about right (given that there will always be 'noise' due to variation between species, conditions etc.). For the three hypersaline and saline sites, recommended operating limits based on actual monitoring data obtained during the project, with some additional safety margin included, are suggested for the following parameters: Maximum WAD CN, 80 percentile WAD CN, TDS and Copper, all mg/L and all at spigot and supernatant. It is then recommended that monitoring of process and tailings solutions and wildlife continue as required under the Code (while WAD CN exceeds 50 mg/L) to encompass a range of climatic variation and ore feed scenarios.

Overall, this approach appears sound and is considered likely to maintain the protective mechanism described. However, it is considered important that aspects not fully understood and noted in this review, be investigated by further analysis of the data annually and, if any wildlife deaths are noted, intensive wildlife monitoring be conducted as soon as possible using external experts, to determine the details and extent of mortalities.

Reference:

EMRC (2008) A review of the MERIWA hypersaline cyanide toxicosis report. Report prepared for MERIWA by Environmental Management and Research Consultants, January 2008.

MERIWA Project M398 – Cyanide Ecotoxicity at Hypersaline Gold Operations

Peer Review Report – Draft Final Report Volume 1 – Preliminary Investigation
Draft Final Report Volume 2 – Definitive Investigation

August 2008

Background

Independent Metallurgical Operations Pty Ltd (IMO) was invited by the study manager Mutis Liber Pty Ltd (ML) to form part of the peer review panel for MERIWA Project M398 – Cyanide Ecotoxicity at Hypersaline Gold Operations.

Mr Ray Biehl - MAusIMM, Technical Expert Auditor Gold Mining Operations the International Cyanide Management Institute (ICMI) - was nominated by IMO and accepted by ML as part of the peer review panel. On 15 April 2008 the peer review panel met with the project coordinator (MERIWA) and the project sponsors [Barrick Gold of Australia (BGA) and Goldfields Australia (GFA)] to review the content of the Preliminary Investigation Report findings. As a result recommendations were made which were to be carried forward to the Definitive Investigation Report.

This part of the peer review comprises two components:

1. marked up hard copies of both reports handed to ML highlighting grammatical, typographical and referencing inconsistencies; and
2. an independent documented evaluation for competence and validity of the scientific research contained in both reports.

A copy of the documented evaluation follows.

Introduction

Standard of Practice (SoP) 4.4 of the ICMI Code for Gold Mining Operations requires that operations "implement measures to protect birds, other wildlife and livestock from the adverse effects of cyanide process solutions." The Code provides a numerical guideline of 50mg/l WAD cyanide as an upper exposure limit which is based on available ecotoxicological data from operations using relatively fresh water in their processes. At operations where the 50mg/l WAD cyanide limit is exceeded and no wildlife mortalities are recorded full compliance with SoP 4.4 cannot be achieved unless the operation can supply a scientific study which outlines the reasons why the higher WAD cyanide levels are not toxic to the local wildlife. "Such a study must be peer-reviewed and sufficiently rigorous that a causal relationship is established."

Minesites in the Eastern Goldfields region of Western Australia are unique in that they typically utilize hypersaline waters (>50,000ppm Total Dissolved Solids) and operate their Tailings Storage Facilities (TSFs) at WAD cyanide levels in excess of the 50mg/l. The project sponsors BGA and GFA are signatories to the ICMI Code and have operations in Western Australia which utilize hypersaline water and operate their TSFs in excesss of the 50mg/l WAD cyanide guideline. This MERIWA project is intended to supply the scientific rationale for the lack of wildlife mortalities at those Western Australian operations where the guidelines are exceeded. This member of the peer review panel has had personal involvement in an ICMI Code audit of another Western Australian gold operation (Sunrise Dam Gold Mine) utilizing hypersaline water where TSF WAD cyanide concentrations exceed Code guidelines and fully understands the outcomes required from this project for each of the sponsors' operations to achieve compliance with SoP 4.4 of the ICMI Code.

Draft Report Volume 1 – Preliminary Investigation

The contents of this report were discussed during a meeting involving the peer review panel, project coordinator, study manager and project sponsors on 15 April 2008.

