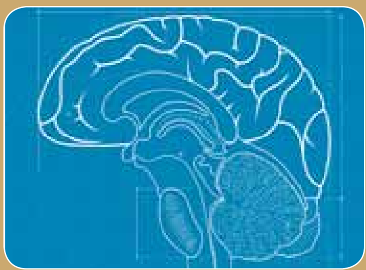
Issue 4 2010

Remediation Australasia

Increasing mineral tailing water extraction with ULTRASONIC ENERGY

CONTAMINANT INGESTION
Tools to assess the risks posed to human health



BODY RESPONSE SYSTEMS
Signalling contamination and fighting cancer

CLANDESTINE LABORATORIES
Damaging the health of communities

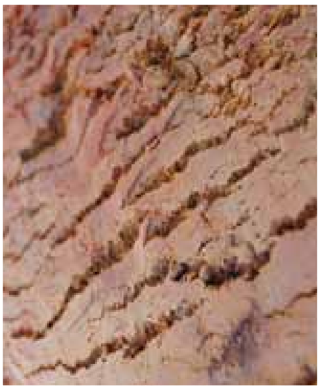
CRC CARE™

Cooperative Research Centre for Contamination Assessment and Remediation of the Environment

CRC CARE is Australia's leading science-based partnership in assessing, preventing and remediating contamination of soil, water and air. With a unique mix of industry, university and government agency partners, CRC CARE's research program focuses on the challenges of best practice policy, better measurement, minimising uncertainty in risk assessment, and cleaning up.

Collaborations between major industry participants, researchers and end users, nationally and internationally

Producing a generation of young Australian professionals highly skilled at solving and preventing contamination



Extensive industry training and workshop program

Fast-tracking science to the field through a national demonstration sites program

Promoting industry access to new technology and knowledge through the Australian Remediation Industry Cluster (ARIC)

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editor's note

Welcome to the fourth edition of the *Remediation Australasia* magazine.

This edition comes with much good news and an expanded section of articles on products, technologies, and information relevant to the industry.

This edition of the magazine also incorporates a new section – the 'Research Roundup' – which will summarise some of the CRC CARE research, findings and subsequent activity. If you're interested in further CRC CARE information, browse through our technical reports and a range of publications. There are also a number of other CRC products and services that are now available, including the CRC CARE Contaminated Sites Law and Policy Directory and the 'Engaging the community: a handbook for professionals managing contaminated land' handbook.

Several recent knowledge transfer, and professional development, workshops and short courses have been coordinated by ARIC, including the highly successful Melbourne risk characterisation (August) and Sydney site assessment and planning (September) courses.

Each event drew excellent attendance numbers, and saw industry representatives and employees from around the country uniting to network, learn and exchange information.

ARIC staff members are currently planning the next round of workshops and short courses, so keep an eye on the Events and Training webpages within this site to ensure you don't miss out next time.

Workshops on risk characterisation and remediation action planning will be advertised shortly.

The demand for online ARIC member services and public services has grown in recent months, as demonstrated by a considerable increase in member numbers. Features offered by ARIC in terms of technology diffusion will continue to grow and develop in future and will be announced in subsequent *Remediation Australasia* magazines.

ARIC membership is still growing by the day, and the decision to extend free membership until December 31 makes now the perfect time to inform colleagues about the relevant and timely information included in the *Remediation Australasia* magazine.

The interactive ARIC member pages, which offer an interactive forum for discussing industry issues, have yet to reach their full potential. The Industry Matters section features the innovative 'Ideas Generator' and 'Solutions Generator' sections for debate, resource sharing and issue resolutions. These webpages are unique, innovative and beneficial to many industry sectors. The current topic for consideration in the Solutions Generator aims to determine whether there are any additional statistics that are required by industry participants for the efficient operation of the remediation industry. Please feel free to explore these pages and drop a few lines in about yourself and your thoughts during the next few months.

I hope you enjoy the articles and updates in our latest edition of the magazine. We look forward to your ongoing support and feedback.

Prof Ravi Naidu
Managing Director, CRC CARE
Editor, *Remediation Australasia*

Remediation Australasia is a quarterly industry magazine produced by the Australian Remediation Industry Cluster (ARIC) for the Australian remediation industry.

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OR adjust properties using the scroll bars
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every issue

Contaminated sites law and policy in Australia

David Cole, Fox Tucker Lawyers

During the past 12 months, several changes have been made to contaminated sites laws across Australia. However, none of the changes introduce fundamental redirection to the regulation of contaminated sites in Australia. Given that the *National Environment Protection (Assessment of Site Contamination) Measure 1999* provides a common basis for site contamination regulation by all Australian jurisdictions, this is not surprising. Therefore, the following briefly summarises the more significant changes that have occurred in Australian jurisdictions in the past year.

Australian Capital Territory

In November 2009, the ACT Government replaced its *Contaminated Sites Environment Protection Policy 2000* with a new policy. Like its predecessor, the new policy is designed to help people understand the contaminated sites provisions of the *ACT Environment Protection Act,* and provides guidance about how to meet obligations imposed by the act in relation to contaminated sites. In May 2009, the ACT also introduced the *Environmental Guidelines for Service Station Sites and Hydrocarbon Storage* policy. The ACT Planning and Land Authority currently offers a reduction in the 'change of use' charge for the redevelopment of service station sites where certain redevelopment conditions are met. It is proposed that this incentive scheme will operate until mid-2011.

Queensland

In the last 12 months, there have been no significant changes to the site contamination provisions of the *Queensland Environmental Protection Act 1994*. However, the *Integrated Planning Act 1997* – which addressed the assessment and remediation of contaminated sites through the land-use planning process – has been replaced by the *Sustainable Planning Act 2009* and equivalent regulations. There has been no notable change to the process for obtaining approval for 'sensitive uses' of contaminated land and, in particular, to the procedures for referral of such proposals to the EPA (now affiliated with the Department of Environment and Resource Management).

South Australia

From 1 July 2009, the site contamination amendments to the *South Australian Environment Protection Act* came fully into effect. No significant changes or additions to these provisions have occurred since then. However, a series of guidelines and information sheets have been produced by the EPA. Notable among these are a range of information sheets detailing the role of site contamination auditors and the information sheet on the transfer of liability in section 103E of the act. That provision permits the transfer of statutory liability for site contamination by agreement between vendor and purchaser, and with the approval of the EPA.

In parallel with the introduction of the site contamination provisions of the *Environment Protection Act,* amendments to the *Land and Business (Sale and Conveyancing) Regulations 1995 (SA)* impose on vendors of land an obligation to disclose to prospective purchasers a range of new information regarding the contamination status of the land. In relation to land-use planning processes involving contaminated land and proposed 'sensitive' uses, relevant authorities under the *Development Act 1993* remain guided by the *Planning Advisory Notice No. 20 – Site Contamination (2001).* It is understood that the Department of Planning and Local Government continues to develop regulatory changes to the land use planning process, and that these changes will reflect the recent site contamination amendments to the *Environment Protection Act*.

Tasmania

No changes to the site contamination provisions of the *Tasmanian Environmental Management and Pollution Control Act 1994* have been introduced in the last year. However, the Planning Commission is currently considering amendments to the state's *Guidelines to Planning Authorities*, whereby assessments of potentially contaminated sites will be triggered by certain proposed changes in land use.

Western Australia

No significant changes to the *Western Australian Contaminated Sites Act 2003* have occurred since mid-2009. However, the Department of Health and the Department of Environment and Conservation issued *Guidelines for the Assessment, Remediation and Management of Asbestos-Contaminated Sites in Western Australia* in May 2009. These guidelines outline the requirements for site contamination assessments, monitoring, remediation and reporting in relation to asbestos-contaminated sites.

New South Wales

The 2008 amendments to the *NSW Contaminated Land Management Act 1997* came fully into effect on 1 July

2009. Those amendments make several important changes to the original act, including the removal of the 'significant risk of harm' test. This test has been replaced by a test that simply requires the EPA to determine whether it considers that the contamination is significant enough to warrant regulation. Investigation orders and remediation orders are replaced with a single management order. In addition, 'preliminary investigation' orders have been introduced. The modifications to the 1997 act have necessitated revision of guidelines. For example, the *Guidelines on Significant Risk of Harm from Contaminated Land and the Duty to Report* (July 2003) have been replaced by *Guidelines on the Duty to Report Contamination under the Contaminated Land Management Act 1997* (June 2009). The *Guidelines for the NSW Site Auditor Scheme* (2006) are currently under review. Due in part to the changes made to the *Contaminated Land Management Act, the Managing Land Contamination Planning Guidelines* (which are within the *Environmental Planning Policy No 55*, and address contaminated site investigation and remediation through the land use planning processes) are being reviewed.

