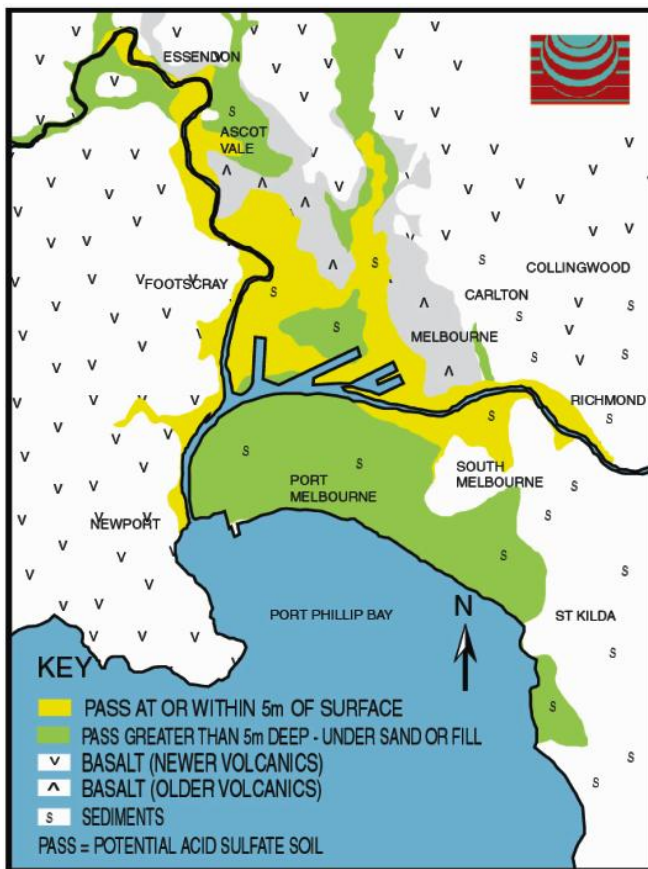


Down to *Earth* Solutions



Welcome to the Autumn 2001 edition of our newsletter. We're keeping you up-to-date on what's happening in our firm, contamination issues, new processes and technologies and the latest legislation.

Acid sulfate soils are potentially widespread



Soils that have the potential to become acid are more widespread than many people imagine. The term potential acid sulfate soils (PASS) refers to soils that have elevated sulfide content, that is, they contain produced sulfur, usually in the form of a sulfur rich mineral (metal sulfide), such as pyrite (FeS_2). A problem arises when these type of soils are exposed to the air resulting in the oxidation of the sulfur and subsequent generation of sulfuric acid resulting in acid sulfate soils (ASS) and or acidified leachate or drainage waters.

The acidic run-off generated from these soils has been observed with pH as low as 2. Acid of this strength can cause corrosion to building materials such as

concrete and steel, and can (indirectly) adversely affect plant and animal life through the mobilisation of heavy metals in soils. Acid in waterways can directly affect the health of marine organisms, for example red spot disease in fish.

In general, industries that encounter this problem are those that produce conditions resulting in acid generation. These conditions may occur when changes to the water table are produced, or in excavation works. As a result, the major industries that encounter acid sulfate soils are mining, agriculture and construction. Regulatory bodies require the monitoring and adequate

management of acid sulfate soils to ensure environmental impacts are minimised or prevented.

In Victoria, potential acid sulfate soils are found in the Yarra Delta of Melbourne and some inner suburbs. Consequently, the construction industry encounters this material relatively frequently. The figure shows the distribution of acid sulfate soils around Melbourne.

Environmental & Earth Sciences has wide experience and expertise in the identification and management of these soils, and are able to provide outcomes that are cost effective and meet the regulatory, environmental and social responsibilities of industry.

Profile – Tracey Bauer

We are pleased to introduce Tracey Bauer, company manager of Environmental & Earth Sciences.



Now a senior engineer, Tracey gained her degree in Geological Engineering from RMIT in Melbourne. Since starting with Environmental & Earth Sciences, she has gained a master in Waste Management from the University of NSW and is currently undertaking business management studies. Tracey has been with Environmental & Earth Sciences for nine of her eleven working years.

As well as managing Sydney office, Tracey works closely with our team of 16 professional staff and numerous administrative, technical and contracting staff and oversees the performance of all branch offices.

In 1999, Tracey was responsible for coordinating the implementation of the company's quality assurance (QA) procedures that were certified under AS/NZ ISO 9001:1994.

Continued on page 3...

