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Contaminated Sites

Environment Australia, 1999
Best Practice Environmental Management in Mining
ISBN 0 642 546460

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Case Study 1

SANTOS LIMITED (QLD, NT AND SA)
Environmental Auditing and Management Systems

Introduction

SANTOS Limited explores for and extracts natural gas and oil in Queensland, Northern Territory and South Australia. Loss of oil is recognised as one cause of potential land contamination. Preventing loss has been a major focus at the business and Santos has a long-term objective of achieving zero oil loss. An 'Oil Stream Process' audit, covering a number of operations (from well sites to point of sale), has been used to identify:

- potential areas of oil loss (high, medium and low risk); and
- approaches to planning, design, handling and management of oil operations to minimise oil loss.

The audit is one part of the management strategy to minimise and mitigate oil losses outlined in the Santos Australia Environmental Management System.

The audit identified procedural and technical areas for potential oil loss. Legislation and other regulatory and non regulatory requirements (e.g. design codes) requiring Company compliance were identified, and existing Santos documentation was reviewed.

Sources of potential oil loss include deficiencies and failures in design and operation. The losses are generally minor and of little environmental significance, but can be numerous. Oil loss through system failures is less common, but if they occur the oil loss may be significant.

Management Systems

The Company has developed a Santos Australian Environmental Management System (SAEMS). An aim of SAEMS is to minimise and mitigate oil losses and resulting effects on land. Strategies developed to achieve this include:

— monitoring, analysing and reporting (to the Environmental Committee of the Board) environmental incidents. By reporting these events, Santos has determined the significance of oil losses, and the consequent environmental and legal implications. In addition, the reporting process provides valuable data for future planning;

— environmental auditing (including the 'Oil Stream Process Audit');

— Environmental Compliance Manuals which outline the legal obligations of Santos, list legislation relevant to the operations in each State and provide an interpretation of the legislation as it may be applied to Santos' operations;

— Codes of Environmental Practice and Procedures. SAEMS also provides for the review of equipment and operational and maintenance procedures; and

— education on oil loss minimisation and other environmental issues, including Environmental Inductions for field staff.

Oil Stream Process Audit

Several aspects of Santos' operations were reviewed as part of the Oil Stream Process Audit, from the well head to the oil storage and processing facilities. The results from the audit were used in two ways: to identify and prevent potential oil loss, and to identify and minimise the impact from existing oil losses.

Potential losses

Potential losses from pipelines, trunklines and flowlines have been identified in the audit as a high priority for action. Although losses are rare, the potential exists for significant oil releases. Lines are located both above and below ground, and detecting oil loss using metering systems can be difficult. The audit identified steps that Santos can take to minimise risk of oil loss through line failure. These include recording the condition and life expectancy of the various lines, with information on the pipe and environmental conditions to which it is exposed (e.g. soil acidity), and developing a subsequent maintenance program.

PHOTO: SANTOS LIMITED

Feed to Tirrawarra line, Meranjin Field, South Australia.

Minimising land contamination

The audit was also used to identify changes as required to minimise land contamination arising from oil loss. The review of oily waste generation and disposal at a number of facilities is an example. The audit identified areas of potential soil contamination from past disposal of oily sludge from storage tanks, process sumps and drains. Wastes had been placed in slop pits, which were identified as potential contaminated sites. A decommissioning and rehabilitation program for these pits is now underway, including the remediation of several sites by landfarming.

PHOTO: SANTOS LIMITED

Moomba facility, South Australia. A new oil interceptor pond to collect stormwater from floating roof hydrocarbon tanks.

PHOTO: SANTOS LIMITED

Santos is committed to maintaining emergency and safety equipment such as this fire alarm and extinguisher in top condition at all their facilities.

Education

Santos' oil spill risk minimisation program has created an internal climate that places high priority on zero oil loss. Santos has achieved a high level of environmental awareness in its employees, recognising the need to adhere to the relevant guidelines and legislation in each State. It is expected that the awareness of environmental issues will assist in reducing operational oil loss incidents.

Conclusion

The Santos audit and the oil spill risk minimisation program is part of a continuing program of environmental improvement being undertaken by the Company, involving:

- identifying potential oil spill sources and reducing the volume of oil lost;
- identifying areas of contaminated land to implement management or remediation; and
- responding to regulatory change.

The program exemplifies a best practice approach to the management of contaminated land. These strategies include reviewing processes and systems to identify and reduce potential sources, identifying and managing existing contamination, and education to assist in avoiding future losses. These strategies are incorporated in the overall environmental management system under which Santos operates, ensuring the appropriate allocation of responsibilities and actions.

PHOTO: SANTOS LIMITED

Jackson Tintaburra facility. Note bunding around storage tanks to contain any accidental spills and minimise contamination.