The National Environment Protection (Assessment of Site Contamination) Measure 1999 (NEPM)

The NEPM was reviewed between 2004 and September 2006, at which time a report of the review was published. In June 2007, the NEPM variation process was initiated to alter the NEPM according to the review's recommendations. The National Environment Protection Council is currently considering the variation. Once it has been approved, public consultation will take place. The public consultation is currently scheduled for the period 24 September to 16 November 2010.

Contaminated Sites Law & Policy Directory

The Contaminated Sites Law & Policy Directory is a resource developed to provide vital information about the legal framework surrounding contaminated sites in selected jurisdictions around the world. The directory brings together the many complex pieces of contaminated site law and policy in a fully searchable online database, and has been analysed and comprehensively annotated by leading authorities. It's free subscription-based website delivers search results through the use of a standard template to enable comparison between jurisdictions. The summaries are designed to provide the reader with a clear understanding of the legislation, guidelines and other documentation and government policies that underlie the approaches taken by authorities in addressing contaminated sites management. Legal advisors, policy makers, industries, academics and anyone with an interest in contaminated sites will benefit from this unique legal resource. The directory is available online now, and currently features Australian jurisdictions as well as Hong Kong and Singapore. The website will continue to evolve to include selected jurisdictions in the EU, US, Canada and the Asia Pacific region. Visit **www.cslawpolicy.com** to access the directory online. ■

Thermal treatment technologies

John Hunt, Thiess Services

Thermal treatment technologies have been developed and applied for more than 25 years in the US to treat soil containing hazardous chemicals, including polycyclic aromatic hydrocarbons (PAHs) and chlorinated hydrocarbons (CHCs).

The treatment of contaminated soils by thermal desorption involves the heating of the material so the contaminants of concern are volatilised for secondary oxidation or recovery. The treatment produces clean soil that can be beneficially reused on-site or, alternatively, disposed of to landfill as an inert waste (providing non-volatile co-contaminants are not present). The technology was first introduced on a significant scale to Australia in the late 1990s by ADI Limited to treat soil contaminated by trinitrotoluene (TNT). A number of small projects and trials treating CHCs and PAHs were undertaken by a few contractors until 2005. In 2006, the first large thermal treatment project commenced on the Rhodes Peninsula in Sydney, treating around 200,000 tonnes of dioxin and CHC contaminated soil.

Thermal remediation process

All thermal remediation processes (both ex-situ and in-situ) involve two main steps:

- desorption of contaminants by either direct or indirect heating of the soil to a temperature higher than the boiling point of the contaminants of concern, typically less than 500°C, and
- recovery by condensation, or destruction by combustion, of the organic compounds in the offgas.

case of the latter system, activated carbon may be used to polish the offgas stream.

Before returning the cleaned soil to the site, it is sprayed with water to cool and remoisturise it and to control dust. The soil is tested for levels of residual contaminants; if it still contains the contaminants of concern, it can be cleaned further by placing it back in the desorber. Once the soil is clean, it is returned to the site.

"Sometimes thermal desorption works where some other cleanup methods can not, including sites that have high boiling point complex organic compounds designed as pesticides or herbicides."

A typical ex-situ thermal desorption system for treating soil is made up of three parts: the pre-treatment and material handling system; the desorption unit; and the post-treatment system for both the gas contaminants and the remaining soil.

Preparation of the soil may be required prior to it being placed into the desorber. This may include crushing, drying, blending with sand, lime or other less contaminated or moist soil, and screening to remove debris. This allows the desorber to clean the soil more evenly and easily. Soil is then introduced into the desorber, which works like a large oven to heat the soil. A common design for this unit is a rotary dryer, which has a rotating cylindrical metal drum. When the soil gets hot enough, the contaminants of concern are vapourised.

During each step of the process, specialised equipment is used to control dust emissions from the soil that are released into the offgas stream, and to treat the offgases that are released to the air. The vapourised contaminants in this offgas may be burned in an afterburner, or recovered in condensation equipment and changed back into liquids and/or solid materials for disposal. In the

Thermal remediation plants

Thermal treatment technologies include mainly ex-situ applications, with in-situ applications now coming more widely into use in the US. Considering only the ex-situ applications, thermal treatment technologies for soil remediation may come in a number of capacities and configurations including:

- large fixed facility continuous feed rotary plants with up to 100 tonnes per hour (t/hr) throughput
- medium-size transportable continuous feed rotary plants with 20 to 50 t/h throughput, and
- smaller highly transportable plants, including both continuous feed rotary and batch plants with 0.5 to 5 t/h equivalent throughput.

Within Australia today there are two main configurations of thermal plants:

- direct heating of soil with destruction of contaminants, termed direct thermal desorption (DTD), and
- indirect heating of soil with recovery of contaminants, termed indirect thermal desorption (ITD).

Why use thermal treatment?

Thermal desorption works well at sites with dry soil and certain types of pollution, such as fuel oil, coal tar, chemicals that preserve wood and solvents.

Sometimes thermal desorption works where some other cleanup methods can not, including sites that have high boiling point complex organic compounds designed as pesticides or herbicides. Thermal desorption can also be a faster cleanup method than most.

Direct thermal desorption

When using the DTD method, the contaminated soil enters the rotary dryer and is heated by direct contact with a flame or the hot combustion gas coming off of a flame. DTD is largely focused at persistent organic pollutants that have little or no recovery value (e.g. polychlorinated biphenyls (PCBs), polyaromatic hydrocarbons (PAHs), chlorinated solvents etc).

This type of technology is generally applied when a low level of contamination is present (typically < 3% total organic carbon (TOC)).

Indirect thermal desorption

When using ITD, the soil does not come into contact with a flame or combustion gases. Instead, the outside of the dryer is heated and the hot metal indirectly heats the soil tumbling inside, with contaminants in the off-gas being condensed for subsequent recovery of destruction. This type of technology is generally applied when the contaminant has some economic value, or when a high level of contamination is present (typically more than 3% TOC and up to very high values – around 50% – of TOC).

A number of thermal treatment processes and plants are now available in Australia.

Their main application is for treatment of chlorinated organic compounds and high boiling point non-chlorinated organic compounds in soil, which are difficult

to treat using greener remediation technologies. The plants come in a range of configurations and sizes suitable for both small and large projects.

The cost of thermal treatment varies according to the type of plant, the source of energy used, the type of soil being treated, the nature of the chemical being treated and the soil treatment standard. Indirectly heated plants use about the same amount of energy as directly heated plants but cost nearly twice as much per tonne treated, due to low relatively low throughputs. Moisture content in particular drives cost, because energy use increases and throughput decreases as moisture content increases.

When should you use it?

Thermal treatment technologies are energy intensive and relatively high cost. From a technical perspective their niche in the remediation market is for the treatment of hazardous compounds in a soil matrix that cannot be treated by other methods, such as PAHs, PCBs, OCPs and dioxins and furans. From on economic perspective, the net cost for thermal methods would only be positive for remediation of high value, inner city, brownfield sites that can be converted to high density residential landuse.

Higher boiling point compounds (such as PAHs and dioxins) also require higher soil treatment temperatures and energy use. The cost of thermal treatment typically ranges from $100 to $200 per tonne of soil treated (excluding associated site works). The per tonne cost also depends on quantity, because the mobilisation costs of large plant are high (more than 1 million).

The following examples outline the use of a small hybrid (indirect heating with a thermal oxidiser) batch plant to treat tarry soil, and a medium sized DTD plant to treat dioxins in soil.

Batch thermal plant

Approximately 70,000 tonnes of tarry soil on the former Highett gasworks site in Melbourne were treated using a hybrid batch thermal plant, called an enhanced thermal conduction (ETC) plant. The ETC plant uses indirect heat to volatilise organic compounds from soil in 650 - 700 tonne batches over one to two weeks. This gives to an equivalent treatment rate of 2 to 4 t/h.

The offgas emission control system comprises a recuperative thermal oxidiser, which operated at a temperature of 760°C; an induced draft fan; and stack. Because the process was passive, dust emissions were minimal. Because no chlorine or sulfur was involved, quenching and scrubbing were not required.

The soil on site was mainly clay and silt, with a moisture content estimated at 12%. The soil treatment temperature (STT) was raised to around 375°C average over two weeks, which reduced benzo(a) pyrene (BaP) – a high boiling point PAH – from 10 to 1 mg/kg in the soil. For a previous project, the same standard was reached after two weeks of treatment from a starting concentration of approximately 80 mg/kg BaP. The STT is below the boiling point of BaP (495°C), but is still effective because of the longer treatment time.