You can get the



- ... on all environmental issues, including:
- ✓ contaminated site assessments/remediation
 - ✓ acid sulfate soil studies
 - ✓ soil treatment and disposal
 - ✓ asbestos and hazardous assessments
 - ✓ EPA approved auditor



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Pesky pesticides

Contamination of soil, ground and surface waters by pesticides is a huge environmental issue, and a thorough understanding of chemical and biological properties of pesticides is necessary to assess and solve the mechanism of off-target movement and problems of environmental persistence.

Pesticides with extremely long half-lives, such as DDT (up to 10 years) and other organochlorine pesticides, have been banned in Australia since the early 1970s as the build-up of bio-accumulation has been detected further up the food chain, both in aquatic and terrestrial systems.

The general accepted view within the community is that the faster a pesticide breaks down in the environment, the better that pesticide is,

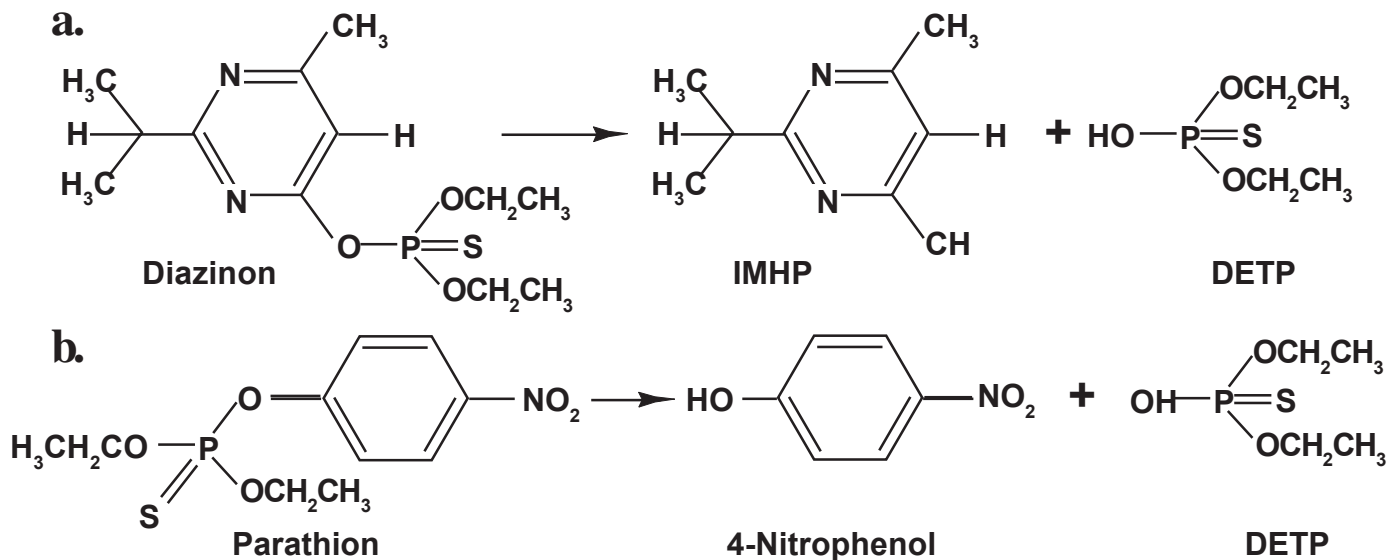
determine. Environmental factors such as soil type, soil water content, pH, temperature, clay, organic matter content and oxygen levels influence the course and rate of pesticide degradation. Molecular factors include chemical structure, molecular weight, functional groups (CH₃, COOH, OH), concentration, toxicity and solubility. Depending on conditions, various processes can occur, including retention (adsorption desorption), transformation (microbial or chemical degradation), volatilisation and transport (overland flow, leaching).

An example relevant to most people is in the use of chlorpyrifos, an organophosphate insecticide which is not only widely used in agriculture, but also under homes. It has a reported half-life

of organochlorine pesticides (OCPs) for the reason they are more readily biodegradable than their more persistent chlorinated counterparts. Under aerobic conditions, concentrations of organophosphate pesticides in soils are often undetectable within a year of application.

Organophosphates are characterised as having the general formula of the type shown in Figure 1. Examples include diazinon, disulfoton, malathion, parathion, chlorpyrifos, trithion, fenthion and phorate. The time for 75-100 per cent degradation of these chemicals is between 7 days and 12 weeks, which is substantially faster than for chlorinated pesticides, for example DDT, which requires four years and chlordane five years to reach the same degree of breakdown.