The Report proposed nine hypotheses to explain the observation of recording zero wildlife deaths attributed to cyanide toxicosis. These nine hypotheses were assessed using data available from a comprehensive literature review together with information from four of the sponsors' sites located in Western Australia. The assessment eliminated six of the hypotheses and recommended further investigations be conducted on the three remaining hypotheses to determine their validity. The peer reviewers concurred with this outcome and recommended that data from another fresh water site be included in the study to fully substantiate the validity of the remaining three hypotheses.

Draft Report Volume 2 – Definitive Investigation

This report summarizes the assessment of the remaining three hypotheses, identifies study limitations and provides recommendations for three sites (Granny Smith, St. Ives and Kanowna Belle) in respect of ICMI Code compliance for wildlife cyanosis.

The peer review follows below and is discussed under the four headings:

- Hypothesis
- Limitations
- Key Recommendations
- Other comments

<u>Hypothesis</u>

Two of the hypotheses (7 and 8) were deemed as valid and hypothesis (9) invalid.

Hypothesis 7 was modified and extended in the light of the definitive data analysis and was documented as valid with causation inferred.

The peer reviewer concurs with this outcome as outlined on page 55 of the report.

Hypothesis 8 was documented as valid with causation inferred.

The peer reviewer concurs with this outcome as outlined on page 55 of the report.

Finally, hypothesis 9 was documented as invalid with causation not inferred.

The peer reviewer concurs with this outcome as outlined on page 55 of the report, but advises that the reference to Section 3.4 is incorrect and requires amendment.

Limitations

The limitations are summarised under the headings of:

- Freshwater control tailings
- Nocturnal wildlife interaction
- Doses that wildlife obtain during interactions with cyanide-bearing habitats cannot be established
- Sheet flow edge sampling
- Site-specific limitations

on pages 56 and 57 of the report.

The peer reviewer concurs with the comments made under each of these headings in particular those listed under site-specific limitations for the Granny Smith, Kanowna Belle and St Ives operations. The peer reviewer further advises that the comments made on copper levels on page 57 make reference to Section 7 of the report. This reference is incorrect and needs to be amended.

Key Recommendations

Five recommendations are outlined on pages 58-66 of the report and are entitled:

- Operating Parameters (Site Specific)
- Continuation of Structured Monitoring Regimes (All Sites)
- Minimise infrastructure in the vicinity of cyanide-bearing habitats
- Vegetation suppression and removal in and near cyanide-bearing habitats
- Cover open seepage trenches with gravel to limit food availability within the TSF

The peer reviewer concurs with these recommendations in particular the last three (listed on page 66) which are easy to implement, but highly likely to be overlooked by site operations and environmental personnel.

The peer reviewer also advises that on page 60 reference is again incorrectly made to Section 7 when discussing process control strategies for copper at St Ives. This reference needs to be amended.

Other Comments

In conclusion the peer reviewer recommends that these two reports along with the ACMER Study completed for the SDGM Code audit be made available to the ICMI as references when conducting its proposed review of SoP 4.4 of the Gold Mining Verification Protocol.

Furthermore the project sponsors are encouraged to incorporate the site specific operating parameters proposed in the “Key Recommendations” section of Volume 2 as key targets in their TSF Operating Procedures.

R Biehl

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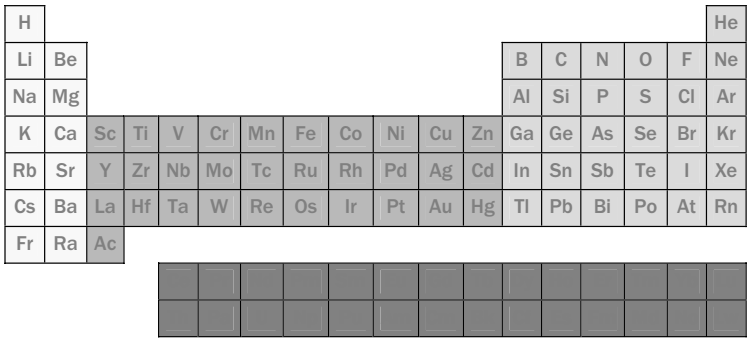

MERIWA PROJECT M398

Influences of Hypersaline Tailings on Wildlife Cyanide Toxicosis

Review of the
Draft Final Report Volume 1 – Preliminary Investigation
Draft Final Report Volume 2 – Definitive Investigation

(produced by M Adams, D Donato, R Schulz & G Smith
5 August 2008)

by

Dr A N Bagshaw
Proprietor
Chemical Systems Pty Ltd

15 August 2008

Preamble

The focus of this Review was to examine whether the report in its entirety adequately addressed the context, objectives and deliverables of the overall M398 project, to identify any perceived deficiencies in the scientific methodology and to make comment, based on the information provided, on the validity of the conclusions drawn.