Continuous DTD plant

Dioxin-contaminated soil on the Rhodes Peninsula in Sydney was treated using large rotary DTD plants. The offgas emission control system comprises (in order) cyclones or multiclones to remove dust; a thermal oxidiser to combust organic compounds; an evaporative cooler to quench the offgas; aghouse to remove particles; an acid gas scrubber to remove chlorine; an induced draft fan; and a stack. The function of the evaporative cooler is to rapidly quench the offgas by introducing a water mist to minimise dioxin reformation. Introduction of the evaporative cooler was a major step forward in preventing dioxin reformation in thermal processes.

The soil on the site contains a high proportion of wet (25% moisture), fine-grained limes which were used to fill the site. The concentration of dioxins and furans in the plant feed material averages approximately 0.05mg/kg toxic equivalence (TEQ). This requires a STT of approximately 525°C with a residence time of 10 minutes to meet a treatment standard of 1 mg/kg TEQ for dioxins and furans. The high moisture content and high STT resulted in a relative low soil feed rate of around 18 t/h. The thermal oxidiser operated at 930 - 960°C. The dioxin concentration standard in the offgas was 0.1 ng TEQ/Nm^3.

Application of 'best practice' concepts to the soil treatment temperature and oxidiser operating temperature, in order to minimise residues in soil and offgas, could result in an increase of approximately 40% in gas consumption and greenhouse gas emissions. The debate on how much is enough, and balancing these two issues, is yet to be had.

Assessment of site contamination – NEPM variation

The National Environment Protection Council (NEPC) Committee has recently released the draft varied Assessment of Site Contamination National Environment Protection Measure (NEPM) and Impact Statement for public consultation.

The major changes included in the draft varied Assessment of Site Contamination NEPM are:

- new and improved methodologies for deriving Ecological Investigation Levels and Health Investigation Levels
- incorporation of Health Screening Levels and Ecological Screening Levels for petroleum hydrocarbons
- incorporation of guidance for assessing asbestos impacts
- incorporation of guidance on stockpile sampling, contaminant leachability and bioavailability, and
- incorporation of guidance for assessment of volatile substances.

There will now be a series of information sessions coordinated by the NEPC Services Corporation and relevant state jurisdictions in major capital cities around Australia during the coming weeks.

Proposed dates are as follows:.

Location	Date	Time
Adelaide	12/10	1-4pm
Canberra	13/10	1-4pm
Melbourne	14/10	1-4pm
Hobart	15/10	1-4pm
Sydney	19/10	1-4pm
Brisbane	20/10	1-4pm
Darwin	22/10	1-4pm
Perth	26/10	1-4pm

The 3-hour information sessions will be held utilising three different methods of consultation. The first hour will comprise an 'open house', in which a series of posters will be displayed. The open house provides an opportunity, especially for community members, to read the information on the posters in their own time and according to their level of understanding. The Open house is open to all comers. The second hour will comprise of formal presentations to present a more detailed overview of 'What has changed in the NEPM'. The third hour will comprise a panel session in which members of the audience are able to ask specific questions to a member panel.

Visit **www.ephc.gov.au/taxonomy/term/99** for further information on the information sessions or documents.

CleanUp 2011

6th International Workshop on Chemical Bioavailability in the Terrestrial Environment (7–9 September 2011)

and the

4th International Contaminated Site Remediation Conference (11–15 September 2011)

Hilton Adelaide hotel

On behalf of CRC CARE and the Australian Remediation Industry Cluster (ARIC), I invite you to join us for the biennial CleanUp conference, to be held at the Hilton Adelaide hotel, in South Australia.

CleanUp 11 will combine the 6th International Workshop on Chemical Bioavailability in the Terrestrial Environment (7–9 September 2011) and the 4th International Contaminated Site Remediation Conference (11–15 September 2011).

The CleanUp Conference is the premier Australian-based conference related to the contaminated site and remediation industry.

It is expected that CleanUp 2011 will have an attendance comparable to the 2009 conference, which attracted over 500 scientists, engineers, regulators, and other environmental professionals from 25 countries. Delegates were able to promote technology transfer and exchange information, innovations and developments in fundamental and applied environmental research towards the assessment, management and remediation of environmental contamination.

The organising committee is pleased to again have secured the Hilton Adelaide hotel as the host venue for the events. This medium sized venue enables attendees to focus on the tightly paced program and exhibits, and to easily meet and share ideas and information.

Ample networking will be possible with a full complement of lunches, receptions, and other meals being served during the breaks in the program. After the sessions conclude each evening there will be poster sessions and networking drinks, with the conference dinners again expected to be a highlight of the social program. At the conclusion of each day's activities, conference participants will find ample sightseeing, shopping and dining options nearby. Located on central Victoria Square, the Hilton Adelaide hotel is in the heart of Adelaide city.

Your contribution to these events is welcome as a presenter, sponsor, exhibitor or delegate.

I look forward to seeing you at the conference in 2011.
I know you will value the experience.

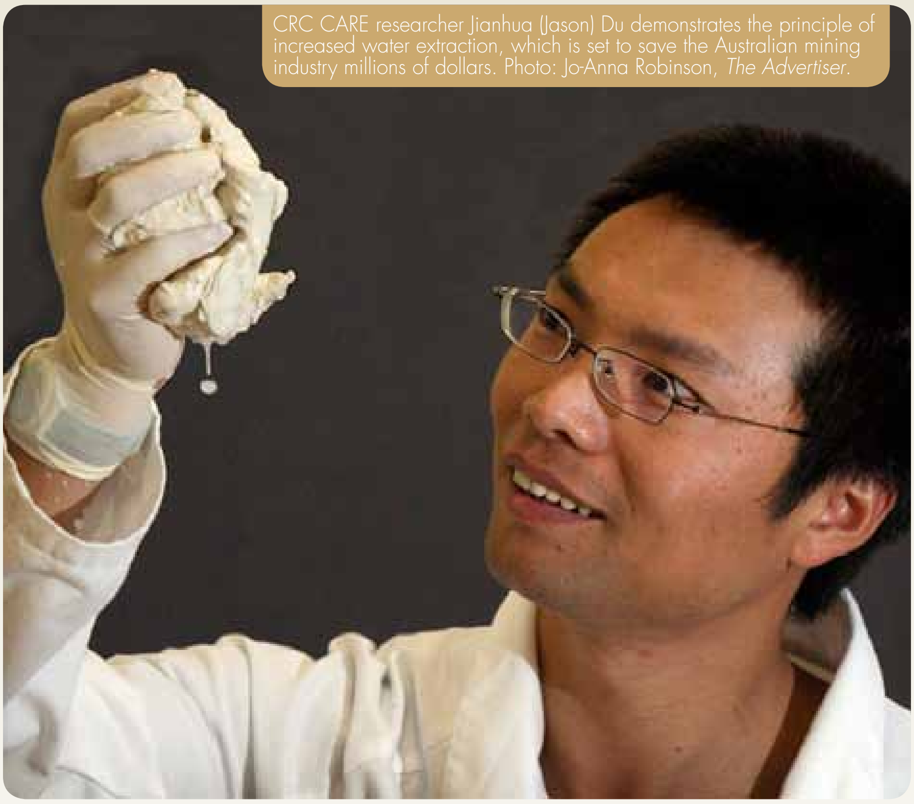
Professor Ravi Naidu
Managing Director
CRC CARE

CRC CARE — ARIC Australian Remediation Industry Cluster — CRC Australia

Using ultrasonic technology to control

Aggregate structure, settling and dewatering in mineral tailings

Mining accounts for 3% of Australia's total water use, so water savings of a few percent in mineral processing can represent large amounts.



CRC CARE researcher Jianhua (Jason) Du demonstrates the principle of increased water extraction, which is set to save the Australian mining industry millions of dollars. Photo: Jo-Anna Robinson, *The Advertiser*.

Mineral processing typically needs 0.4 - 0.6 tonnes, or 500 litres, of fresh water for every tonne of ore ground. It is estimated that the world produces more than 10 billion tonnes of tailings waste every year, typically consisting of 60 - 95% water. However, it is widely recognised that the processes used to separate liquids from solids are low in efficiency. This means very large disposal landfill sites are needed.

Tailing streams with kaolinite (clays) contain loose, water-holding materials which result in slow settling rates and poor sediment density. By applying ultrasonic energy to a tailings stream before the thickener, these loose structures can be re-arranged into denser forms that retain less liquid, thereby enabling water savings.

The principle of this treatment is like shaking a jar full of flour, which causes the flour to compact down. The subsequent use of flocculants enables these new denser materials to settle 40% faster, but no further water is saved at this stage of the process. This project set out to determine whether ultrasonic energy applied after flocculant addition could compact the waste materials further and thus release more water.

