Down to *Earth* Solutions

Welcome to the Winter 2002 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.

OH&S considerations

Shoring to protect collapse of excavations into Coode Island silt and sandy soils—more pictures on page 3.

Environmental & Earth Sciences has undertaken a number of large soil and groundwater remediation jobs along the east coast of Australia and in New Zealand involving tank removals, excavation and bioremediation of solvent, oxidising agents and hydrocarbon contamination. All of these jobs required stringent OH&S and environmental controls due to sensitive neighbours, close proximity to beneficial uses such as waterways, site activities, legislation requirements and, of course, to protect our environment.

Safety measures and environmental controls we use include the following:

— site safety inductions;
— appropriate personal protection;
— job safety analysis and risk assessments;
— traffic management plans;
— extensive OH&S signage;
— barricading and fencing around open excavations;
— breathing apparatus;
— trained first aiders on site;
— fire extinguishers, fire blanket and first aid kit;
— sedimentation controls using bidum filter socks—which also absorb any hydrocarbons as well as preventing silt moving offsite—hay bales or sediment fencing;
— dust control using burlap sheeting, hessian or shade cloth;
— shoring to protect collapse of excavations in unstable soils;
— odour controls using substances such as Anotec odour suppressant and natural surfacants.

Queensland office now open

General Manager, Environmental & Earth Sciences, Tracey Bauer opened the Queensland office in Brisbane on 1 July 2002.

Tracey is a senior geological engineer who has been with the company for 10 years and will head the Queensland operation, which is already undertaking a number of environmental assessment and remediation projects.

Environmental & Earth Sciences, is also active on a number of environmental issues, having participated in the founding meetings of ACLCA, Queensland, and working together with several consultants on a sub-committee to provide input to potential changes in legislation which the Queensland EPA is currently assessing.

The Queensland branch of ACLCA will have its first AGM in September 2002.

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Remember
to check our internet site at:
www.groundscience.com
for updated information and
employment opportunities.

Profile – Johan Faurie

After working for twenty five years in South Africa, Johan emigrated to New Zealand in 1995. He has a BSc (Hons) degree in geology with applied geophysics and a MSc degree in geology from the University of Pretoria. Johan joined our Auckland office in 1999 and became manager in 2001.

Before emigrating to New Zealand, Johan was involved in the environmental aspects of a radioactive waste management program for the storage and disposal of radioactive waste in South Africa.

In New Zealand Johan has carried out several landfill investigations ranging from leachate and ground-water quality studies to the assessment of the environmental affects of historic and recently closed landfills. He has a practical knowledge of environmental policies and contaminated site issues, including due diligence audits, environmental audits, assessment criteria. asbestos in soil surveys and reporting and has also managed a number of hydrogeological projects.

Contact Johan at Environmental & Earth Sciences in Auckland on: 64-9-476 4483, or email on: eesnz@xtra.co.nz

Cap and capture vs cap and contain

Inserting a sump during the construction of a cut-off trench to prevent contamination from an old gas works from reaching a river.

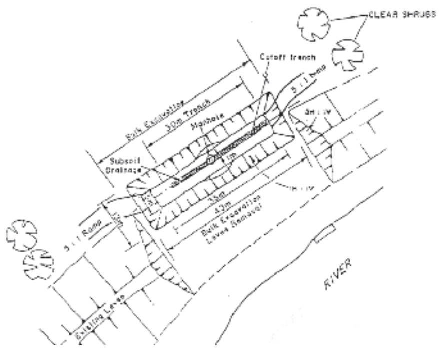
One form of remediation, particularly for compounds that are hard to degrade in low permeable terrain, is to isolate the contamination on site. The normal engineering approach is to isolate the contamination by building a cap or cover to prohibit access from above and to contain the contamination from the sides to prevent leachate leaving the site or water travelling through the contamination. This highly engineered remediation strategy is known as 'cap and contain'. Natural and artificial liners are used for the cap and bentonite slurry walls, often with HDPE liners as well, are used as the cut-off walls. The walls are normally bedded into an underlying low permeability barrier such as rock or clay which prevents contamination migrating offsite and groundwater migrating onto site through the contamination.