The Review did not involve a detailed technical assessment of the results and their implications.

REVIEWER'S FINDINGS

1. ***Overview***

   This project was well designed and executed by a team of researchers whose combination of appropriate expertise in the area is probably beyond peer. This provides strong credence to the conclusions drawn.

2. ***Scope of Work & Project Management***

   The Scope of Work was appropriate to the problem being investigated. The division into two Phases enabled a critical review of the Phase 1 information before proceeding with further work. This interim review identified some key areas where further or somewhat different investigations would benefit the overall conclusions. I was pleased to see that my comments at the interim review were considered and acted upon in Phase 2. In addition, operating gold plants are challenging scientific testbeds to prove hypotheses; the review provided a formal opportunity for the plant personnel to input their considerable expertise and knowledge.

   The Phase 2 work provided an important extended timeframe for data collection and additional important testwork. These enabled greater emphasis to be placed on the identification of the correct hypotheses and clarity on the final conclusions.

   The overall project was well managed by the researchers working closely with plant personnel – critical to success. I was particularly impressed by the thought which went into the thoroughness of the surveys (literature, chemistry, wildlife, etc.), criteria for and choice of laboratories for the important analytical work and the application of the researchers themselves in the field.

3. ***Hypotheses, Limitation and Recommendations***

   I support the conclusions in Section 7 of Volume 2 that hypotheses 7 and 8 are valid but hypothesis 9 is invalid.

   I concur with the Limitations identified in Section 8 of Volume 2.

   I support all Recommendations detailed in Section 9 of Volume 2.

4. ***Acknowledgment***

   I commend MERIWA for supporting this project. It deals with an issue which is important for the gold mining industry operating in an area of Western Australia with particular challenges.

Addendum 2.4 Investigators' Response and Rebuttal

Response to M398 Peer Review Report from Dr Tony Bagshaw

The Peer Reviewer is thanked for making his time and expertise available to critically examine the Draft Final Report for the M398 project and provide a critique in the form of a Peer Review Report.

The reviewer found no fatal flaws and concurred with the conclusions drawn.

Responses to Specific Comments

There are no changes or amendments to the report required by this reviewer; the few typographical and grammatical errors that were highlighted by the reviewer have been corrected in the final report proof.

Gap Analysis Closure

The reviewer concurs with the closure of gaps identified at the Gap Analysis Review Meeting on 15 April 2008.

Hypotheses

The reviewer concurs with the established validity of Hypotheses 7 and 8 and invalidity of the remaining hypotheses that were considered. No additional hypotheses were proffered to describe the data.

Limitations

The reviewer concurs with the listed limitations and there are no additional ones.

Recommendations

The reviewer concurs with the suggested recommendations in the report.

Response to M398 Peer Review Report from Dr Owen Nichols

The Peer Reviewer is thanked for making his time and expertise available to critically examine the Draft Final Report for the M398 project and provide a critique in the form of a Peer Review Report.

The reviewer found no fatal flaws and concurred with the conclusions drawn.

Responses to Specific Comments

There are several changes or amendments to the report required by this reviewer and these are addressed below and in the report where warranted. The few typographical and grammatical errors that were highlighted by the reviewer have been corrected in the final report proof.

xiii Para2: Last sentence needs clarification.

> *"No predictions of WAD cyanide toxicity thresholds is given although toxicity thresholds exist for all systems that have wildlife visitations." Changed to "WAD cyanide toxicity thresholds are not given but must exist because wildlife do interact with these systems".*

P5: Text says Figs 2 and 3 show BGS and GSI, but the figures actually show BGS and BKB.

> *Corrected to BGS and BKB.*

P20: Second last para is a repeat of an earlier one.