By analysing scanning electron microscope (cryo-SEM) images, it was found that large amounts of water were still locked in the honeycomb structure. Traditional 'raking' was found to break down the honeycomb structure into smaller self-supporting structures, but these still trapped a large amount of water.

The breakthrough achieved by this research and its new contribution to mineral processing was the finding that ultrasonics could help release more water from these closed structures. The results showed that this amended process increased the density of output from the thickener process by 4% (by weight). This new treatment will increase water recovery at just one of Rio Tinto's mines by 436 mL/year, worth $5.57 million per year to the company. ■

Clandestine laboratories: risk and management

Ravi Naidu (CRC CARE) and Raktim Pal
(University of South Australia)

Australia's clandestine laboratory problem is growing. Used to produce most of Australia-manufactured illicit drugs, a clandestine laboratory (commonly known as 'clan lab') is any secret, usually highly portable, place to produce illicit amphetamine type substances (ATS) including amphetamine, methamphetamine, ecstasy, cocaine, heroin, gamma-hydroxybutyrate (GHB or 'fantasy') and lysergic acid diethylamide (LSD or 'acid'). They are typically small, and use improvised laboratory equipment and readily available chemicals. Clan labs are discovered in houses, apartments and motel rooms, or even cars, camping sites and horse floats, which have all been known to be adapted for illicit drug production.

The global nature of clandestine manufacture of ATS is evidenced by detections of laboratories in more than 60 countries worldwide since 1990. Organised criminal groups generate significant funds through the manufacture and trafficking of illicit drugs and their precursors. Greater organised crime involvement has resulted in larger and more sophisticated ATS operations being detected, particularly in North America (methamphetamine and ecstasy), east and southeast Asia (predominantly methamphetamine and, in recent years, ecstasy), Europe (mostly amphetamine and ecstasy, with increasing manufacture of methamphetamine), and Oceania (methamphetamine and, to a lesser extent, amphetamine and ecstasy).

In July 2009, evidence of possible ATS manufacture in West Africa emerged following the discovery of more than five tonnes of 3,4-methylenedioxy-N-methylamphetamine (ecstasy) precursor chemicals and large-scale reaction vessels in various regions of the Republic of Guinea.

The chemicals linked with clan labs are quite pervasive and, if proper cleanup measures have not been undertaken, continue to cause serious health problems for future occupants of the property or neighbours unaware about the contamination. However, cleaning up clan labs is a complex, time-consuming and costly process. These difficulties are exacerbated by the fact that as the problem grows, and agencies seek to restrict the products needed to make illicit drugs, the methods and the locations of its production are changing. As a result, health and environmental agencies find it increasingly difficult to assess the contamination risks posed by clan labs.

Often, clan labs may be used to perform quite simple procedures such as extracting cannabis oil from plants. However, these can also be very sophisticated operations, with highly technically advanced facilities used to manufacture high grade amphetamines. The size and output of clan labs vary from super labs producing 4.5 kg or more of the drug per production cycle, to small box labs producing as little as 30 g or less.

ATS in different countries are manufactured by employing a range of methods, depending on the availability of the starting material (precursor). The clandestine manufacture of methamphetamine in USA, Australia, and New Zealand very frequently involve the use of pseudoephedrine and ephedrine as precursor, due to its easy availability.

However, ATS manufacturers also change the methods of preparation depending on the availability of the precursor chemicals in the market. The most common precursors for ATS manufacture are ephedrine, pseudoephedrine, phenylpropanolamine, acetone,

ether, methanol, toluene, trichloroethane, red phosphorous, iodine, hydrochloric acid, hydroiodic acid, sulfuric acid, sodium metal, sodium hydroxide, and anhydrous ammonia – plus the materials available in retail outlets without any regulation, such as cold and allergy medications, lye, rock salt, battery acid, lithium batteries, pool acid, iodine, lighter fluid, matches, fireworks, road flares, antifreeze, propane, paint thinner, drain cleaner, kitty litter, etc.

Irrespective of the size or level of sophistication of individual clan labs, the corrosive and hazardous nature of many of the chemicals used pose significant risks to the community. More than 5 kg of toxic waste is generated for every kg of methamphetamine produced. These toxic wastes may contain the residual drug, un-reacted precursors and by-products, and are commonly dumped into soil, sinks, toilets and other public waste management facilities.

Ultimately, many of the chemicals used in clan labs are extremely volatile, and through a variety of environmental processes can find their way into soil, air, and water to create serious risks to public and wildlife. However, very little information is available about the impact of these chemicals on the environment. This is increasingly being recognised as a critical issue of concern.

The Australian Crime Commission's 2008-2009 Illicit Drug Data Report showed that the number of clan lab detections in Australia has tripled since the beginning of the decade.

In the last year alone the number of clandestine labs discovered in Victoria has risen by 50%, with a significant trend showing the more frequent occurrence of clan labs in regional areas.

Queensland still tops the list as the worst offender with 148 labs detected last year, and Western Australia experienced the highest rise of the number of clan labs detected.

This is a global problem: UNODC has reported that the number of ATS-related clan labs increased by 20% in 2008 from the previous year.

The Australian Crime Commission differentiates the various types of clan labs as:

- Category A – actively using the chemicals and equipments
- Category B – storing or using the chemicals and equipments
- Category C – storing the chemicals and equipments but not using, and
- Category D – used site or having evidence of prior laboratory.

These categories pose a varying level of risks to their environments and human health, but none are completely safe. The clan lab may generate toxic, corrosive, explosive and carcinogenic substances. Clan labs cause mainly three types of hazard:

- physical hazard such as explosion, fire, chemical burns, release of toxic fume, etc.
- environmental hazard, and
- child endangerment.

This means that clan labs pose potential health risks to the lab workers, neighbours, and future residents of the contaminated sites as well as the local community, fire fighters and environmental cleanup crews due to the chemical exposure by inhalation or skin contact. Children living in the laboratory environment may also be exposed to the potential hazards of the clan labs by crawling on carpets where toxic chemicals used to produce methamphetamine have spilled; cooking their meal in the same microwave oven that their parents use for methamphetamine production; or playing in areas where chemicals used for methamphetamine production are improperly stored.

The long-term risks arising from the toxic substances associated with clan labs are not fully known, but are likely to include the carcinogenic effects of different organics. However, the immediate effect may be more serious, causing nausea, dizziness, intoxication, chemical burns and damage of internal and external body organs, serious respiratory problems including sudden cardiac arrest and lung damage, and even death.

The immediate cleanup is carried out with certified authorities, but complete remediations of the contaminated sites are only occasionally performed due to unsettled responsibility of the cleanup and extremely high cost. Currently in Australia, no systematic guidelines are available for the clan lab cleanup and remediation standards; however, clean-up guidelines were being drawn up by the Health Department, Department of Environment and Conservation and ChemCentre. The New Zealand Department of Health has also recently released *Guidelines for the Remediation of Clandestine Methamphetamine Laboratory Sites*.

It is clear that strong legislation and regulations need to be established to ensure that contamination created by clan labs is properly and effectively cleaned up. This should be coupled with public safety awareness programs to raise awareness of contamination risks posed by clan lab operations. Finally, and critically, more research is urgently needed to help combat the contamination problems posed by the ever-changing methods and locations of illicit drug production. ■

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Tools for assessing the

Risk to human health from contaminant ingestion

Brent Clothier, New Zealand Institute for Plant & Food Research

Following the completion of a project on soil contaminants and their entry into the food chain through home-grown vegetable consumption, a decision support tool (DST) has been developed which assesses the risk to human health posed by the consumption of these vegetables.

Across many developing countries there is a general increase in popularity of growing produce for home consumption. Peri-urban expansion has resulted in many houses being located on, or near, former agricultural lands, or even on land that had previously been used for industrial or waste-disposal purposes.

A project led by Dr Euan Smith (UniSA) has been completed on soil contaminants and the risks that they can enter the food chain through consumption of home-grown vegetables (**www.crccare.com/research/pn1-3-01.html**).