Often there is no suitable layer occurring beneath the site and a more extreme method of isolation for full containment is required. This involves preparation of a special cell that completely encapsulates the waste. The liner and walls are constructed using HDPE liner and clay into which the waste is placed and then a cap is used to seal off the waste. A leachate collection system is sometimes added as an extra precaution.

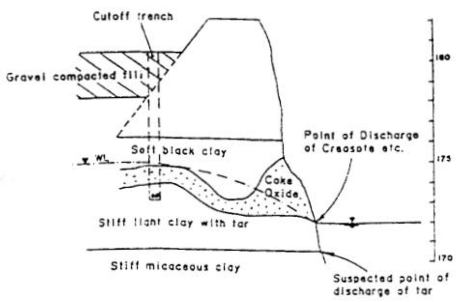
These highly engineered solutions have many limitations, the greatest of all being cost. Other limitations include the requirement for substantial ongoing groundwater controls. These include depressurisation, collection and disposal, and substantial ongoing monitoring of the surrounding area to confirm that the containment is working.

Environmental & Earth Sciences has developed a different strategy—known as 'cap and capture'—for situations when containment is required. Where possible, we try to ensure that the cap will be a concrete floor of a building or bitumen pavement of a car park or tennis courts. This results in a low groundwater recharge so that we are able to construct a cut-off trench to intercept horizontal flow. The cut-off trench is designed to recover water and liquids both more or less dense than water and is lined with a geofabric and backfilled with gravel so that the groundwater is able to drain. A number of collection sumps are sufficiently spaced to ensure that the trench at the midpoint between the sumps has a water level at least 0.1 m lower than the downgradient monitoring bore. This ensures that the gradient is reversed and no groundwater is able to leave the site. The collected leachate is treated and either disposed to sewer, taken offsite in a tanker or reinjected.

Although the cap and capture system can only be used when there is a confining layer within 15 m of the surface and the groundwater make is low, it is ideal for gas works sites and is substantially cheaper than the more frequently used, highly engineered cap and contain option.



Above: *Plan of cut-off trench excavation and installation.* Below: *detailed profile of cut-off trench.*



Zinc—the 30th element

Zinc is the 30th element in the periodic table and is classified, along with a number of other chemicals such as lead, copper and mercury, as the heavy metal group. It is a naturally occurring substance that, apart from occurring in ore bodies, can occur in significant concentrations in natural soils—such as black shales where up to 1 500 mg/kg is commonly recorded.

In addition to a number of common uses as an ingredient of alloys (including bronze and brass), as a protective coating to prevent corrosion and in a multitude of building materials, it is also an essential trace element for biota to facilitate metabolic functions. Because of its role as an essential trace element, insufficient intake (deficiency) or ingestion at greater than recommended tolerable intakes (toxicity) can present unacceptable risks to environmental receptors.

The NSW EPA generally requires for most environmental site assessments that both human health and environmental exposure to chemicals of concern are addressed in assessing the suitability of a site for its intended use. In the case of zinc, there is a significant difference between the human health based investigation levels (HHBILs) of 7 000 mg/kg for the most sensitive land use scenario, and the provisional phytotoxicity based investigation levels (PPBILs) of 200 mg/kg. Because of this PPBIL, relatively low concentrations of zinc in soils with respect to human health risk often require detailed explanations as to why the same concentrations do not pose an unacceptable phytotoxic risk.

A number of physicochemical factors such as the soil type and pH need to be taken into account in assessing phytotoxicity. Therefore, potential impacts in terms of phytotoxicity are assessed on a site-specific basis. The provisional phytotoxicity based investigation levels are derived from the values supplied in ANZECC (1992)—*Australian and New Zealand guidelines for the assessment and management of contaminated sites*. These criteria, although widely adopted, are based on total metal concentrations in the soil, which bears little relevance to the protection of either groundwater or plant and soil fauna. It is also acknowledged in ANZECC that for an urban setting, the levels are "somewhat arbitrary".

