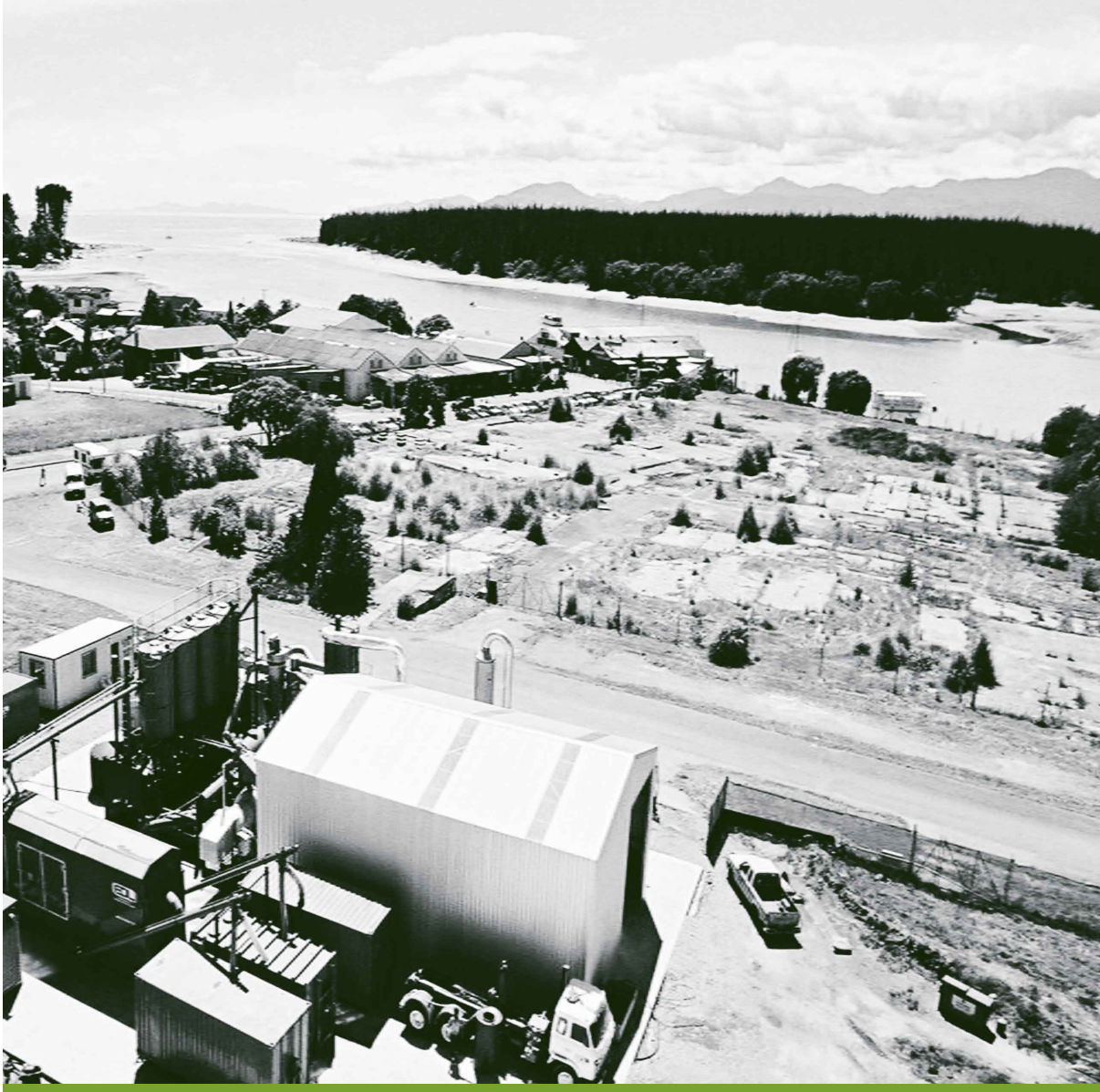

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Investigation into the remediation of the contaminated site at Mapua