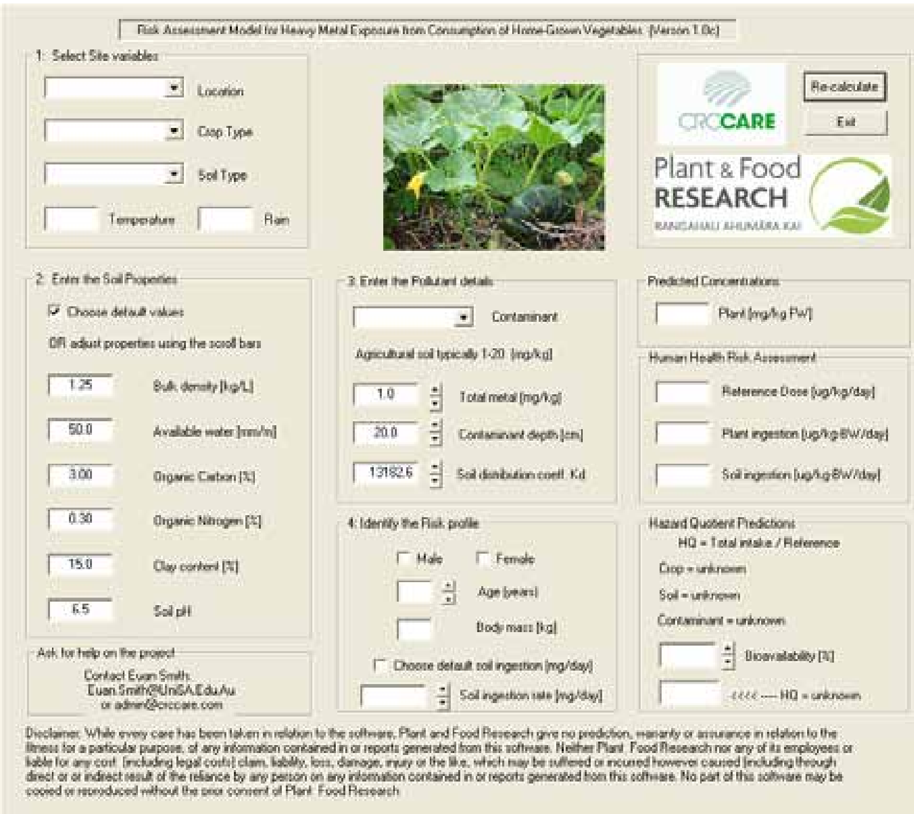


FIGURE 1 The screen displayed to the user when working with the decision support tool program.

Dr Smith and his team investigated the accumulation of contaminants in a range of commonly cultivated vegetables, and studied the potential bioavailability of the plant contaminants to people. A major goal of the project was to develop a decision support tool (DST) to assess the risks to human health from the consumption of vegetables grown in contaminated soil. The project pathway for the development of the DST is shown in Figure 2, as well as the steps between the boxes involved the modelling of contaminant transport and fate along the exposure pathway.

The soil-plant uptake model used was that of Soil Plant Atmosphere System Model (SPASMO), which was developed by Plant & Food Research in New Zealand. Drs Steve Green and Brent Clothier were the team members involved in writing the code and working with Dr Smith to design the DST. The DST is a Windows-based format (Figure 1) with four panels of input information required via pull-down menus.

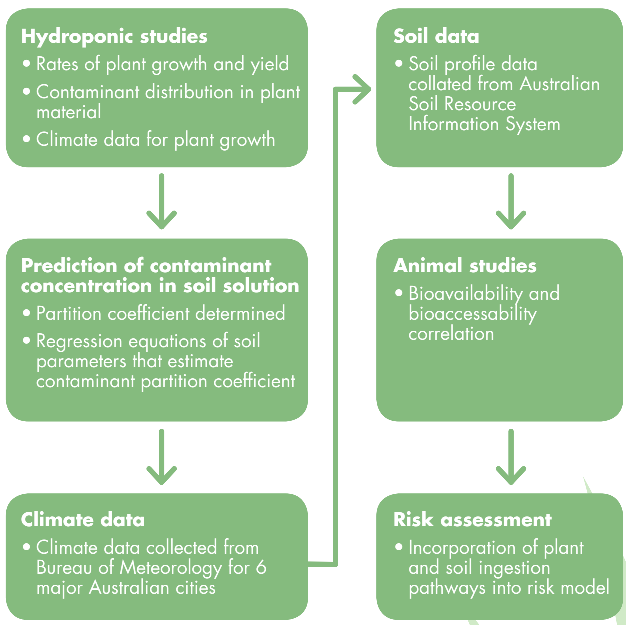
The panel information includes the site and weather variables, the soil biophysical properties, the pollutant details and distribution, and the recipient's risk profile. The information may include default values, or require input of known values. From a large number of published reports and databases, default relationships were developed between soil type and soil properties, between the people's age and their body weight, between people's age and vegetable consumption rate, as well as between people's age and their soil ingestion rate.

Completion of the local climate information and vegetable grown, soil properties, nature of the contaminant and the risk profile allows the calculation of the plant contaminant uptake, as well as the prediction of the 'hazard quotient'. The contaminant accumulated in the edible portion of the vegetable is calculated by the SPASMO model.

By reference to the New Zealand total diet survey of 2004, the DST then calculates contaminant exposure through both vegetable consumption and soil ingestion. This total exposure is then compared to published allowable daily intake values, the reference dose, to compute a hazard quotient (HQ). If this ratio of ingestion amount to reference value is found to be less than 0.005 the risk is termed 'very low'. The other qualifiers of risk used are for when the HQ is <0.05 low, <0.5 medium, 1-5 high, and for >5 very high.

Although animal studies were included in this research to determine the bioavailability of contaminants in the vegetables, for prudence, the bioavailability percentage is set to a default of 100% in the DST. It can, however, then be used by the operator, via up/down scrolling of the percentage arrows, to examine the impact of bioavailability on exposure risk by entering a selected level of bioavailability.

FIGURE 2 Decision support tool developmental pathway.



The decision support tool provides a simple and useful means of synthesising complex data to provide users with an assessment of risk due to ingestion of vegetables grown in contaminated soil. Visit **www.crccare.com** for more information.

The Dirty Dozen become the Dirty 21:

the new list of Stockholm Priority Contaminants (POPs)

Ilia Rostami, FMG Engineering

The addition of nine new chemicals to the existing 12 identified by the Stockholm Convention on persistent organic pollutants (POPs) means that sites previously considered unpolluted may now be classified as contaminated. Environmental protection agencies are facing the challenge of acquiring resources to manage and remediate such contaminated sites.

The Stockholm Convention on Persistent Organic Pollutants (POPs) is a global treaty designed to protect human health and the environment from highly dangerous, long-lasting chemicals by restricting and ultimately eliminating their production, use, trade, release and storage. Signed in May 2001 by 92 countries and the European Commission, the treaty covers 12 different POP compounds.

In August 2009, this 'dirty dozen' was expanded to include nine additional chemicals, once common pesticides and flame retardants, which have been newly classified as persistent organic pollutants.

POPs are a group of carbon-based compounds that possess toxic properties, resist degradation and bioaccumulate. The 'Dirty 21' can be placed in three categories (box on far right).

POPs can travel long distances and deposit far away from their sources of release. In addition, they can persist in their environment for long periods. During the last few decades, POPs have been widely distributed throughout large regions, and in some cases they are found around the globe, including areas where POPs have never been used. This extensive contamination of environmental media and living organisms includes many foodstuffs, and has resulted in the sustained exposure of many species, including humans, for periods of time that span generations. This has resulted in both acute and chronic toxic effects.

Though not soluble in water, POPs are readily absorbed in fatty tissue where concentrations can become magnified by up to 70,000 times

Birds such as the Kittiwake migrate around the world as seasonal changes occur. The Kittiwake journeys across the North Atlantic, travelling as far as North America during winter. This is one example of the potential for POP contamination to spread through the food chain and by migration patterns, leading to the presence of POPs at locations such as the Arctic which are thousands of kilometres from any major POP source.

the background levels. Fish, predatory birds, mammals, and humans are high up the food chain and so absorb the greatest concentrations. When they travel, the POPs travel with them. As a result of these two processes, POPs can be found in people and animals living in regions such as the Arctic, thousands of kilometres from any major POP source.

Exposure to POPs can cause serious health problems. Health and environmental concerns associated with POPs include:

- accumulating in the fatty tissues of living organisms
- causing complications like cancer and birth defects
- triggering adverse effect on the ecosystem and biodiversity, and
- potentially disrupting immune and reproductive systems and even diminishing intelligence.

Specific effects of POPs can include cancer, allergies and hypersensitivity, damage to the central and peripheral nervous systems, reproductive disorders, and disruption of the immune system. Some POPs are also considered to be endocrine disrupters, which, by altering the hormonal system, can damage the reproductive and immune systems of exposed individuals as well as their offspring; they can also have developmental and carcinogenic effects.