Breakdown rates of pesticides



however, there is a misconception in this thought process. Most agricultural pesticides must have some level of persistence and stability in the intended environment or host material in order to be effective. For example, if long term weed or insect control is required, it is inappropriate to apply a chemical which will last only one day or until the first shower of rain. Whether a compound lasts in the environment for two days or two years is not an environmental issue unless the compound is no longer required or the compound is capable of moving to another location or environmental compartment.

Another issue is that the prediction of half-life or degradation rates of pesticides involves a complicated interplay of variables, therefore accurate time frames are almost impossible to

in soil varying from less than 10 days to greater than 120 days, depending on the different mechanisms involved in the pesticide degradation process in protected areas such as under buildings or slabs.

The trend now is for the synthesis of new pesticides which have the desired characteristics of sufficient longevity to destroy the pests without remaining persistent in the environment. Also, less halogenated compounds are being produced with the aim of reducing biological factors and initiating the breakdown mechanism, including ultra-violet light and chemical hydrolysis.

Organophosphate pesticides

Organophosphate pesticides (OPPs) have been used extensively in agriculture as replacement chemicals for

relate to reactions that occur in the transformation of individual chemical groups of pesticides. Relatively short-lived pesticides, such as organophosphates, are attacked initially by hydrolysis of the aryl phosphate bond with subsequent ring-cleavage of the benzene ring. One of the main ways this breakdown pattern occurs is through bacterial metabolism, usually by a consortium of microbes rather than a single species. Some of the microbes involved in organophosphate breakdown include *Flavobacterium*, *Bacillus* and *Pseudomonas diminuta*, which can hydrolyse and cleave organophosphates such as diazinon and parathion to form DETP (diethyl thiophosphoric acid).

Malathion is an example of an organophosphate chemical which has a wide range of applications. **Cont. page 3**

Whyalla soil remediation



The remediation pad was constructed from heavy clay, won locally from an aquitard horizon found at a depth of between two and approximately six to seven metres.

Over a period of many years, operation of a steel mill at Whyalla, South Australia by OneSteel (formerly a division of BHP Steel), generated quantities of soil contaminated with heavy oil and fuel. Over 4 000 tonnes of this soil has been stockpiled to date.

Environmental & Earth Sciences has been commissioned to undertake a bioremediation program over the next three years and then on-going, to remediate this soil so that it may be used as inert waste fill or topsoil around the site. This result will be achieved through a combination of landfarming and composting.

The remediation pad area was constructed from heavy clay, won locally from an aquitard horizon found at a depth of between two and approximately six to seven metres. Regional groundwater is confined and encountered below this layer. Over 1 500 tonnes can be treated on the pad at one time, and the first treatment was placed in mid-February. During placement the required proportions of mulch, sand, fertiliser and surfactant were added. Whyalla receives only about 250 mm (10 inches) rain a year and experiences 2.5 m evaporation! Therefore, a program of turning (scarifying) and irrigating has been implemented.

In early April base-line and progress soil samples were collected and chemically analysed to check the nutrient

balance and microbe populations as well as starting and progress contamination levels. Subsequent samples will be collected monthly to track breakdown progress and to facilitate the accurate addition

of soil/microbe ameliorants. It is expected that each treatment will take six to nine months. Before it is landfarmed, the more heavily contaminated soil will be composted in conical piles to create more heat and allow water percolation through the pile.



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Profile—Tracey Bauer continued . . .

Before setting up the New Zealand branch in Auckland in 1997, Tracey worked for Environmental & Earth Sciences all over eastern Australia. She continues to work with councils in rural and urban areas, on reducing waste to landfill and impacts of landfills. This includes providing landfill management plans that incorporate groundwater/surface water/gas/dust monitoring and waste disposal plans.

Tracey also has extensive experience in costing, managing and overseeing remediation projects involving contaminants from timber treatment sites, gas works, former paint manufacturing facilities, petroleum hydrocarbon contaminated sites and large mill, as well as a range of other sites involving pesticide and heavy metal contamination. Her co-ordination and project management skills, combined

Pesky pesticides continued . . .

These include use as an insecticide against sucking and chewing insects and spider mites on vegetables and fruits.

It is effective in field crops, greenhouses, gardens and forests. In soils, malathion undergoes mainly microbial breakdown with degradation in organic-rich soils being up to six times faster than in soils without organic matter. When exposed to air, malathion can undergo volatilisation as well as be degraded by photolytic processes from UV light.