Case Study 2

RED DOME GOLD MINE, QUEENSLAND
Incentives to Avoid Site Contamination

The Red Dome Mine was an operational gold and copper mine until 1998 and is near Chillagoe, 135km west of Cairns in far north Queensland. Part of its operations to avoid contamination included washing and neutralising drums used on the site. An incentive scheme to promote this cleanup demonstrates a proactive commitment by the company to encourage workers to adopt an environmentally-responsible mindset.

All empty drums on site were pressure washed. Reagent drums were washed within the plant, and lubricant drums cleaned on a workshop washdown pad fitted with an oil-water separator. Fuel and heat exchanger fluid drums were returned to the supplier or sent offsite for disposal.

All washed drums were then stored in a compacted soil (60cm) area, surrounded by a clay bund, until being collected by a local drum reconditioning company.

The incentive for staff was the transfer of proceeds from the sale of cleaned drums to the social club and local charities. Meeting the company's environment targets directly benefited the environment, the company, the workers and needy local groups. The scheme emphasised company training to help staff understand the importance of environmental systems. This included the need to protect clean water sources and the environment and minimise effluent streams as 'part of the overall job', rather than as an afterthought.

Benefits

- Cleanup and closure costs were reduced by staff adopting a proactive approach during mining.
- The number and extent of environmental incidents fell noticeably after staff had been trained in environmental awareness. Training also reduced environmental damage and operational costs.
- Staff focussed on avoiding clean-up incidents during production, with consequent boosts to worker morale and demonstrated environmental performance.
- Because of the new outlook adopted by workers labour resources were more cost-effectively used in mining as processing activity wound down. Workers were fully occupied until their last days on the job, as they understood the project was not complete until the cleanup was finalised.
- Closure was easier as known problem areas were cleaned up *during* processing operations and the impact of dirty water minimised. The location of incidents, and their nature, were well remembered — not left until long after the incident and the departure of workers.

PHOTO: NIUGINI MINING (AUSTRALASIA) PTY LIMITED

A used drum storage compound for containing drums prior to recycling or reconditioning.

Case Study 3

ARDEER LEAD SMELTER, VICTORIA
Lead Contamination of Residential Properties

Introduction

A property at Forrest Street, Ardeer was used for lead smelting and battery recycling, from the 1950s to 1983. Activities at the smelter included breaking old car batteries and re-smelting their lead plates. After decommissioning, the site was redeveloped for low density housing. In 1989, after houses were built on part of the site, contaminants were detected. The primary contaminant was lead but arsenic, cadmium and zinc were also identified.

Various companies who had been involved with the site formed a Joint Management Committee (JMC) to deal with the contamination. The JMC worked with the Environment Protection Authority of Victoria (EPA Vic) and Brimbank City Council to develop a strategy for managing the site.

Investigations

During 1989 EPA Vic investigated the degree of contamination by taking 100 targeted samples across the 1.6 ha site. This investigation showed high lead concentrations. Because of this contamination, families living on the site were relocated, new houses on the site demolished, and adjacent houses affected by the contamination cleaned.

By installing groundwater wells it was shown that contamination was restricted to the surface soils, and groundwater was not contaminated.

Samples were initially taken using hand augers and a drilling rig. Subsequently, more detailed investigations for the JMC used test pits. The contamination was found to be associated with fill, and this enabled suspect material to be identified visually. More contamination was identified during remediation, when structures such as concrete footings and pipes were discovered. After remediation, residual soil was sampled and analysed to prove that the clean-up had been complete.

PHOTO: CARTER HOLT HARVEY

Remediation underway (March 1997) at the Ardeer site which was used for lead smelting and battery recycling during the 1950s to 1983.

Remediation Options

A review of site history and additional fieldwork for the JMC confirmed the preliminary findings by the EPA Vic and helped develop a suitable remediation strategy. Remediation options included excavation and disposal at an off-site landfill, excavation and transportation of the soils to a smelter to recover the lead, and containment onsite. Options for future landuse included residential and parkland.

In developing the remedial strategy, the JMC engaged a remediation consultant. The consultant worked with an environmental auditor appointed by the JMC to determine the most appropriate clean-up criteria for the landuse options.

The removal of contaminated soils—with pretreatment as necessary—to landfill was selected as the best remediation option for developing the site as parkland. A conceptual statistical model was used to estimate the volume of soil to be excavated and treated. Lead and the other metals identified in the preliminary assessment were considered in the model. The output from the model indicated an average excavation depth of 0.5 m would be required to meet the nominated remediation criteria.

The remediation criteria for the site was derived from a semi-quantitative risk assessment, based on the site being used as parkland by the local council. A 95% upper confidence limit (UCL) of 2100 mg/kg for lead was proposed to avoid possible effects on the health of people using the site. To minimise risk from remaining contaminants, and effects on plants, a clay cap of 0.5 m was also proposed.

Remediation included sampling soil using a grid program. This determined the depth of excavation, and which soils would need to be treated before being removed. Soils that required pretreatment were stabilised using various additives, and then tested to confirm those requirements for leachability were met.