New POPs means more contaminated sites, new legislation and greater recognised risks

The inclusion of the additional nine POPs as part of the Stockholm Convention demonstrates the commitment of governments around the world to reducing and eliminating such chemicals, but it also creates additional challenges for international remediation efforts. The increase in the list of priority contaminants means that sites which may not have been previously considered to be polluted have now been re-classed as contaminated with POPs. This means that in any one country, including Australia, the number of sites considered to be contaminated should increase significantly. For example, sites where fluorinated hydrocarbons have been utilised during fire-fighter training would now be classed as contaminated, significantly raising the number of sites. This creates a greater challenge for environmental protection agencies, one which requires significant investment in resources to legislate guidelines for the management and remediation of such contaminated sites. To this end, guidelines for meeting the challenges of a POP-free future have been outlined by the convention. Recommendations to signatory nations include:

- moving away from the production and use of POPs towards safer alternatives, and eventually eliminating the release of unintentionally produced POPs
- identifying other substances with POP characteristics that place human health and the environment at risk
- ensuring that technical and financial resources are available to developing countries and parties with economies in transition
- meeting their obligations according to the convention, and
- ensuring the convention meets its goal of protecting human health and the environment from POPs so that the international community is satisfied that the convention is effective.

Annexure: Brief description of the nine new POPS and their usage

1 & 2: Hexabromodiphenyl ether and heptabromodiphenyl ether, and tetrabromodiphenyl ether and pentabromodiphenyl ether. Bromodiphenyl ether congeners are a group of brominated organic substances that inhibit or suppress combustion in organic material, and are used as additive flame retardants. They are mainly manufactured as commercial mixtures where several isomers, congeners and small amounts of other substances occur.

3. Chlordecone: a synthetic chlorinated organic compound mainly used as an agricultural pesticide. It was first produced in 1951 and introduced commercially in 1958. Current use or production of the chemical is not reported.

4. Hexabromobiphenyl (HBB): an industrial chemical used mainly in the 1970s as a flame retardant. Based on existing data, HBB is no longer produced and is not used in new or existing products.

5. Lindane: used as a broad-spectrum insecticide for seed and soil treatment, foliar applications, tree and wood treatment and against ectoparasites in both veterinary and human treatments. Lindane production has decreased rapidly in recent years and only a few countries still produce it.

6 & 7. Alpha- and beta-hexachlorocyclohexane. Although the intentional use of alpha- and beta-HCH as an insecticide was phased out years ago, these chemicals are still produced as an unintentional by-product of lindane. Approximately 6 - 10 tonnes of other isomers including alpha- and beta-HCH result from each tonne of lindane produced.

8. Pentachlorobenzene (PeCB): used in PCB products and dyestuff carriers, as a fungicide, and as a flame retardant. It has also been used a chemical intermediate in processes such as the production of quintozene; it may still be used for this purpose. PeCB is also produced unintentionally during combustion in thermal and industrial processes. It appears as an impurity in products such as solvents or pesticides.

9. Perfluorooctane sulfonic acid (PFOS), its salts and perfluorooctane sulfonyl fluoride. PFOS is both intentionally produced and an unintended degradation product of related anthropogenic chemicals. The current intentional use of PFOS is widespread and found in products such as in electric and electronic parts, fire fighting foam, photo imaging, hydraulic fluids and textiles. PFOS is still produced in several countries today.

Purging groundwater wells - is it necessary?

Ravi Naidu, R. Praveen Kumar and Victor Arias Espana, CRC CARE and Centre for Environmental Research and Remediation

FIGURE 1 In-situ sealed samplers deployed downhole, secured and locked at well head (source: Britt et al. 2010).

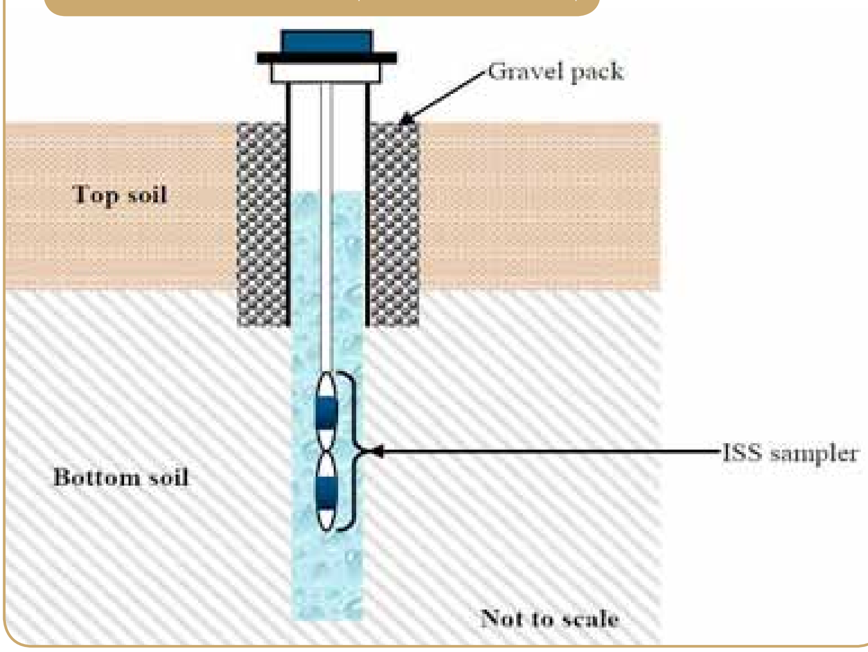
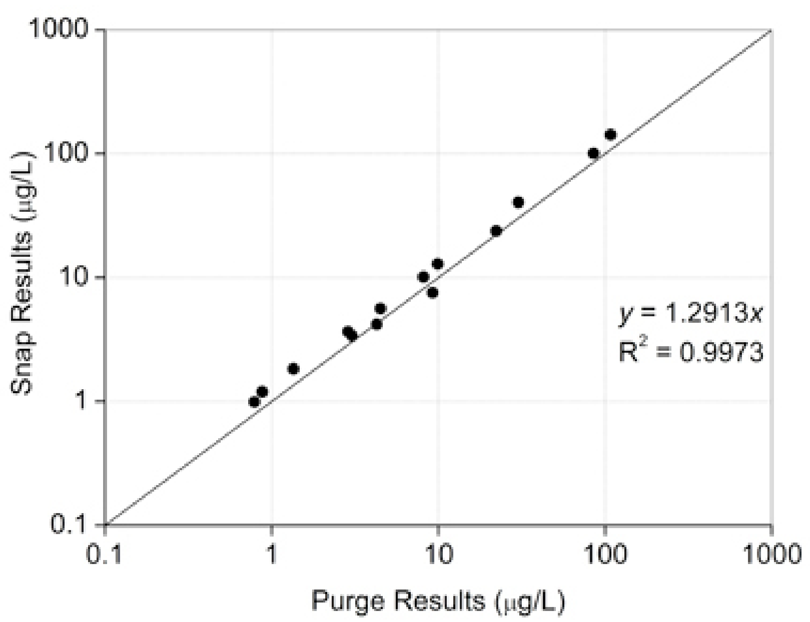


FIGURE 2 Comparative data plot of volatile organic compounds from Morgan Hill site



Groundwater monitoring and sampling are an important part of the hydrogeological study of a contaminated site, and play a key role in the choice of remediation technology. For these to work well, regulatory advice suggests that the well should first be 'purged' – which can be defined as removing a sufficient quantity of stagnant water from the aquifer surrounding the well, before taking samples that are representative of the affected groundwater plume.

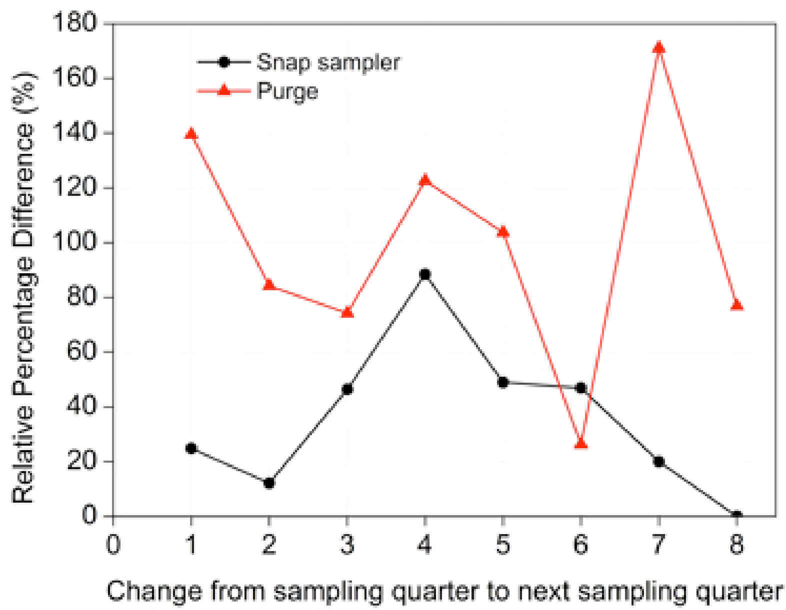
Various techniques exist for obtaining samples which can be classified into two types:

- the uphole or active sampling system where the groundwater is pumped out of well and samples are taken at the surface, and
- the downhole or passive sampling system where samples are obtained from the well at depth in their natural state.