Although generally considered to be more environmentally friendly than their chlorinated counterparts, organophosphate pesticides can still have detrimental effects. Symptoms of human exposure to malathion arise from neurotoxic properties and include headache, nausea, diarrhoea, ataxia, eye and skin irritation. The LD₅₀ limits for malathion, lethal dose to kill 50 per cent of a population, range from 600 ppm for chickens to as little as 100 ppb for rainbow trout.

As organophosphate pesticides will continue to be used in Australia in the foreseeable future, it is important that they are managed effectively to protect the environment. This involves having a thorough understanding of their persistence and breakdown patterns in soils and waters, as well as minimising misuse of these chemicals.

Contact Tracey Bauer on 02 9922 1777 for further information.

with a strong knowledge of earthworks and the environment ensure professional and successful results.

Tracey has broad experience in community liaison and her projects frequently involve working with the relevant authorities. Using her wide experience in environmental planning, she has also completed numerous development applications for a range of clients.

Company occupational health and safety inductions and ensuring that staff and sub-contractors use correct procedures are also Tracey's responsibility. This ensures that all work undertaken complies with the required standards and legislation. In determining required remediation strategies and viable options, she liaises closely with clients and internal project managers to ensure that all objectives of all projects are met professionally and safely.

Ten years after the Act



Observing waterflow over a small weir is part of the hydrogeo-logical study of historical water taking rights in the Northland area of New Zealand.

Resource Management Act in 1991 over-ruled this right but allowed for a grace period of ten years for adjustments to be made. Consequently, many existing rights will expire on 1 October 2001. Holders of the old 'Notice of Existing Use of Water' permits will now have to apply for resource consent for the continuation of water extraction.

The New Zealand Resource Management Act (RMA) came into force on 1 October 1991. The aim of the Act is to promote the sustainable management of New Zealand's natural and physical resources. A key feature of the legal regime established by the Act is the focus it places on the effects of activities rather than upon the activities themselves.

Many activities, such as taking water from streams that drain natural high level forests and produce clean, fresh and good quality water, were prime targets early in the last century for the supply of water for townships and related industries. The design and architecture of some of these water supplies and aqueducts are unique. For example there are weirs constructed in streams deep within steep dipping mountains and hills. The weirs are normally placed at elevations higher than the town's water supply reservoir so that it is able to benefit from gravity feeding. Supply pipelines of ten or more kilometers in length are not unusual.

These historical water extractions were registered at the local authorities as a 'Notice of Existing use of Water' and granted the right to use for an indefinite time, however the introduction of the

Environmental & Earth Sciences Ltd is presently undertaking a number of hydrogeological studies of historical water taking rights in the Northland area of New Zealand. The objectives of these studies are to investigate the catchment yield with respect to the volume of water being taken and include:

- determination of the mean annual rainfall and frequency of occurrence;
- establishment of the catchment hydrogeology and yield;
- estimation of the low flow characteristics of the stream from which water is being taken;
- evaluation of the present volume of water taken in light of the above and the constraints imposed by The Revised Water and Soil Plan for Northland ; and
- provision of documentation summarising the results of the study to be used as supporting evidence with the resource consent application.

The Revised Water and Soil Plan for Northland recognises that, especially in small rivers or streams (with flows less than 300 L/s) in which invertebrates, indigenous or other fish are shown to have a low diversity, a minimum flow

below the point from which the water is taken is to be maintained in order to sustain the aquatic life in the stream. The minimum flow requirements for small streams are defined as the seven day, one in five year low flow (also referred to as the design low flow), which generally represents between 70-84 per cent of the mean annual low flow (MALF).

To accurately determine the design low flow (DMF) value of any stream, detailed gauging information over long periods are required. However very little, if any, stream gauging information is available for some of the historical water takes under investigation. One method of estimating the low flow characteristics of ungauged catchments is by comparative studies with other catchments with similar hydrogeological characteristics and with long term gauged recordings. However, it is not always possible to find a gauged catchment with similar characteristics and low flow estimates have to be made by utilising all geological, hydrogeological, rainfall, published data and comparative studies.

Taking water from some of the streams under investigation results in sporadic non-compliance with the minimum flow requirements.

This occurs during times of very low rainfall and drought conditions. However, the Revised Water and Soil Plan for Northland makes provision for this non-compliance with the minimum flow requirements. It states that lesser minimum flows will be considered *where it can be demonstrated that lesser flows do not result in adverse effects and cumulative adverse environmental effects on the aquatic ecosystems.*

Environmental & Earth Sciences Ltd is working closely with Clunie and Associates who investigate the life supporting capacity of aquatic systems above and below the points where water is taken from a number of streams under investigation.



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soil is the foundation of life