The contamination was found to be generally restricted to a shallow surface layer of fill (about 0.5m), and removing the fill resulted in the bulk of the contamination being eliminated. After remediation, validation testing showed that most of the site complied with residential use criteria, with the 95% UCL for the mean lead concentration being less than 300 mg/kg. After validation, a plastic warning barrier was placed at the base of the excavation and covered with clean fill and top soil. A site management plan was prepared to assist the city council with its future management of the site.

The auditor compiled an audit report confirming the land was suitable for its proposed use as a community park, and issued a Statement of Environmental Audit to this effect.

PHOTO: CARTER HOLT HARVEY

Ardeer site March 1989. The EPAVic investigation showed high lead concentrations at the site. Note the need for fencing and signage to restrict public access and warn of danger.

Stakeholders

There were various stakeholders associated with the remediation of the site, including: the former owners/operators of the site, the Victorian government, regulatory agencies, the local council, residents (onsite and offsite) and the local community. Liaison with these groups began before remediation work started, and continued throughout the process.

Conclusion

Past activities at the Ardeer site had resulted in significant lead contamination, which was only identified after the site had been developed for residential use. The contamination was found to be largely restricted to the surface soils, and remediation required excavating, pretreating where necessary, and disposing of contaminated material to a landfill. The site was then capped to minimise residual risk to future users of the site. A high level of cleanup was achieved. The cleanup was subject to review by an auditor, who confirmed that the land was suitable to be used as parkland.

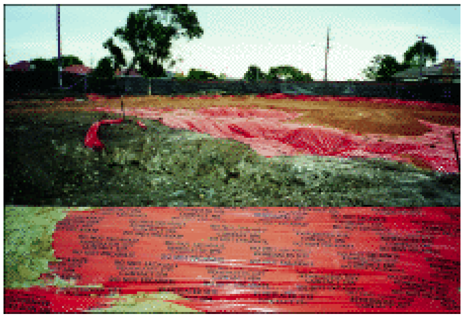

PHOTO: CARTER HOLT HARVEY

Contamination at the site was generally restricted to a shallow surface layer and removal of this layer eliminated the bulk of the contamination.

Case Study 4

EAST PERTH GASWORKS, WESTERN AUSTRALIA
Innovative Site management Strategy

The former East Perth Gasworks manufactured gas from 1922 until 1971 and was heavily contaminated by gasworks waste. The 4.6ha site includes 300m of Swan River foreshore, part of Perth's main river (see photos). Remediation, started in late 1994 and finished in early 1996, cost $15 million.

The gasworks site is owned by the City of Perth and was part of a major urban renewal program by the East Perth Redevelopment Authority. It was one of the first large-scale remediation projects at a gasworks site in Australia.

The project included:

- investigating site soils and groundwater;
- preparing an environmental impact statement;
- consulting the public;
- a risk assessment study; and
- implementing a multicomponent remediation strategy.

The project shows how a risk-based remediation approach can achieve a cost-effective solution to a significant contaminated site problem. It demonstrates:

- the innovative use of bioremediation for treating contaminated soils;
- conventional excavation; and
- offsite disposal of contaminated material (river sediments) for safe onsite containment of more highly contaminated material at depth on the site.
- offsite disposal of contaminated river sediments so these are safely contained at depth on a new site.

All these strategies can apply to contaminated mine sites.

Contaminants onsite

Leaks and inadequate disposal of by-products from the gasworks had contaminated the site. By-products included ammoniacal liquors, coal tars and both phenolic compounds and spent oxides.

Significant concentrations of polycyclic aromatic hydrocarbons (PAHs) from coal tars were found in the soil. Other contaminants were also detected in the soils, and, where significant, coincided with high PAHs concentrations. The cheapest way to clean up was to target the PAHs. Elevated PAH concentrations, petroleum hydrocarbons, ammonia and phenolic compounds were detected in groundwater. Sediments in the adjacent Swan River were also contaminated.

Risk Assessment

A risk assessment helped determine the acceptance criteria. The five sets of criteria in the following table were developed (in some cases these varied with the depth of the contamination):

TABLE 1: Soil Categories

Soil Class	Designated Use	Criteria
Class A	suitable for any use	background levels
Class B	suitable for residential land-use	residential criteria
Class D	suitable for public open space	public open space
Class E	to local, secure landfill	200 mg/kg total PAHs
Class F	to distant, hazardous landfill	Greater than 200 mg/kg total PAHs

Note: Class C was rubble

These criteria then helped determine which soils required treatment, disposal or safe containment at depth.

Remedial Works

Using a 25 by 25m sample grid, soils were classified at 1m depth intervals. Based on preliminary investigation results, the soils were classified against the acceptance criteria above by using visual evidence (staining) and some confirmatory analyses.

Remediation options

Various remediation options were considered, including:

- containment;
- excavation and landfill disposal;
- bioremediation;
- soil washing;
- thermal desorption; and
- processing in a cement kiln.