> *Deleted.*

P40 Para 4: Re the sentence 'Indications are that despite lower salinity, wildlife are drinking elsewhere' it may be worth mentioning that other factors are likely to be involved e.g. visual 'unattractiveness' – looks unnatural to wildlife (this is touched on elsewhere but could be mentioned here.

> *Inserted ", perhaps partly due to the inherent unattractiveness of the unnatural geometry" at end of the sentence.*

P40 last line: Water chemistry may not have been the reason – they may have just drowned

> *Inserted ", or just simply drowned." After "Some dead macroinvertebrates were collected but these were attributed to dispersal of winged adults which then died within the supernatant due to the water chemistry"*

P42 Para 2 Sentence 1: Check the figure for BGS in text vs Table 14 for Active Cell – Buzz ratio 0.16 is quoted, should be calls/hr of 0.9

Changed to calls/hr of 0.9.

P43 Section 5.2: Table x?

Reference deleted as Table 15 is referred to in the following sentence.

P44 Table 15: Diversity is actually the number of species so technically it should be called either Species Richness or Number of Species

Changed to Species Richness.

P45: Check table number reference, it should be 15, not 14

Corrected.

P46 Last Para: Should 'At times all sites discharge below 50mg/L' be above 50mg/L? Note units also should be mg/L, not m/L

Changed to "At times all of the investigated sites in this study discharge above 50mg/L".

P47: Table 16 Generally more conventional to quote Standard Errors, not Std Deviations

This would be correct when comparing a sample set with a known true value. In the present application the use of the Standard Deviation is retained as more appropriate for the measure of variability in the WAD cyanide levels at discharge. This variability is a result of the normal changes in process plant and climatic conditions.

P47: Sentence beginning 'As a comparison…' needs checking

Grammar corrected.

P49 S5.5 Para1: Add that wildlife may also find TSF's unattractive due to the lack of other wildlife there.

"and other wildlife" inserted after "and lack of vegetation".

P54: Have you got the Findings for 6.3.1 and 6.3.2 around the wrong way?

The Findings are in the correct order, but to enhance clarity, " concentrations" has been inserted after "The predominance of $HCN_{(aq)}$ over $CN^{-}_{(aq)}$".

P55 Para 3: Nevertheless, a specific data set from CSD has…

Typographical error corrected (p. 56).

P55 Para 4: spelling of Wether

Typographical error corrected.

P62 Table 19: There is no # in the table

Typographical error corrected.

P66 S9.3: Particularly organic waste

", particularly organic waste" inserted after "This includes maintaining the tailings system devoid of waste materials other than tailings".

P66 S9.4: Mention that vegetation provides bird shelter, food and invertebrates

Inserted "Vegetation also provides birds with shelter, macroinvertebrates and other food."

App6 P2: Check dates e.g. BGS on-site monitoring

Corrected to read "15/6/06 – 31/5/08" under BGS column.

Gap Analysis Closure

The reviewer concurs with the closure of gaps identified at the Gap Analysis Review Meeting on 15 April 2008.

1. **Species that can drink saline water.** In Phase 1 it was noted that Zebra Finches can drink water up to 47,000 mg/l TDS. Were Zebra Finches were one of the species that suffered mortalities at the freshwater CSD mine? *[Response – Zebra Finches are found in the vicinity of the three hypersaline TSFs and in the vicinity of the CSD TSF. They were not recorded within the TSF structures at any of the sites]*.
2. **Can wildlife detect salinity** – what is the avoidance mechanism? Although the study did not determine whether tasting or ingestion is necessary for some individuals, in combination the above reasons appear to largely explain why avoidance happens in practice; however it should be noted that freshwater systems also have most of these characteristics and clearly birds do interact with them, so they alone are not the whole reason why utilisation is low. *[Response – the issue of whether wildlife can detect salinity prior to ingesting the solution is neither known nor tested. Why avoidance occurs can not be determined other than it is likely a combination of resource and habitat provisions, on which salinity has a strong influence. It was more importantly documented that wildlife behaviour and subsequent ingestion of solutions was strongly influenced by salinity]*.
3. **Do wildlife limit the amount of saline solution ingested?** It would strengthen the argument if the authors were able to quote data on species such as Red-capped Plovers feeding in nearby natural freshwater sites and compare this with numbers feeding on TSFs. For example, in Volume 2 Appendix 6, results show that Red-capped Plovers are present on both fresh water bodies and TSFs; however,