A downhole passive sampling system called 'in-situ sealed' (ISS) has been developed to reduce bias and error in groundwater sampling by reducing the amount of sample handling (Figure 1) (see Britt, SL, Parker, BL & Cherry, JA 2010, 'A downhole passive sampling system to avoid bias and error from groundwater sampling handling', *Environmental Science and Technology*, vol. 44, iss. 13).

They compared the concentration values of contaminants trichloroethylene (TCE), perchloroethylene, dichloroethylene and volatile organic compounds obtained using different traditional groundwater purging techniques, with their technique for various hydrogeological conditions. They observed a strong correlation (R2 = 0.99) between

FIGURE 3 Change in TCE concentration for Los Angeles site for different sampling periods



ISS and various traditional purging techniques for volatile organic contaminants (VOCs) concentrations (Figure 2), and a substantial difference for chlorinated hydrocarbon contaminants (Figure 3).

These investigators explain the bias as being due to exposure to air and sorption by the polymer materials used in the traditional purging methods.

At CRC CARE and CERAR, a research team is investigating whether or not it is necessary to purge groundwater wells in order to obtain representative samples from hydrocarbon contaminated sites in Australia. A purging method has been implemented that combines both low flow and volume purging for groundwater sampling at a hydrocarbon contaminated site. From the initial data, it seems that purging of 0.9 (≈ 1) bore volumes is required to achieve representative samples.

The general recommendation requires remediators to purge three to six bore volumes before collecting representative samples, which from the team's limited work seems excessive. It was observed that the concentration values of contaminants (TCE, VOC) were lower for pre-purging samples than post-purging samples, suggesting that the pre purging samples are not representative. Further work is being carried out to check the relevance of the team's observations to different hydrogeological conditions, as well as different seasons.

Traditional purging techniques involve labour costs and require disposal of the purged contaminated groundwater. In the case of passive sampling, no pumping is required and the materials used are cheaper, and so downhole sampling may prove cheaper and safer than traditional methods. One of the drawbacks of passive sampling is its inability to measure the in-situ hydrogeological parameters such as pH, electrical conductivity and oxygen reduction potential, which are required for selecting the most suitable remediation technology. In conclusion, more information is required for making an accurate comparison between the two methods. ■

Selling contaminated land:

Does silence constitute misleading or deceptive conduct?

Charmian Barton, DLA Phillips Fox (Sydney)

A vendor's silence in relation to contamination may not always constitute misleading or deceptive conduct. The recent NSW Supreme Court decision in *Vitek v Estate Homes Pty Ltd* [2010] NSWSC 237 (Vitek) confirms that silence will be misleading or deceptive only if what was said and the context in which it occurred gives rise to a reasonable expectation of disclosure.

The facts

Mr and Mrs Vitek as vendors, and Estate Homes Pty Ltd as purchaser, entered into a contract for the sale of a commercial property at Redfern, NSW. The contract provided for an extended settlement, with a view to Estate Homes obtaining development consent for the carrying out of certain works on the property for residential purposes.

The vendors used the property as a showroom and workshop for the sale and installation of burglar alarms for motor vehicles. In obtaining development consent for this use, the vendors had obtained a contamination report that identified that the property had been used in the past as a petrol station and that it was possibly contaminated. The report was not provided to the purchaser. The vendors eventually terminated the contract for the purchaser's failure to comply with a notice to complete. The purchaser purported to rescind the contract on the following grounds:

- breach of warranty, in that the planning certificate under section 149 of the *Environmental Planning and Assessment Act 1979* (NSW) (EPAA) annexed to the contract failed to specify the true status of the land in relation to contamination;
- that the vendors, knowing that the land was contaminated, annexed to the contract a section 149 certificate stating that the land was not contaminated and thereby caused and induced the purchaser to enter into the contract, and
- that the vendors' representation constituted misleading or deceptive conduct in contravention of section 42 of the *Fair Trading Act 1987* (NSW).

The vendors commenced proceedings in the NSW Supreme Court, claiming that the purported rescission was a repudiation of the contract and seeking forfeiture of the deposit and damages. The purchasers cross-claimed, seeking a declaration that Estate Homes had validly rescinded the contract and that the vendors had breached the *Fair Trading Act 1987* (NSW), plus damages and consequential relief under that act.

Vendor satisfied statutory obligations of disclosure

In NSW, section 52A of the *Conveyancing Act 1919 (NSW)* requires a vendor to attach certain prescribed documents to the contract for the sale of land. One of these documents is a planning certificate under section 149 of the EPAA. In addition to the requirements to attach a section 149 certificate, the *Conveyancing (Sale of Land) Regulation 2005* (NSW) prescribes a number of warranties that will apply to the sale, including that the section 149 certificate discloses the true status of the land.

The *Contaminated Land Management Act 1997* (NSW) (CLMA) prescribes additional matters that are to be specified in a section 149 planning certificate. These include whether the land is declared significantly contaminated, or is subject to a management order, an approved voluntary management proposal, or a site audit statement. In Vitek, the section 149 certificate stated 'no' against each of the prescribed CLMA matters. However, the certificate also included a note that stated: *Note: Council has adopted by resolution a Development Control Plan (DCP) on contaminated land (adoption date 17/7/00) which may restrict the development of the land. The DCP is implemented when zoning or land use changes are proposed on land which has previously been used for certain purposes or land which has been remediated for specific use. Consideration of Council's adopted DCP and the implications of provisions under relevant State Legislation is warranted.*

Barrett J held that Estate Homes had received from the vendor all

the disclosures and warranties required by the sale of land legislation and, therefore, the vendors had fully discharged their statutory disclosure obligations.

No representations by silence

The purchasers alleged that, by the inclusion of the section 149 certificate in the contract, the vendors had represented (by silence) that the property to the knowledge of the vendors was not actually or potentially contaminated for the purposes of the Council's development control plan. It was also alleged that the vendors were not aware of any matters, facts or circumstances which may have indicated that the property was actually or potentially contaminated.

Essentially, the purchaser was alleging that the section 149 certificate only disclosed part of what the vendors knew about the contamination status of the land and their misleading and deceptive conduct lay in their failure to communicate the balance of their knowledge.

In order to determine if the alleged silence constituted misleading or deceptive conduct, Barrett J considered the context in which the silence was maintained and whether there was a reasonable expectation that disclosure would be made and the silence broken. He found that the vendors knew that the land had in the past been used as a petrol station, and were aware that the land was possibly contaminated. However, Barrett J also found that the purchaser knew about the possible contamination by virtue of its experience in building and property development, its own inquiries of the council, and its receipt from the vendor of all disclosures and warranties required by the sale of land legislation.

Barrett J concluded that the circumstances were not such as to justify any expectation on the part of the purchaser that the vendors would volunteer the limited additional information they had about the potential for contamination obtained from their own investigations and dealings with the local council.

In reaching his decision, Barrett J distinguished the decision of Noor Al Houda Islamic College Pty Ltd v Bankstown Airport Ltd that found that a lessor of contaminated land had engaged in misleading or deceptive conduct under section 52 of the *Trade Practices Act 1974* (Cth). In that case, the lessor failed to disclose to the lessee that the land was contaminated in circumstances where the lessor was aware of the lessee's intention to use the site for a school, and where extensive discussions had occurred between the parties to identify the advantages of the site for the lessee's purposes.

In Vitek, the vendor did not engage in extensive discussions with the purchaser in an endeavour to comprehensively point out the advantages of the site for the purchaser's purposes. On this basis, Barrett J held that there was no conceivable basis on which silence could be actionable under section 42 of the *Fair Trading Act 1987* (NSW), as there was no suggestion that anything should have been volunteered or disclosed in response to some reasonable expectation of the purchaser.

Implications

This decision has consequences for both purchasers and vendors. For purchasers, it demonstrates the importance of comprehensive due diligence pre-exchange. For vendors, it highlights the need to satisfy statutory disclosure obligations in relation to land contamination. But importantly, vendors should be cautious about entering into discussions about the quality and prospective use of land, as incomplete disclosure may form the basis of a claim for misleading or deceptive conduct.

For more information, please contact your DLA Phillips Fox representative, or a member of our Real Estate Practice Group.

Publications Update

The following CRC CARE titles have been published since the last edition of *Remediation Australasia*. The publications may originate from research institutions, regulators or industry groups. Please let us know if you have any appropriate publications (no promotional material) to be included by sending details to **aric@crccare.com**.