Strategy adopted

The adopted remediation strategy included:

- installing a groundwater drain above the site to intercept and divert groundwater, sending it around the site to the Swan River. This reduced water flow through the site and therefore reduced the discharge of contaminated groundwater to the Swan River;
- dredging contaminated sediments from the Swan River and, after dewatering them, placing them onsite (criteria for river sediments much lower than for soils);
- excavating all contaminated soil from elevated site areas planned for high value residential use, and contaminated soil down to the groundwater table from areas planned as parkland;
- placing some low level contaminated soils on the lower area of the site and capping it using dredged sediments and some fresh soil. The capping (containment) was designed to prevent contact with the underlying contaminated soil and minimise groundwater recharge;
- disposal of low to moderate level contaminated soil to a nearby secure landfill; and
- bioremediation (landfarming) of highly contaminated soil (1500mg/kg total PAH) to make it suitable for landfill disposal (200mg/kg total PAH).

Thermal desorption was assessed as uneconomic. Treating wastes in a cement kiln was also evaluated, but dropped following community concern.

Site remediation under a stringent quality control program ensured all soil was handled correctly. The system tracked soil movements to ensure they were disposed at the intended destination, either at landfill or at depth onsite.

PHOTO: EGIS CONSULTING AUSTRALIA

A silt curtain is used to contain suspended sediments when dredging contaminated sediments.

Bioremediation (landfarming) process

As part of the 25 x 25m grid pattern described above, soils were divided into 525m^3 blocks and five categories. Class E soils (200mg/kg total PAHs) and Class F soils (greater than 200mg/kg total PAHs) would require secure/hazardous landfill.

Disposing of 8000cu.m of class F soils in an isolated intractable waste disposal facility (600km east of Perth) was then $160 / tonne, so alternatives were investigated, including bioremediation. Bioremediation was trialled using 1500 tonnes of Class E soil. Tests reported that bacterial populations did degrade PAHs in the soil.

Tests checked the performance of three soil batches which used nutrient addition and turning of the soils, and nutrient addition only. Over three weeks, average total PAH concentrations dropped from 900mg/kg to well under 200mg/kg. Soils were kept moist (daytime temperatures regularly exceeded 30‰C).

Consequently, Class F soils were treated using bioremediation/landfarming. Tests showed marked falls in PAH levels with frequent turning and nutrient addition. Turning soils had an even greater effect upon degradation than nutrient addition. The conclusion was that bioremediation was viable and its impact could be maximised.

The remaining soil was bioremediated in three batches. Class E soils had average total PAH levels of 900mg/kg and these concentrations fell to well below the landfill criteria of 200mg/kg within three weeks. Bacterial population checks showed these bacteria had increased during the bioremediation, suggesting bacteria helped reduce total PAH concentrations. The treated Class F soils were disposed of in a nearby landfill ($65/tonne), instead of being transported long distances at significant cost and placed in a specialised intractable waste disposal facility.

PHOTO: EGIS CONSULTING AUSTRALIA

Trucks leaving the site have a tarpaulin cover to prevent contaminated soils becoming airborne and are subject to wheel washing.

PHOTO: EGIS CONSULTING AUSTRALIA

Extensive excavation of contaminated soils at the East Perth Gasworks site included 300 metres of the Swan River foreshore.

PHOTO: EGIS CONSULTING AUSTRALIA

Excavating contaminated sediments from the Swan River with sediment curtain in the background.

Stakeholders and Approvals

Key stakeholders in this project include:

- East Perth Redevelopment Authority and the City of Perth (responsible for site edevelopment);
- Environment Protection Authority and other government departments;
- the local community; and
- Cement Kiln operators and the surrounding community (local community objections meant the option of treating soil in a cement kiln was not pursued).

As the project was formally assessed under the Environmental Protection Act 1986, an environmental impact statement (EIS) was prepared and sent to the stakeholders, in this case the public and relevant government authorities. The EIS was prepared in conjunction with environmental management plans to remediate the Swan River, the site and determine the proposed containment strategy for residual contamination.

Conclusion

The East Perth Gasworks Remediation Project was one of the largest of its kind in Australia, and demonstrates a range of cost-effective remedial approaches to protect human health and the environment. A risk assessment, environmental impact statement and environmental management plans have contributed to the success of this remediation project.

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Case Study 5

COMALCO ALUMINIUM LIMITED, BELL BAY SMELTER, TASMANIA
Containment of Wastes

Background

The Comalco Aluminium smelter at Bell Bay in Northern Tasmania has operated for more than 30 years, with waste from the smelting process stockpiled on company land east of the smelter. This led to an unacceptable environmental impact, by today's standards, through leachate and dust generation. In response to these potential problems, the stockpiles have been relocated and, as an interim measure, encapsulated in a polyethylene membrane. New technologies to treat the wastes over the long term are being developed.