July 2008

Parliamentary Commissioner for the Environment
Te Kaitiaki Taiao a Te Whare Pāremata

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Preface

The settlement of Mapua has grown beside a particularly beautiful estuary a few kilometres west of Nelson. My childhood memory of Nelson-Tasman is of sunshine, beaches and apple orchards. In 1932 Mapua would have been a logical place for the Fruitgrowers Chemical Company (FCC) to build its plant for manufacturing pesticides. Thirteen years later, production of the powerful new organochlorine pesticides (OCPs) began.

The FCC plant was established in a time of far less scientific understanding of chemical toxins, and consequently little appreciation of the need for protecting people or the environment from exposure to them. By the time the plant closed in 1988, this situation had changed. The site was abandoned and its legacy of contaminated soil inherited by the people of the Tasman District.

The Mapua site was considered to be one of the worst contaminated sites in the country. It was a problem of a complexity and scale that was clearly beyond the resources of many councils. In 1999, with a growing awareness of the contaminated land issue in New Zealand, the government decided to assist Tasman District Council (TDC) with funding, as well as research and advice. From that time the Ministry for the Environment (MfE) began to work actively towards the remediation of the site.

In 2008, the remediation was completed. The long process was fraught with challenges. The type and scale of remediation was new territory for New Zealand, and indeed it would be astonishing if there had been no mistakes or errors of judgement. Further, although the remediation technology is now being used successfully overseas, that success must, to some extent, be based on the lessons learned by its owner from the less-than-satisfactory operation in its first commercial application.

It is my hope that this investigation will be seen as providing the opportunity to learn and feed positively into contaminated sites policy and management. To help reduce risks to people and the environment, a number of lessons can be drawn from the Mapua experience. These include the need for:

- robust decision-making
- clear separation of roles to avoid conflicts of interests, and management of such conflicts where they are unavoidable
- respect for, and appropriate use of, technical expertise.

The environmental outcomes are mixed. The OCPs in the soil have almost certainly been mostly destroyed, although confirmation must await the final Validation Report. The use of a large quantity of an ecotoxic copper compound as a reagent should have been controlled; and there is a possible residual problem with mercury.

During the process of destroying the OCPs, a variety of toxins may have been released into air and water. Discharges to air are mainly of concern because of the potential risk to human health; discharges to water are mainly of concern because of the risk to the ecology of the Waimea Estuary.

The problems with discharges to air stem from the design and operation of the soil clean-up plant and inadequate monitoring of emissions. Of greatest concern is the possible creation of dioxin in the soil drier and its release, due to deficient control

systems. Certainly a small amount of dioxin was created and emitted during one of the early trials. If dioxin (and other toxins) were emitted to air later, the amount may well be insignificant; the problem is that inadequate monitoring systems have rendered the monitoring data of little value.

My predecessor, Dr Morgan Williams, initiated this investigation in 2006 in response to complaints from members of the public. At that time, he appropriately referred matters relating to human health to the Ministry of Health, and matters relating to workplace health and safety to the Department of Labour. For this reason, I have not made any recommendations regarding the potential health impacts on people on the site or in the vicinity of the plant. However, I appreciate the anxieties local people may have about this matter, and understand that reports from the Ministry of Health and the Department of Labour will be forthcoming.

The problems with discharges to water chiefly arise from the use of certain reagents during the remediation process, namely copper sulfate, diammonium phosphate and urea. These can make their way to the estuary via groundwater and runoff. Copper is highly toxic to marine life; phosphate and nitrate (from the urea) degrade water quality by promoting the growth of algae. Residual OCPs are also still elevated in the groundwater. There is still an opportunity to reduce future discharges to the estuary through relatively inexpensive technical fixes.

Two decisions seem to have been fundamental in creating the risks that have undermined the success of the project – the decision to remediate the soil rather than contain the contamination, and MfE's decision to hold the resource consent when the main contractor (Thiess) pulled out.