NSW vapour guidance

The Department of Environment, Climate Change and Water (DECCW) has recently released its *Vapour Intrusion: Technical Practice Note*. This guidance note is intended to provide guidance to consultants in New South Wales undertaking assessment of contaminated sites where there may be exposure to vapours at sufficient concentrations to pose a chronic health risk. It also provides a policy and regulatory supplement to existing technical guidelines and provides auditors accredited under the *Contaminated Land Management Act 1997* with guidance for audits of vapour intrusion investigations.

CRC CARE Technical Reports

Technical Report no.14: *Contaminant bioavailability and bioaccessibility. Part 1: A scientific and technical review*

This comprehensive review was undertaken as part of recommendation 24 of the National Environmental Protection Measure 5-year statutory review, and provides information relevant to evaluating the bioavailability of contaminants via the incidental soil ingestion pathway.

Technical Report no.10: *Health screening levels for petroleum hydrocarbons in soil and groundwater*

This suite of documents details the development of health screening levels for petroleum hydrocarbons in soil and groundwater for Australian contaminated land assessments. Three parts and a summary have been submitted to the National Environment Protection Council Service Corporation for consideration into the revised National Environment Protection Measures.

Visit **www.crccare.com** to see our full range of Technical Reports.

Research RoundUp

Research RoundUp is an ARIC initiative that will keep you up-to-date with current research on environmental contamination assessment and remediation in Australia. We hope that by keeping the content succinct and by focusing on particular projects we will make it easier for you to find the time to read about areas which are relevant to you.

Using early body responses to contamination as a signal

Arsenic and cadmium are environmental pollutants from both natural and anthropogenic sources, and can cause cancers and chronic diseases in humans. Oxidative stress, a main mechanism of arsenic and cadmium toxicity, occurs when the generation of damaging free radicals exceeds the body's ability to eliminate them. These radicals can damage DNA, proteins and lipids in our bodies and ultimately cause cells to become cancerous.

Research in a CRC CARE funded project at the University of Queensland, has looked at the mammalian protective mechanisms against arsenic and cadmium. In particular, it has examined how two enzyme systems respond to this toxicity. The aims of the project are to understand the mechanism by which the antioxidant bilirubin is regulated during oxidative stress, and to identify bilirubin metabolites (BOMs) that can be used as biomarkers of an early response to arsenic/cadmium toxicity. Studies to date have been able to measure the enzyme response in mice to arsenic exposure, and at the same time, observe that these enzymes appear to protect the liver from damage. ■

Risk-based framework for safe on-site retention of contaminants

Following a review of national and state regulatory frameworks, it has been identified that there is a need for a formal process to determine the precise circumstances under which contamination can be retained on a site at concentrations in excess of published guidelines. At present, different regulatory arrangements apply across Australia for this situation, and generally they do not explicitly provide guidance other than at a broad level.

Particular issues to be addressed include the appropriateness of decisions made by environmental auditors and agencies to determine the acceptability of proposals for on-site retention of contaminants; and the nature of longer-term administrative arrangements for such sites.

This work aims to develop a risk assessment method to assist in determining acceptable approaches to this issue, with selected Australian sites considered as case examples. Case examples included a gasworks park, and gas analysis from a landfill. The analysis included the use of a framework consideration for each site, involving 'boundary, pathway, receptor, impact, likelihood, consequence and risk', with scope to record observations relevant to assigning risk. See Technical Report 16, Safe on-site retention of contaminants Part 1: regulatory approaches and issues - a legal perspective. ■

Adsorbed chemical species on inhalable iron-rich particles

Health guidelines of airborne particulate matter are usually based on the size, quantity and type of substrate, with little or no consideration of organic and/or inorganic species that may be adsorbed on the surface of the particle. Even with this traditional approach, exposure to airborne particulate matter has often been associated with asthma, bronchitis, chronic cough, respiratory illness and lung cancer.

Several published articles, however, have indicated that significant health effects can be attributable to toxic organic compounds adsorbed on other particulate matter apart from those from diesel emissions. It is known, for example, that airborne particles of 50 µm diameter or less can penetrate into the human respiratory system carrying with them adsorbed chemicals. It has also been shown that certain pollutants can become concentrated on airborne particles and consequently alter the surface chemistry of the dust. This collaborative research project involving the Chemistry Centre of WA and the University of Queensland seeks to:

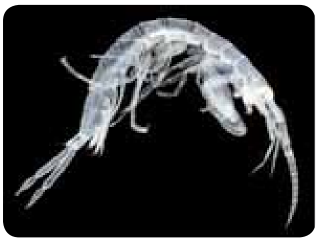
- investigate the cytotoxic potential of particles with certain adsorbed chemicals on the human respiratory system
- identify vulnerable population groups and estimate likely health effects, and
- identify ways in which human health can be protected and/or effects mitigated.

An initial review of the literature on the impact of iron ore dust on community health, and on possible toxic chemical species involved, was carried out in 2009. ■

Assessment and management of groundwater fauna at contaminated sites

The surprising abundance of tiny fauna and microbes in groundwater has been discovered in recent years. This has led to the idea that variation in their form or condition could be used as an indicator of water quality, including the presence and concentration of certain contaminants.

Spending their lives underground, the 'stygofauna' studied in this work have included bacteria, protozoa, fungi and crustaceans. Field sampling also uncovered a number of new, previously undescribed taxa, and DNA-based methods for their identification were explored. Results of this project have suggested that the considerable variability observed in microbial assemblages over time and between bores does indeed translate to differences in sensitivity to toxicants. Furthermore, it appears that the microbes are less responsive to variations in the level of contaminants than larger organisms such as crustacea, which is likely to lessen their value as indicators.



A large variation in samples from the same bore over time also suggests that other factors are at play which will complicate any interpretation of the effect of contaminants. The project report will include a practitioner's guidance document on stygofauna sampling methodologies. Browse **CRC CARE Technical Report 21: Sampling strategies for biological assessment of groundwater ecosystems** at **www.crccare.com**.

Community attitudes to remediation of contaminated sites

The local and broader community has a legitimate interest in how government and public agencies, and industry and commercial stakeholders manage the contamination at sites affecting them, as well as how they plan, manage and undertake the eventual remediation and reuse of these sites. Exploring and understanding the ways in which community members think and feel about the issue is therefore critically important.

However, studies exploring community feelings, perceptions and attitudes to land contamination and its remediation within the Australian context are extremely limited. A research project undertaken by researchers at the University of Technology, Sydney was designed to address this gap, responding to the need expressed by regulators, site managers and other practitioners in the contaminated lands industry for a better understanding of how Australian communities perceive and experience contaminated land and its remediation.

The research focused on two case study sites, both in New South Wales, Australia: the Botany Area, and the North Lake Macquarie Area. Amongst the findings from both locations is that residents rated information from government, remediators and other private companies as less trustworthy than information from community and environmental groups or local councils. Indeed, a (perceived) poor quality and quantity of the information received appears to have amplified levels of distrust. These findings are in line with other international studies. The project was completed in 2010. Browse **CRC CARE Technical Report 17: The Australian experience – A comparative analysis of the effects of contamination and its remediation on individuals and communities at two Australian sites** at **www.crccare.com**.

Evaluation of heavy metal tolerance in grass species

Old mine and mineral processing sites are often contaminated by concentrations of metals such as copper, zinc, cadmium, nickel and lead. Often these metals are present in significant amounts in stockpiles of waste material that need to be spread and revegetated. Research undertaken by the University of Queensland has developed a rapid screening method for a range of pasture species, including native grasses, that clarifies their tolerance to these metals and their ability to take them up.

As part of this research, hyper-accumulating species and other plant species/genotypes differing in resistance to the heavy metals of interest were used to characterise the physiological mechanisms of resistance. The research focused on three tolerance mechanisms: (1) exudation of complexing agents into the rhizosphere, (2) binding of metals in the apoplasm and decreased transport into the cell, and (3) prevention of upward transport of metal ions into above-ground parts, as well as complexation with various ligands in the cell.

It is anticipated that the project outcomes will have direct application in the mining and refining industries, and agriculture. Companies will be able to select appropriate species to use by consulting a dataset describing the sensitivity of grass species used in contaminated land revegetation.

Identifying of mechanisms of tolerance may provide a more rapid screening tool for species of interest, and/or an opportunity for biotechnologists to produce plants more suited for use in phytoremediation. A number of scientific publications have arisen form this work to date, including a practitioner guidance document for the revegetation of land contaminated by metal(loid)s. Browse **CRC CARE Technical Report 20: Guidance document for the revegetation of land contaminated by metal(loids)** at **www.crccare.com**.

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