The Waste

The waste contained cyanide, fluorides and a number of metal compounds. Four types of waste (spent cell liners, dross, cryolite sludge and material from the sludge pond) and contaminated soil were stockpiled and encapsulated on site. Three thousand tonnes a year of spent cell liners (SCL) (lining material which has broken down) are produced (i.e. two liners are replaced each week). 140 000 m^3 of SCL was stockpiled at the site. The SCL are the most heavily contaminated waste and consist of carbon and refractory fluoride and cyanide salts. The salts are of concern as an alkaline leachate containing fluoride and cyanide can be produced.

Other wastes stockpiled on the site include dross, cryolite sludge and waste from a sludge pond on the site. Dross is waste from the top of the molten aluminium and contains fluoride and aluminium compounds. Historically, dross was stored on site; now it is sold to a local company for further recovery. Cryolite sludge is a combination of two wastes: solids from the SCL leachate moat and sludge from the cryolite recovery plant. Cleaning of the cryolite plant, treatment plant and fume towers produced waste which was stockpiled in the sludge pond. After dry scrubbing technology was installed at the smelter, these areas were decommissioned in September 1997.

Overall Strategy

Comalco sought a medium term solution for containing existing waste, while a suitable technology to treat these wastes was being developed. It is also researching new process methods/treatments to reduce the volume of waste being produced.

The issue of waste treatment is not unique to Comalco, it faces every producer of aluminium. The waste contains substantial quantities of aluminium and steel with some salvage value. Previous attempts to minimise leachate and dust generation included sealing the SCL and dross stockpiles with bitumen. This approach was only partially effective and not consistent with current best practice for managing waste.

The preferred option was to construct a secure containment system for the existing stockpiles and dry storage of new SCL in a building while identifying and implementing a suitable treatment process. The containment system design life is 50 years. This will provide dry storage for the wastes and eliminate dust generation and minimise leachate production.

Containment System Design

Best practice design of the containment system resulted in unobtrusive mounds with batter slope angles able to minimise the volume of infiltration. The batter angle (16°) also allowed for the revegetation of the soil cover and ensured the stability of the SCL material (stable at angles < 27°). A composite of high density, 1 mm thick polyethylene (HDPE) and clay was used for the cap and base. The HDPE liner alone is an effective barrier to the leachate but may be penetrated by sharp objects. A quality assurance and quality control program was implemented to ensure it was correctly installed and risk of puncture minimised.

The containment system includes base and cap, leachate collection system and gas venting. The base of the containment system is slightly below the natural surface providing further storage capacity and clean fill for the construction of the bunds. The total cap thickness is 1200 mm, consisting of six layers, including a 1 mm HDPE liner and a geotextile and geonet (used to filter material that may block the drainage system).

A gas venting system was installed to prevent damage to the geomembrane, using PVC slotted pipes placed in the sand layer of the cap. The vent pipes are equipped with spark arresters to prevent flashback from ignition sources.

The base is approximately 800 mm thick, and incorporates a clay layer and a layer of coarse sand which provided the leachate collection system. The drainage pipes collect leachate which flows into the leachate collection tank, located at the lowest point of the base. A stormwater management strategy and vehicle decontamination procedures were implemented to minimise transporting contaminants offsite during waste relocation.

PHOTO: COMALCO ALUMINIUM LIMITED

Officer inspects one of the revegetated mounds to the centre right. Batter angle 16 degrees assists revegetation and stability.

Stakeholders

Comalco contacted the Tasmanian Department of Environment and Land Management for approval of the relocation concept and stockpile encapsulation.

Also involved in the project were various stakeholders, potentially affected by the construction of the encapsulation mounds. These included:

- local council;
- utility companies (ie. electricity, telecommunications);
- road authority;
- local community; and
- interest groups.

Comalco is now looking forward to developing processes to eliminate the need to stockpile the wastes and remove cyanide and fluorides from the SCLs. In the meantime, any SCL resulting from existing operations is placed in dry storage in a modified building which has the capacity to hold approximately five years of SCL use.

Another incentive was the salvage of steel and aluminium from the waste. This has resulted in savings and reduced the total volume of waste contained.

Conclusion

Comalco has benefited from the project by protecting the surrounding environment from further contamination and reducing the liability to the company. The encapsulation of existing waste has minimised the potential for further contamination of the site, while changing past practices means less waste is being produced and stored.

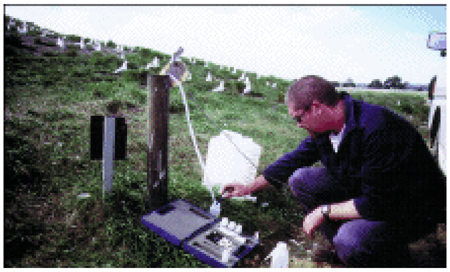

PHOTO: COMALCO ALUMINIUM LIMITED

Monitoring groundwater adjacent to mounds is routinely carried out by environmental staff. Note plentiful bird life in background.

PHOTO: COMALCO ALUMINIUM LIMITED

Ryecorn vegetation growth on spent cell liners (SCL) Encapsulation No #1 Vegetation early Feb 1996 with stockpiles 3 & 4 at centre rear. New vegetation requires irrigation.