The decision to remediate the soil

In 1997, Tasman District Council obtained consents for capping the site with clay and installing a subterranean bund wall to reduce the discharge of contaminants into groundwater. However, this containment strategy would have limited the use of the land to open space and possibly some commercial development.

In 1997, the Government expressed a desire to see the land remediated rather than contained. Funding was provided in the 1999 Budget, and expected to be sufficient for remediation to a standard that would allow a wider range of future land uses. The final amount of funding provided by the Government has turned out to be approximately double the initial amount envisaged. However, much of the land is now likely to be suitable for residential development and thus of considerable value.

In hindsight, remediation of the soil on a site in the middle of a residential area and adjacent to a sensitive estuary was a high-risk strategy. Trucking the soil offsite for treatment was considered and rejected, although it may well have been preferable. However, the original containment strategy had much to commend it.

There is a more general lesson here. There are many contaminated sites in New Zealand – an unwitting legacy from past activities like timber treatment. The correct solution for each site will depend on its particular circumstances. In most cases, the actual area of these individual sites is small, but the cost of remediating the soil will be prohibitive. Expectations will need to be addressed, as policy on contaminated sites is developed. Moreover, containment strategies that close or limit pathways by which the contaminants can be mobilised may often be superior environmentally as well as financially, as it is only when contaminants are mobilised that they become dangerous.

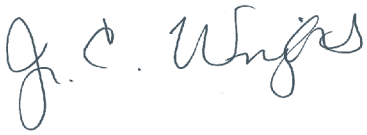
MfE's decision to take over the resource consent

When the relationship between Thiess and EDL "broke down", MfE elected to become the holder of the resource consent. This gave MfE a much greater operational management role alongside its responsibilities as agent of the Crown. Multiple roles set the stage for conflicts of interest.

The capability of a policy agency to undertake operational management is another concern. MfE was created as a small policy advisory agency in 1986 in accord with the prevailing public sector philosophy. Over recent years, its role has become increasingly operational.

I make no judgement as to whether or not this is appropriate, but some thinking about its role is clearly needed. If MfE is to perform operational functions, those functions need to be clearly defined and supported by the appropriate in-house technical capability.

Finally, I would like to thank the staff, past and present, who have spent many hours wrestling with the complexity of this investigation. I am particularly grateful to Dr Simon Watts who has led the investigation to its conclusion with grace and rigour.



Dr Jan Wright
Parliamentary Commissioner for the Environment

1 Mapua story

1.1 Introduction

In late 2006, the Parliamentary Commissioner for the Environment received allegations of poor environmental management related to remediation of a contaminated site at Mapua, in the South Island's Tasman District.

This report is the result of an investigation under s 16(1)(c) of the Environment Act 1986, carried out to determine how well the remediation of the Mapua contaminated site has been managed, and to extract any available lessons for the future management of contaminated land

Concerns were expressed by members of the community about the health and safety of workers on the site, and about the effects of the remedial works on the health of the Mapua community. After making initial inquiries in response to these allegations, the Commissioner referred matters relating to human health to the Ministry of Health and matters relating to health and safety in the workplace to the Department of Labour. The reports of those agencies will be separate to this report.

1.2 Mapua site

Mapua is a small coastal village located between Nelson and Motueka at the mouth of the Waimea Estuary (see Figure 1). The site of approximately 5.1 hectares (including coastal sediments) is located in the village centre, and surrounded by houses, commercial properties and tourist facilities.

Figure 1: A location map of Mapua, showing the Fruitgrowers Chemical Company site

Source: URS

From 1932 until 1988, the Fruitgrowers Chemical Company (FCC) and minerals processor Mintech (formerly Lime and Marble) both operated factories and their own private landfill on the site. The FCC factory closed in 1988. Activities by FCC left the soil, groundwater, the Waimea Inlet and estuarine sediments contaminated.