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Soil contamination from horticultural activities—NZ

Contamination of soil from past horticultural activities in the Auckland Region (with reference to acceptable copper levels in soils).

Background

The contamination of soils from past horticultural activities (mainly vineyard and orchard farming) in the Auckland region came under the spotlight recently when a study undertaken by the Auckland Regional Council (ARC) indicated that approximately 4000 to 6000 hectares of land in the Auckland area are potentially contaminated. The organochlorine pesticides DDT and dieldrin were the main contaminants detected on properties developed prior to 1975, whilst copper (contained in various fungicides, algaecides etc) was the main contaminant of concern on properties developed after 1975. The report recommended (amongst other) that territorial local authorities require a contaminated site assessment prior to allowing a change in land use, subdivision or redevelopment of a greenfield site. Some local authorities have now adopted this recommendation.

The Henderson area in West Auckland has been intensively used for horticultural farming activities in the past. As the city boundaries have expanded many of these properties are now being redeveloped and historic farmland is now being subdivided into residential blocks varying in size from 700 m^2 (in the urban area) to one or more hectares (rural lifestyle) in area.

Over the last few years Environmental & Earth Sciences Ltd has been involved in the review of many contaminated site assessment reports from this area and it was noted that copper was by far the most consistent contaminant encountered in almost all site investigations. Soils in the Henderson area consist mainly of silty sandstones from the Waitemata Group as well as pumiceous mudstones of the Tauranga Group. A study by the ARC found that the background levels of copper in soil from the Auckland region to be in the range of 1—45 mg/kg for soils derived from non-volcanic rocks and 20—90 mg/kg for soils overlaying volcanic material. Copper concentrations on former horticultural sites in the Waitakere City Council area have been detected at concentrations between 20 and 500 mg/kg (and more in isolated cases) in soils. It should be noted though that these elevated copper concentrations have been detected in the top 10 to 15 centimetres of soil and that copper concentrations in soil below these depths are generally at background levels.

Relevant guidelines

The New Zealand Ministry for the Environment is currently in the process of developing a guideline for the hierarchy and application of environmental acceptance criteria in New Zealand. This document should be available soon and will give guidance to consultants and Councils (Regional and Territorial) regarding acceptance criteria when conducting contaminated site investigations. Although this guideline is currently in the development phase, first tier guidance documents have been established that derive risk-based acceptance criteria for a number of contaminants specific to certain industries.

One such guideline, that addresses copper amongst other elements and compounds, is the *Health and Environmental Guidelines for Selected Timber Treatment Chemicals in New Zealand* published by the Ministry for the Environment in 1997. This document also forms the source document for the Auckland Regional Council's *Soil Sampling Protocol for Horticultural Sites – Preliminary Draft 1*. This guideline derives investigation levels for copper in soil based on the type of land use as follows;

— 40 mg Cu/kg for agricultural use;
— 80 and 390 mg Cu/kg for residential use based on a consumption of 50% and 10% home grown produce respectively;
— 130 mg Cu/kg as a 'protection of plant life' level.

Based on these values the ARC has recommended that a value of 80 mg/kg of copper in soil be accepted as a *trigger level for further investigations* on all sites.

Councils' responsibility

Apart from their judicial duty, Councils also have a 'duty of care' to ensure that no decisions result in a negative impact on public health or have an adverse effect on the environment.

Councils, in making decisions, are not liable for that decision if the decision is taken in 'good faith'. 'Good faith' is demonstrated by conforming to national and international guidelines authorised by the appropriate authorities, like Regional Councils, the Ministry for the Environment and the Australian and New Zealand Environment and Conservation Council. Thus the City and District Councils within the Auckland region and rest of New Zealand should recognize the recommended value of 80 mg/kg of copper in soil as a trigger level for further investigations, however conservative it might be, until there are changes in either regional or national guidelines, or unless it can be scientifically proven that this level is not appropriate for a particular site.