calculations show that, of the total recorded, the percentage foraging is 36% on TSFs (Table 12) but more than 50% on the BGS Saline Wash and the Kambalda Wetlands (Table 16). This suggests that although the species visits both sites, it forages more on the 'natural' sites. It is suggested that the authors consider whether more analysis of the data could be done to compare foraging rates of individual species in TSFs and natural wetlands. *[Response – the literature review provides information on the physiological and behaviour patterns of avian species that inhabit hypersaline environments, such as Red-capped Plovers. To maintain osmotic balance, wildlife in such environments have specialized physiological adaptations and have developed behavioural patterns to avoid ingestion of saline solutions while feeding]*.

4. **Chain of custody and time delay** in getting samples to NATA Labs mentioned in the review of Phase 1 have been resolved. *[Response – gap closed]*.

5. **Cyanide degradation under different weather conditions** is briefly discussed in Volume 1 Section 5.1.4, in relation to the effects of UV irradiation and wind. However insufficient data are available to understand what processes occur under different weather, sunlight, dark etc. conditions. It is therefore suggested that monitoring continue, as described in point 11 below, to improve the sites understanding of the links between WAD CN levels, weather patterns, and any impacts on wildlife. *[Response – the relevant cyanide speciation and degradation chemistry has been demonstrably quantified over the 5-month period considered, to the point of predictability of individual cyanide complex species compositions and WAD cyanide levels in supernatant, given a few simple system input parameters. Sufficient further information on the chemical reaction and mass-transfer specifics is considered to be available in the open literature, and is referenced and covered in parts of Volumes 1 and 2]*.

6. **Carcass detection** issues have been resolved through the use of decoy balloons at all three mines. *[Response – gap closed].*

7. **Wildlife tracks** were noted (Sections 7.5 and 4.2.4 of the revised Volume 1 report) and these showed that apart from the occasional tracks of scavengers such as the dingo, fox, feral cat and feral dog, no other tracks were recorded suggesting that visitations by terrestrial wildlife are few. However, the situation with regards to fencing to exclude terrestrial wildlife at the three TSF's needs to be clarified. *[Response – the necessity of fencing to restrict terrestrial wildlife was beyond the scope of this work; however, in the process data was collected on all wildlife including terrestrial species, which could be used by clients to assess the necessity of a fence to meet Code compliance]*.

8. **Rainwater on the supernatant** – what risk does it pose? In the Phase 1 review, it was stated that at some stage there will need to be a clearer assessment of the risk associated with drinking rainwater sitting on top of the saline supernatant – does this commonly happen *[Response – the decant and spigot TDS and rainfall data shows that this is exceedingly rare, with only one such event occurring at the three sites over the 5-month period, at GSI, which had the smallest supernatant volume, after several days of heavy rainfall]*, does the risk of cyanide deaths increase under certain scenarios e.g. when strong winds result in greater mixing, or when the overlaying layer of freshwater becomes shallower? *[Response – the data shows the supernatant generally to be shallow and well mixed; therefore there would be no increase in the risk of cyanide deaths if the supernatant control parameters are met].* This is only

addressed to a limited extent. *[Response – this aspect is now mentioned in Section 9.2.1].* As well as the few observations of drinking by Welcome Swallows and Red-capped Plovers, it is recognised (in Section 9.2.1) that significant rainfall events may result in a decrease in the salinity of tailings discharged to the TSF, and a decrease in the salinity of spigot-derived supernatant (which in turn would become less saline through direct rainfall). This would decrease the effects of salinity on WAD CN loss, potentially increasing risks to wildlife. This is acknowledged and the proposed solution involves rigorous sampling of salinity in the process and make-up water, spigot discharge and spigot-derived supernatant. Linking these data to rainfall events and wind (resulting in greater mixing) over a range of weather patterns and seasons will increase TSF operators understanding of the risks to wildlife, and management options. *[Response – the data shows negligible effect of rainfall on salinity in process and make-up water, spigot discharge and spigot-derived supernatant, even after 60 mm of rain over a 2-day period at BKB; however, the potential use of make-up water from fresh aquifers, where present, necessitates ongoing monitoring. Section 9.2.1 has been revised accordingly to reflect this].* The study also notes the much of the BKB monitoring took place after rainfall events; monitoring of wildlife utilisation and CN levels during drier periods, as proposed, is needed. *[Response – intensive wildlife and chemical surveys have been carried out at all three sites in the dry May/June 2008 period. Full environmental conditions and scenarios are not likely to occur within the duration of this study, although in broad terms annual seasonality was captured. The environments of arid Australia are extremely variable and a full scenario of environmental conditions, such cyclonic rainfall and prolonged drought would only be achieved probably within a 25-year cycle. To address this limitation, recommendations have provided for ongoing daily monitoring, which will provide real-time data to assess if a risk is likely to occur under all extreme environmental scenarios that are encountered].*