The site was left orphaned. (Orphan contaminated sites are those where either no party can be identified as having legal liability, or the liable party is unable to fully fund the remediation.)

In 1989 Tasman District Council (TDC) inherited from the Harbour Board about 0.7 hectares of reclaimed land next to the original FCC site. In July 1996, it also took ownership of the original 2.8 hectare FCC site and a further 1.6 hectares of coastal sediments and adjacent land.

1.3 Contaminants on the site before the remediation

Several investigations into contamination on the site, surrounding marine sediments and adjacent residential lots identified the presence of some of the substances known to have been stored or manufactured on-site, including:

- extensive contamination with organochlorine pesticides (OCPs), especially DDT and its breakdown products (collectively DDX), aldrin, dieldrin and lindane (collectively ADL)
- occasionally elevated levels of heavy metals (including chromium, arsenic, lead, cadmium and mercury) and elemental sulfur
- occasionally elevated levels of petroleum hydrocarbons,
- traces of chlorophenoxyacetic acid herbicides, phenoxy herbicides, organophosphates, triazines and other related nitrogen-containing pesticides
- traces of polychlorinated biphenyls (PCBs).

Contamination was typically found in areas used for chemical handling and bulk storage, and within stormwater drains and low-lying areas. Concrete on the site was also contaminated. Topsoil on four neighbouring properties was contaminated to varying degrees, and parts of two of these properties were included in the area to be remediated.

Marine sediment samples from the Waimea Inlet revealed contamination mainly by OCPs, particularly DDT and its metabolites, and to a lesser extent dieldrin. Metal and OCP levels in groundwater[1] exceeded guidelines for the protection of aquatic ecosystems and recreational water quality.

1.4 History of the Mapua site remediation

Activities at the site are summarised in a timeline at the end of this section.

Before remediation, some action had been taken to prevent the release of contaminants, including partial capping with compacted clay, and installing a three-metre-deep clay cut-off wall along the seaward edge of the landfill to prevent contaminated groundwater leaching into the Waimea Inlet.[2]

In 1997, TDC obtained resource consents for capping the site with clay and installing a subterranean bund wall to reduce the discharge of contaminants. However, the 1997 consent conditions for this work would have not allowed buildings on the cap, which contrasted with the future use of the land that TDC had planned: a mix of residential, commercial and open space.[3] It would have limited the use of the land to open space and possibly some commercial development.