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More OH&S consideration pictures . . . from page 1

Off-site sedimentation control using bidum filter socks or hay bales.

Barricading and fencing around open excavations.

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Guidelines and pitfalls

There is a huge variation in acceptable copper levels in soil between different guidelines, both nationally and international. The range varies from 63 mg/kg (Canadian Soil Quality Guidelines) to 4 000 mg/kg (National Environmental Protection Council 1999 - residential with minimum soil access (Australia)). This large range is a result of different land use or zonings of sites, however, a number of uncertainties in the calculation of these guideline values also contribute towards some discrepancies and also in some of the conservative values quoted in some guidelines.

Some of these uncertainties are listed below:

— the uncertainty in the measure of the bioavailability of copper;
— varying estimates for a reasonable 'daily intake value';
— variations in soil types, structure and pH;
— soil guidelines have been developed on the basis of absolute worst case exposure scenario rather than reasonable maximum exposure;
— guidelines multiply conservative factors; and
— assumptions that 90 % of the average daily intake of copper is from other sources leaving only 10 % from soil.

Based on the ARC guidelines nearly all the current horticulture areas are unsuitable for agricultural activities and at least a half are unsuitable for lifestyle blocks. Yet these areas produce the food consumed by New Zealand.

Conclusions

In the current environment of increasing litigation, Councils are finding themselves in an increasingly difficult situation. On the one hand they have land owners and developers who are developing "lifestyle" blocks and who argue that current guidelines are unreasonably conservative and pressure Councils to approve sites that, according to current guidelines, are unfit for residential use. On the other hand, if that approval is given, then Councils become vulnerable to legal action. The only way for Councils to avoid legal action is to demonstrate "good faith" by following the approved guidelines as described earlier. The ANZECC MFE and NEPM all set out a similar procedure. Essentially a statistical mean or medium is compared with a threshold level and if this level is exceeded a risk assessment or clean up is required. The risk assessment is used to demonstrate at what level the site is safe for the proposed use. Whilst the threshold levels are unnecessarily conservative, until they are raised, exceedence of the levels require a risk assessment to be undertaken prior to council approval of the development.

Until there are changes in the national and regional guidelines or approved adjustments to the existing levels at which soil is considered to pose a health risk to residents, Councils are obliged to accept the current guideline trigger or investigation levels, including the 80 mg/kg for copper in soil. However the *Health and Environmental Guidelines for Selected Timber Treatment Chemicals in New Zealand* clearly states that its acceptance criteria were derived from specific exposure scenarios and that *scope exists for different acceptance criteria to be developed on a site-specific basis*. A similar risk assessment is therefore recommended but taking into consideration the characteristics of the local soil types, background copper levels and exposure conditions. The latter seems to be the only way to obtain meaningful acceptance levels that will put an end to the current confusion caused by the wide range of acceptable levels for copper (amongst others) in soils as quoted in the various national and international guidelines.

The Auckland Regional Council is currently conducting trails on vertical mixing of soils in the Henderson area as a method of remediating large areas with elevated copper (or other elements) in the top layer of soil. From a soil management perspective, this is less desirable than undertaking a risk assessment.

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Zinc—the 30th element

Given this qualification, factors which need to be evaluated in assessing the relevance of zinc soil concentrations with respect to phytotoxicity include:

— heavy metals are generally taken up by plants in the pore water and the pH of the soil is considered to be the most important factor that influences metal concentrations in pore water. At a soil pH of 6.5 to 7.5, the solubility of zinc is extremely low, which indicates that its bioavailability to plants is not significant;
— not all soluble metal is bioavailable and ligands such as hydroxides, silicates and phosphates can further reduce the amount of metal that is bioavailable;
— soils with high iron and manganese oxide content—such as the weathered soil horizons found in the Sydney region—tend to store, rather than liberate metals to pore water;
— the bedrock geology of the area. Shales such as those found in the Sydney region are known to contain elevated heavy metal concentrations. Owing to the low solubility of the majority of heavy metals, the weathered horizon of such material can be enriched with metals such as zinc.

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