9. In the review of Phase 1 it was suggested that more detailed evidence was needed to show that **wildlife are really exposed to WAD CN levels >50 mg/L**. The use of the radio controlled sampling boat was suggested as one means of doing this. Volume 2 of the report provides good evidence that wildlife utilise TSF's at times when WAD CN levels exceed 50 mg/l. For example, photographs in Appendix 8.1 show water birds present on a number of the TSF's, near points where tailings solution samples were taken for analysis. Supernatant samples taken on the same day Black-winged Stilts were observed foraging at GSI showed a mean WAD CN concentration of 114 ppm (Appendix 6 P22); see also P23. Other data (Appendix 6, Figures 1-3) show that wildlife visitations occurred at all three mines on days when spigot discharge concentrations exceeded 50 mg/L WAD CN, although the details of exactly what interaction took place are not given. Nevertheless, the combined information presented provides more substantial evidence that the absence of wildlife deaths is not because WAD CN concentrations are never high enough; they are, and it can be concluded that some protective mechanism exists. *[Response – gap closed].*

10. **Do similar sites with fresh water experience mortalities?** In the Phase 1 review it was noted that for Hypothesis 7 to correctly explain why no deaths occur, it must be established that under non-saline conditions, wildlife deaths would occur at this site, i.e. is there the right combinations of species, Cyanide concentrations >50 mg/L, habitats, species behaviour in habitats that pose a risk, etc. Data obtained during Phase 2 from studies conducted at CSD Gold Mine in 1997 (Section 5.3 and Appendix 7), where the TSF was relatively fresh (<1,500 mg/L), show that

considerable bird mortalities occur at WAD CN concentrations above 50 mg/L, and comparable to those recorded at the three goldfields study sites. These data were recorded during the wetter months of the year – during dry months, it is likely that mortalities would be even higher. Overall, this is quite convincing evidence that saline and hypersaline TSF's have some protective mechanism that results in few or no bird deaths. However, the actual species dying at CSD, which is a considerable distance from the three study sites, are not mentioned; it needs to be established that they are the same species that occur in the region of the three mines, and have been recorded in adjacent freshwater sites and/or in the TSF's themselves. This would add convincing evidence that the species suffer mortalities at fresh water sites but not at saline and hypersaline sites. *[Response – most of the species of the duck, tern and waders guilds are distributed throughout most of inland Australia. Although CSD and the three hypersaline TSFs of this study are over 3000 km apart, some of the carcasses recorded at CSD were of species that occur in the region or were recorded within the hypersaline TSFs. A list of the species that suffered deaths at CSD and also occur at the hypersaline study areas is provided in Appendix 6, Table 20].*

11. The **full range of seasons** and a broader range of climatic cycles need to be assessed; The Phase 1 review posed the question - could low frequency high consequence events occur? i.e. consideration needs to be given to whether wildlife deaths could happen under unlikely scenarios or particular circumstances not encountered during the study period, e.g. during severe drought, after a big rainfall event, at a time when migratory waders are present in bigger numbers. The present study has added data from an important time of the year, i.e. March/April, when migratory birds are present. However, semi-arid regions experience wide variability between seasons and this needs to be taken into account by ongoing monitoring of wildlife and key process parameters. Thus, while the present study has provided sufficient data to have a relatively high level of confidence that the protective mechanisms exist and are understood, it is important that routine chemistry and wildlife monitoring take place as described in Section 9, data are regularly analysed to increase the sites understanding of links between ore feed characteristics, process controls and seasonal climatic variability; and if mortalities are observed intensive monitoring by external experts is conducted as soon as possible. *[Response – routine site chemistry and wildlife monitoring is listed as a recommendation as is intensive investigation in the event of mortalities. See also response to Query 8].*