Case Study 6

COPPER SMELTER AND REFINERY, SOUTH EAST AUSTRALIA Closure and Remediation Strategy

Introduction

An Australian copper smelting and refinery site, which ceased operations in 1995 after 87 years, needed to be investigated for contamination before it could be sold or decommissioned. Closure and remediation planning for the site was managed by Rio Tinto from 1995ú1997. At the time of closure, it was expected that the site be to be decommissioned and remediated. However, the site was sold to new investors and it is expected to reopen in the latter half of 1999.

The stakeholders potentially affected by site contamination included the current owners, the buyers, the regulator, and the community. Contamination surveys of the site showed which areas needed to be cleaned-up and monitored and this was taken into account in discussions about the sale of the plant. They also showed which areas, both onsite and offsite, needed to be cleaned-up and monitored.

Investigations

The site area is 18.6 ha and was divided into 17 zones according to the site history and processing plant layout. Investigations focussed on soil (onsite) and groundwater contamination (both onsite and offsite). Particular attention was paid to areas known to contain fill material (slag and ash). Ninety-four soil samples were taken from the fill and from top layers of natural soils in each of the 17 zones.

The results of soil sampling indicated elevated total metal concentrations above ANZECC B guidelines in 220,000m^3 of the fill materials. Approximately one-third of this material was considered to have significant levels of leachable heavy metals under neutral or weak acid conditions.

The study of groundwater revealed two aquifer systems separated by a clay layer, both of which had been contaminated by various metals including copper. It was also shown that the contaminants in part of the deeper aquifer had spread to 300m north of the site boundary under an adjacent industrial property.

Remediation Options

Best practice methods were adopted as part of the remediation strategy, with health and ecological risk assessments conducted both onsite and offsite. These showed that risks to people and the environment were very low and that natural attenuation and removal of the contaminant source would prevent the further spread of contaminated groundwater. However, consideration of a range of factors including community perception led Rio Tinto to propose active remediation of the groundwater. The groundwater contamination in the deeper aquifer is being managed by maintaining a pump and treat system. Contaminated groundwater in the shallow aquifer is intercepted by a boundary drain, which directs water to the treatment plant.

Conclusion

This site provides an example of how historical contamination can result in significant remediation costs and potentially affect the community's perception of the mining industry. Best practice methods, which were adopted as part of the site assessment, indicated that the risks posed by the contamination of the deeper aquifer were very low. However, because of the need to recover offsite contamination, where this can be effectively done, Rio Tinto selected pump and treat methods to remediate the groundwater. Information gathered during the assessment and remediation planning phases proved adequate confidence for all the stakeholders that site contamination could be appropriately managed.

PHOTO: RIO TINTO LIMITED

Part of the dewatering system for the deep aquifer showing typical well head layout, with pump controls on the left and sampling port on the right. The contaminated groundwater can be pumped from 12 such wells to the water treatment plant to remove dissolved metals.

The interception pit is part of the system used to intercept and collect contaminated surface water and groundwater from the shallow aquifer. The system collects drainage from parts of the site, which has been contaminated by heavy metals. The collected water is pumped to the water treatment plant to remove metals.

PHOTO: RIO TINTO LIMITED

Case Study 7

GOLDFIELDS (TASMANIA) LIMITED, HENTY GOLD MINE, TASMANIA
Bioremediation

The Henty Gold Mine is in a world-renowned, sensitive environment and was the first gold mine to open in Tasmania since late last century. Its operating procedures have been designed to accommodate the site's high rainfall (3.6 m annually) and limited sunlight (average of 4.8 hr/day).

During development of the mine in 1996, peat and subsoil were stockpiled on a site previously employed during hydroelectric facility construction. The Newton Works Area was employed for hydroelectric program workshops, storage and transport yards from 1985 to 1991. It was decommissioned and rehabilitated in 1991.

Later, in 1996 during site preparation by Henty, two concrete sumps of hydrocarbon-contaminated material were uncovered at the former workshop site. These were then decontaminated and backfilled. In consultation with Hydro and the Department of Environment and Land Management it was decided to remediate the contaminated material by developing a "Landfarm" on a nearby compacted area.

The contaminated soil was turned and windrowed to allow for maximum aeration and was then fertilised to increase microbial activity and surrounded by a peat bund. Oil absorbent materials were strategically placed to collect runoff from the stockpile.

The area was regularly fertilised to encourage biological activity and turned to facilitate oxygenation. Since the landfarm was established, there has been noticeable growth of native button grass and other sedgeland species, which have germinated from the peat seed bank.

A groundwater monitoring bore was installed downstream of the contaminated site in early 1997 to see if nearby groundwater was being contaminated. Results indicated that hydrocarbon levels are below, or at, detection limits. Surface water sampling of Newton Creek (approximately 300m downstream) began early in 1995 as a part of Henty's water monitoring regime. No hydrocarbons were detected in Newton Creek either before or after the 1996 disturbance of the contaminated site.