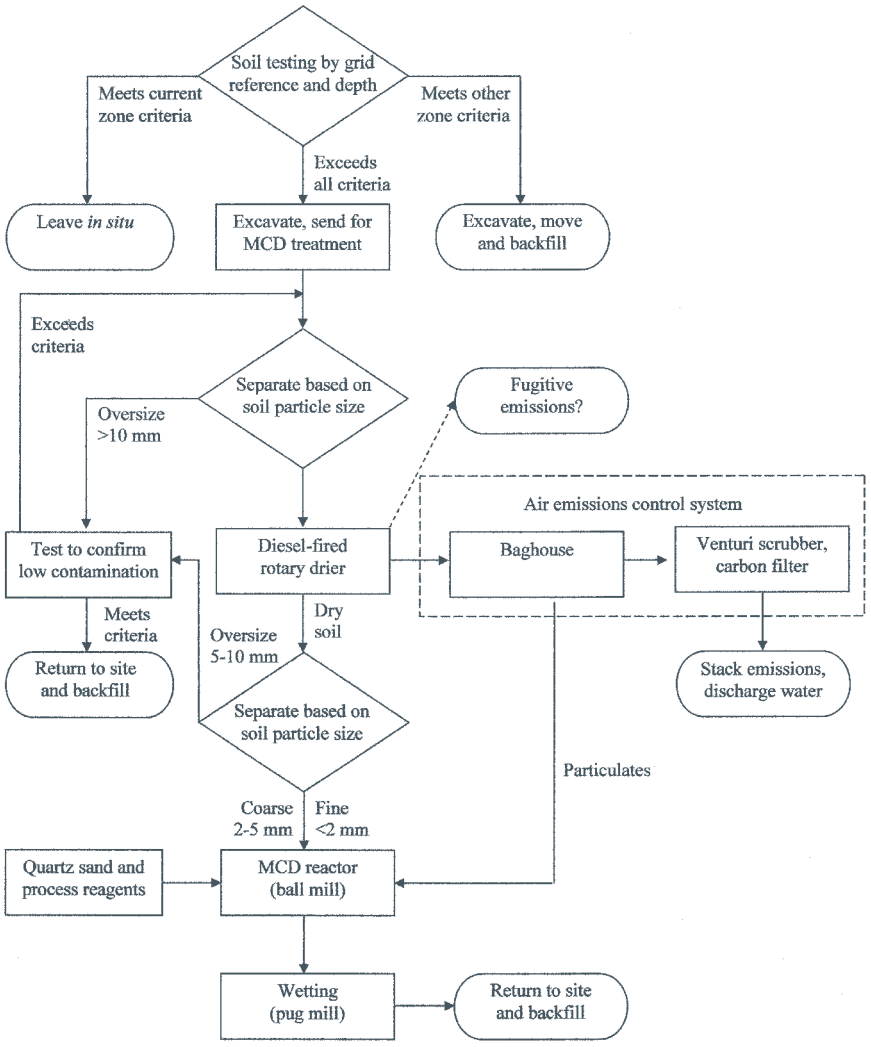
In the same year, the Ministry for the Environment (MfE) convened a Technology Review Committee to evaluate potential remediation technologies for a growing number of identified contaminated sites. The Mapua site was deemed a priority and, in 1999, the Government allocated $3.1 million to its remediation.[4] This central government subsidy was made available because of the particular circumstances that contributed to the site's orphan status:

- TDC was neither the polluter nor owner when the contamination occurred.
- TDC was assigned ownership of part of the site following local government restructuring in 1989.
- TDC had assumed responsibility for the remainder of the site to avoid continual negotiation problems between the three land-owning parties.[5]

In July 1999, TDC agreed that trials of promising technologies using contaminated soil from the site should be carried out. Both TDC and MfE provided some funding for the trials. Three companies were chosen to trial their technology from the 26 companies that submitted expressions of interest. All three technologies successfully reduced DDX and ADL in the soil to meet preliminary proposed criteria for future mixed use of the land.

In June 2001, TDC awarded a tender for remedial works at Mapua to a partnership comprising Thiess Services, an Australian specialist remediation contractor, and Auckland-based Environmental Decontamination Limited (EDL). Thiess was the main contractor and was to hold the resource consents. EDL supplied the remedial technology, Mechano-Chemical Dehalogenation (MCD) (see Figure 2). EDL's associate company, Manco Environmental Limited, had funded construction of a pilot MCD plant and research into the technology's effectiveness. EDL had also received more than $450,000 in funding from the Foundation for Research, Science and Technology to help with development of the MCD technology.

Figure 2: MCD process



Because the FCC site is located in the village of Mapua, the option of trucking contaminated soil off-site for treatment was considered. Off-site treatment would have involved a large number of heavy truck movements, however, and both proposed alternative treatment locations were rejected. Strong local opposition was expected, due to the perceived risks of transporting contaminated material.

Ground investigation to extend previous work to characterise the distribution of contamination started in September 2001. The volume of soil requiring treatment was estimated at about 6,150 m^3. In November 2001 the contract for the remedial works was signed; the total project costs were estimated at $6.5 million, to be shared between TDC and the Crown.

In November 2001, the proof-of-performance MCD reactor unit was installed on-site under a short-term resource consent, for preliminary trials. Initial treatment results were promising, although vibration from the plant was a problem for neighbours, and modifications were made to the plant.