12. Data obtained and analysed during Phase 2 of the project produces a much clearer picture of the **effects of hypersalinity on WAD CN loss, concentrations of WAD CN in relation to wildlife utilisation of TSF's**, feeding and drinking patterns and other aspects related to risk to wildlife. These are summarised in Sections 6 and 7. *[Response – gap closed].*

13. In Phase 1, the issue of **nocturnal wildlife** was raised. Monitoring of bat activities has been carried out and in Phase 2 further analyses were carried out. Overall results clearly show that bats utilise freshwater sites to a much greater extent than saline sites (both natural and TSFs). The ratio of feeding, drinking and social 'buzz' calls to total calls was much higher in freshwater sites than in hypersaline water bodies. There is no evidence that the TSF's studied pose a significant risk to Bats. *[Response – gap closed].*

Hypotheses

The reviewer concurs with the established validity of Hypotheses 7 and 8, subject to the additional limitations listed below. The reviewer concurs with the established invalidity of the remaining hypotheses that were considered. No additional hypotheses were proffered to describe the data.

Limitations

The reviewer concurs with the listed limitations and provided the additional ones extracted and summarized below:

- It is acknowledged that **calculating actual doses** is very difficult, as is determining the mechanism that individual birds use to detect and avoid hypersaline water bodies. Nevertheless, behavioural studies and mortality data indicate that they are not ingesting toxic amounts of tailings solutions, and are generally avoiding the hypersaline sites. *[Response – this is already listed as a limitation in the report. However, it should be noted that calculating actual dosage is a limitation only when attempting to determine a toxicity threshold for individual species. This work provided safe operating parameters not toxicity threshold and as a consequence this is not strictly a limitation in the current work]*.
- Establishing that deaths occur in fresh water TSF's (CSD) that discharge at similar WAD CN levels provides good evidence that saline and hypersaline sites provide a barrier, although it should be confirmed that in each case the **same bird species** are involved. *[Response – this is not considered a limitation. See response to Query 10]*.
- Both **process and wildlife monitoring** need to continue over a range of seasons, and if significantly different ore feed is utilised, to ensure that protective mechanisms remain in place and that the management systems work under the full range of weather conditions likely to be experienced in this region. *[Response – this is not considered a limitation as such, is listed in the report recommendations and is a current Code requirement for any site discharging at >50 mg/L]*.

Recommendations

The reviewer concurs with the suggested recommendations in the report.

Response to M398 Peer Review Report from Mr Ray Biehl

The Peer Reviewer is thanked for making his time and expertise available to critically examine the Draft Final Report for the M398 project and provide a critique in the form of a Peer Review Report.

The reviewer found no fatal flaws and concurred with the conclusions drawn.

Responses to Specific Comments

There are several changes or amendments to the report required by this reviewer; the few additional typographical and grammatical errors that were highlighted by the reviewer have been corrected in the final report proof.

P55. Hypothesis 9 was documented as invalid with causation not inferred. The peer reviewer concurs with this outcome as outlined on page 55 of the report, but advises that the reference to Section 3.4 is incorrect and requires amendment.

Referencing error to Section 5.4 corrected.

P57. The peer reviewer further advises that the comments made on copper levels on page 57 make reference to Section 7 of the report. This reference is incorrect and needs to be amended.

Referencing error to Section 9.1.1 corrected.

P60. The peer reviewer also advises that on page 60 reference is again incorrectly made to Section 7 when discussing process control strategies for copper at St Ives. This reference needs to be amended.

Referencing error to Section 9.1.1 corrected.

Gap Analysis Closure

The reviewer concurs with the closure of gaps identified at the Gap Analysis Review Meeting on 15 April 2008.

Hypotheses

The reviewer concurs with the established validity of Hypotheses 7 and 8 and invalidity of the remaining hypotheses that were considered. No additional hypotheses were proffered to describe the data.

Limitations

The reviewer concurs with the listed limitations and there are no additional ones.

Recommendations

The reviewer concurs with the suggested recommendations in the report.