PHOTO: GOLDFIELDS (TASMANIA) LTD

Native sedgeland species have successfully regenerated within the landfarm area, either directly from the seedbank within the contaminated peat, or from windblown seed. The predominant species featured is Juncus pauciflorus*, commonly known as loose-flower rush.*

PHOTO: GOLDFIELDS (TASMANIA) LTD

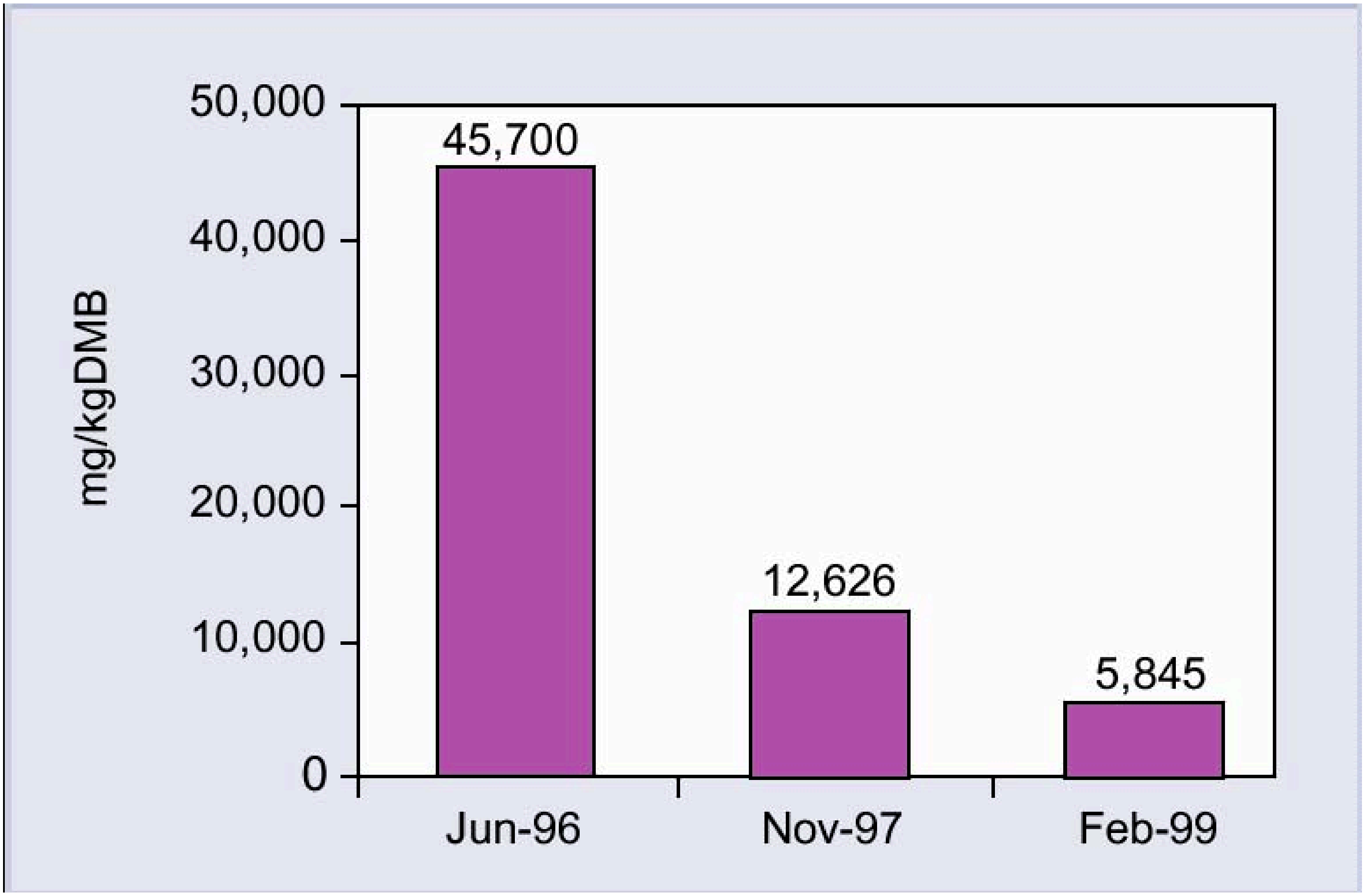

FIGURE 1: Newton Creek Landform Total Petroleum Hydrocarbons

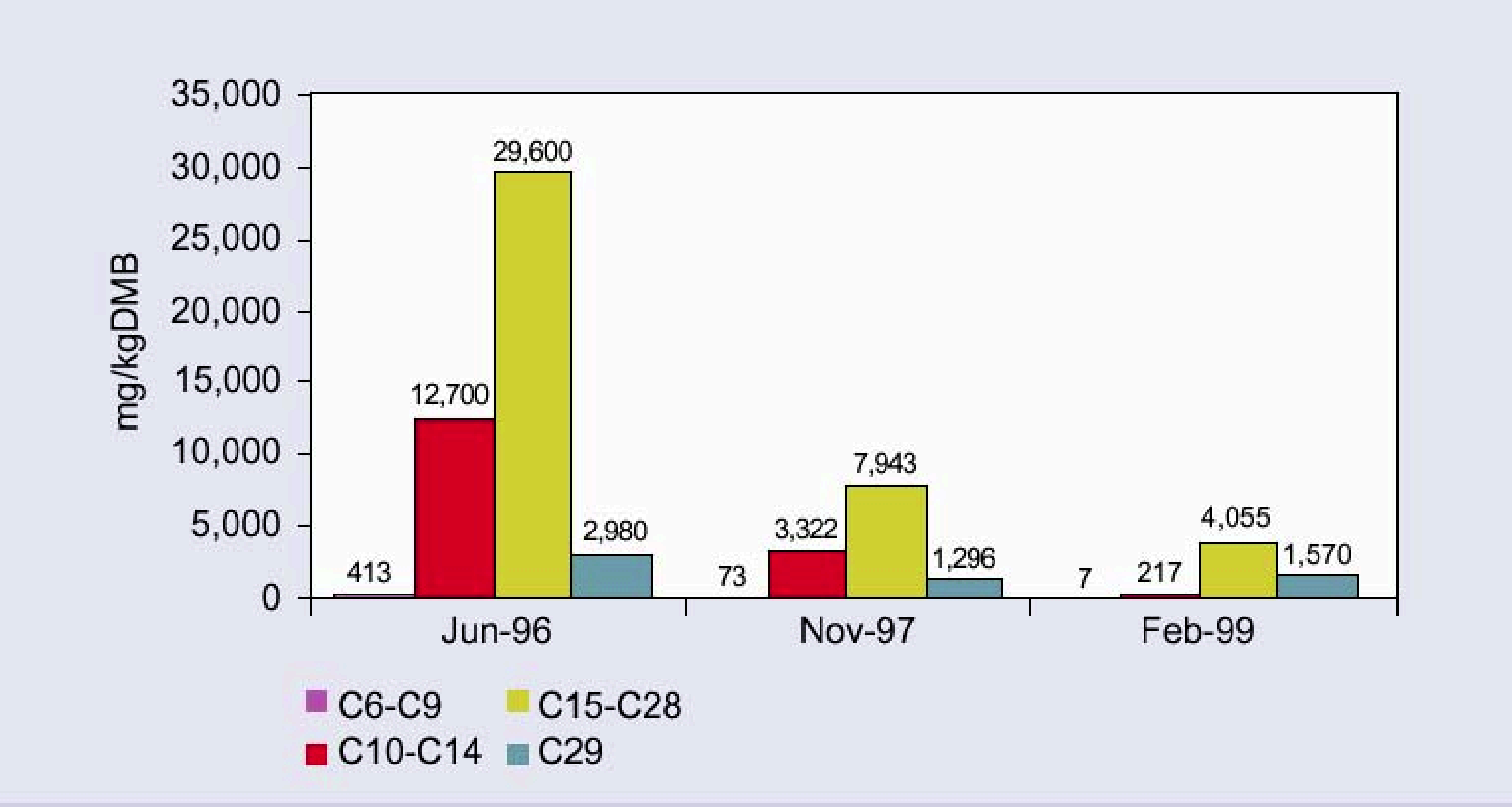

FIGURE 2: Newton Creek Landform Short and Long Chain Hydrocarbons

Surface soil has been sampled since the land farm was first developed. Soils were originally analysed for total petroleum hydrocarbons (TPH), short and long chain hydrocarbons and aromatics (benzene, ethyl benzene, methyl-benzene and xylene). Total petroleum hydrocarbons were tested every 12-18 months thereafter. Results for TPH and chain hydrocarbons are shown at left.

Results indicate an initial 72% decrease in TPH levels from June 96 to November 97 (18 months). A further 13% decrease in TPH levels occurred from November 97 to February 99.

Government regulators have indicated the landfarm material currently meets requirements for clean landfill purposes. Although no further amelioration or treatment of the landfarm material is planned, the site will not be decommissioned immediately. Instead, the material will either be incorporated into waste rock material used for construction in the leach residue pond precinct, or it will be further remediated to a quality suitable for rehabilitation and revegetation.

PHOTO: GOLDFIELDS (TASMANIA) LTD

When the landfarm was established, the combined contaminated soil and peat was windrowed, fertilised and regularly turned to facilitate oxygenation and microbial activity. The landfarm is partially inundated with water for several months of the year. This photograph was taken in mid-winter, making it difficult to identify the windrowed material.

PHOTO: GOLDFIELDS (TASMANIA) LTD

The landfarm area (foreground) is about 80 square metres and is located within the Newton peat storage works area. The Tyndall Ranges in the distance are south of the Henty Lease.

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