Formal proof-of-performance trials were carried out during February through April 2004 to confirm that the plant was able to:

- comply with consent conditions
- meet target soil acceptance criteria and destruction efficiency
- achieve a throughput of 108 m^3 per week.
- Monitoring during the testing included:
- the quality and volume of the soil remediated
- air quality, noise, dust and odour
- vibration (to guard against structural damage to buildings)
- material handling (for protecting the employees and for limiting dispersal into the environment).[6]

The plant was found to be effective in decontaminating the soil to within the soil acceptance criteria specified in the resource consent.[7, 8]

During one of the four trials, a mechanical breakdown led to the formation and release of small quantities of dioxin from the proof-of-performance plant. It was considered that the dioxin emissions did not represent emissions during normal operating conditions, and that the problem could be eliminated.[9] Interestingly, the plant did not succeed in meeting the 108 m^3 per week soil throughput requirement.[10]

By mid-2004, the relationship between Thiess and EDL had "broken down",[11] and in August 2004 Thiess withdrew from the project. Resource consents for the project were transferred from Thiess to MfE, which appointed Effective Management Services Ltd (EMS) as site manager.

EDL signed a contract with MfE to complete the soil treatment part of the remediation works. It appears that one factor in EDL continuing once Thiess pulled out was that the resource consent that had been granted was specifically for the operation of the MCD technology developed by EDL for use on the site.

Remediation of the site began in September 2004. It is difficult to pinpoint the date works ended. Certainly MfE returned the bond it held from EDL in October 2007, thus indicating that in the opinion of MfE the remediation part of the work was completed by that date. However, work on the landscaping, drainage and car parking continued until mid-April 2008. In June 2008, the Certificate of Practical Completion was signed off by TDC.

Figure 3: Timeline of activities at Mapua site

1932	• Fruitgrowers Chemical Company (FCC) opens pesticide formulation factory at Mapua, producing spraying oils and lime sulfur.
1940s	• Lime sulfur replaced by organomercury compounds. • Arsenical compounds stored at the Mapua site. • FCC subsidiary Lime and Marble processes minerals on part of FCC East.
1945	• Organochlorine pesticides including DDT, DDD, dieldrin, 2,4-D and paraquat are produced. • Pesticide microniser located on Lime and Marble land.
1950s	• Reclamation of site margins from Waimea Inlet, vested in Nelson Harbour Board. • Wastes from site disposed of in Landfill Area.
1958	• Organophosphorus pesticide formulation introduced.
1962	• Production of organomercury pesticides, dieldrin and lindane ceases.
1967	• Production of DDT ceases
1978	• 124 chemicals used to produce 84 different formulations.
1988	• FCC operations cease. • Lime and Marble continues minerals storage.
1989	• Tasman District Council (TDC) inherits ownership of reclaimed land parts of the Mapua site from the Nelson Harbour Board.
1992	• TDC takes over the functions of the Nelson Marlborough Regional Council, including Resource Management Act responsibilities for land, water, air and coast. • Landfill Area is capped, clay cut-off wall installed along its southern boundary to reduce leaching into the Waimea Inlet.
1992–1996	• Site investigation, risk assessment, groundwater modelling, containment strategy, resource consent application undertaken for TDC by Woodward-Clyde (NZ) Ltd.
1996	• TDC acquires the remainder of the Mapua site from investment company Ceres Pacific (owner of FCC) and Mintech (successor to Lime and Marble). • Proposed Tasman Resource Management Plan (TRMP) notified for public submissions. • FCC East and West areas are made part of the 'Chemical Hazard Area'.
1997	• Resource Consent Commissioner hearing grants resource consents for containment solution; estimated cost $2.75m. Resource consent conditions prevent building on the clay cap of the Mapua site. • Royal Forest and Bird Protection Society appeals. • Government expresses desire for site to be remediated rather than contained.[12] • MfE convenes Technology Review Committee to look at alternative options. • Shortlist of four remediation companies drawn up. Remedial cost estimated at $5–11m.

1999	• Cost of containment solution reassessed at $3.7m and funds allocated in the 1999 Budget.
1999–2000	• Three companies involved in treatment trials using Mapua site soil. All three are able to meet target concentrations.
2001	• Three successful triallists are invited to tender for remediation of the Mapua site. • Thiess, offering the MCD technology operated by EDL, is awarded the contract. • Thiess carries out investigations to identify contaminated soil requiring treatment, estimated at 6,150 m^3.
2003	• Resource consent application for the remedial works lodged by Thiess, consents issued by TDC, appealed by Forest and Bird and Greenpeace New Zealand, granted with amendments by the Environment Court.
2004 February	• First Peer Review Panel meeting.
April	• Proof of Performance testing.
August	• Thiess withdraws from the project. • MfE becomes consent holder and re-engages contractors.
September	• Works begin with establishment and vegetation clearance.
October	• EMS starts as MfE's full-time site manager. • Air, groundwater, noise and vibration monitoring begin.
2005 (early)	• Copper sulfate replaces slag as one of the MCD process reagents.
June	• Groundwater monitoring amended, analyses for nutrients added.
2006 May	• Site auditor raises concerns over concentrations of DDX, ADL and nitrogen compounds in groundwater.
June	• After at least four months of unsuccessful email/verbal attempts, TDC finally writes to MfE to request extra monitoring of groundwater.
December	• MfE varies EDL's contract to reduce its destruction efficiency target from 90% to 80%.
2007 May	• Groundwater and sediment investigation for MfE by CH2M Hill.
September October	• MfE issues EDL with a Certificate of Practical Completion and returns its contract bond.
November	• Resource consents expire. • The Mapua site becomes the responsibility of TDC. • MfE-funded monitoring ceases.
December	• TDC receives groundwater issues report from PRP.

2 Governance and management

2.1 Legal framework

New Zealand has no specific regulatory framework for the remediation of contaminated land. Its management is based on several pieces of legislation including the Resource Management Act 1991 (RMA), the Hazardous Substances and New Organisms Act 1996, and the Health Act 1956. The legislation is designed to provide some means of addressing adverse health and environmental effects arising from contaminated land and the activities on, and uses of, such land. It is also designed to minimise the potential for future impact resulting from storage and use of hazardous substances.

Remedial works at the Mapua site were controlled under the RMA and Tasman Resource Management Plan (TRMP) by a package of seven resource consents. These outlined the general conditions for the management of the site, and detailed specific conditions on different aspects of the cleanup, including:

- constructing and operating an industrial facility
- disturbing land and the coastal marine area
- making discharges
- taking groundwater.

2.2 Roles and responsibilities

The Mapua remediation involved interaction of a number of public sector and private sector organisations. These parties carried out the remedial works under resource consents, operational documents, and through contractual arrangements. Some parties performed multiple roles that changed during the course of the project.

Tasman District Council (TDC) was the regulatory authority for all the consents. Thiess was the original consent holder and responsible for managing the project, a role later taken over by the Ministry for the Environment (MfE).

Regulation and governance

As well as being owner of the site, TDC is also the local authority with jurisdiction over the site that was the subject of the remedial works. It therefore has responsibility for regulation, and some responsibility for the governance, of the remediation works.

As a unitary authority, TDC exercises responsibilities both of a territorial authority (including preventing or mitigating adverse effects of redevelopment of contaminated land) and of a regional council (including investigating, identifying and monitoring contaminated land). The challenge for TDC was to resolve the environmental problems of a major contaminated site situated in the middle of a village, while at the same time protecting the wellbeing of people and the environment in the vicinity.

TDC was also to be responsible for:

1) conducting the process of the resource consent application(s)
2) seeking to ensure that appropriate conditions and safeguards were put in place in the resource consent
3) ensuring that the above consent conditions were complied with
4) managing any potential conflicts of interest.

The key TDC personnel involved in the Mapua remediation were all part of the Mapua Task Force that predated the cleanup. The Head of Environment & Planning made the decisions about appropriate enforcement actions during the project. Because of his experience with the site, the project manager was seconded from Landcare Research and chaired the Peer Review Panel. The Compliance Officer regularly inspected works, attended meetings, investigated public complaints and prepared compliance correspondence.

Project management

At the start of remedial works in 2001 **Thiess Services** was the main contractor, under contract to TDC and holding the resource consent package. Thiess withdrew from the project in August 2004, just before full-scale remedial works were about to start. By this stage they had carried out extra site investigation, assessed volumes of soil requiring treatment, begun community liaison, drafted the schedule and site management plans, and submitted the Remedial Action Plan to the site auditor and TDC.

MfE partly funded the remediation and, following Thiess's withdrawal, assumed the role of consent holder. MfE thereby took on responsibility for overall management, compliance with the resource consent, and procurement of contractors. Although the project initially reported to the GM Sustainable Business within MfE, day-to-day control of the remediation moved to MfE's GM Corporate and Community. The MfE project team included legal and accountancy expertise, but the evidence suggests that they lacked operational experience with contaminated land issues or with civil engineering projects.[13]

MfE engaged **EMS** as site manager to oversee and direct site operations, including responsibilities for consent compliance, work programming, validation sampling and community liaison. Ultimate control remained with MfE, and the site manager was not able to authorise new expenditure or variation work. EMS reported monthly to MfE in writing.

MfE further engaged Montgomery Watson Harza Ltd (**MWH**) to provide an Engineer to the Contract, responsible for verifying contractors' progress claims and variations.

EDL was responsible not only for operating and maintaining the treatment plant, but for uplifting excavated soil for treatment, assessing pesticide concentrations before and after treatment, and stockpiling treated soils. Earthworks contractors

carried out excavation and backfilling. Other contractors included the analytical laboratory and an environmental monitoring contractor. These contractors were originally engaged by Thiess, but for most of the remediation period were contracted to MfE.

Site auditor

The site auditor (from Australian environmental consultancy Egis) was appointed on 31 January 2002. It seems that this appointment was originally to reassure MfE that it was getting value for money.[14] The RMA does not include a specific framework for environmental auditing, as is provided for in some jurisdictions. For the remedial works at Mapua, the resource consent package provided for a site auditor, which it defined as:

> *The person appointed by the Council and the Ministry for the Environment to provide independent advice on the remediation of the site and associated matters including setting the Soil Acceptance Criteria for the end uses of the site proposed by the Council.*

Given the complexity of the Mapua site, the appointment of a site auditor was a wise decision. Unfortunately, the definition of the role did not make clear the scope and objective of "advice on the remediation of the site and associated matters". The only specific function for the site auditor within the consents package was to approve (together with TDC's Compliance Co-ordinator) the consent holder's Remediation Action Plan and Project Management Plan before any remedial works started. Although these documents were drawn up by Thiess, and revised throughout the project by MfE, it appears they were incomplete and never approved by TDC.[15]

The Assessment of Environmental Effects (AEE) for the remedial works also provided that the site auditor would issue a site audit statement on completion of the works to "confirm that the objectives of the [Remedial Action Plan] have been met and that the site is suitable for its proposed land uses". At the time of writing this report, MfE has advised that it has not yet contracted anyone to prepare the site audit statement.

Peer Review Panel

The resource consent also provided for TDC to appoint a Peer Review Panel to review, comment and make recommendations on remediation management plans and monitoring reports. The Peer Review Panel was formed in February 2004, with members to be selected for their expertise in noise, air quality, vibration, pesticide contamination, water resources and coastal ecology. The panel met at approximately quarterly intervals throughout the remedial works.

Site management meetings

Site managment meetings were set up as part of the operational process of managing the site, Starting on 10 November 2004, these monthly meetings were between the site managers (EMS), the EDL project manager, the MfE project manager, the Engineer to Contract (MHW), and occasionally others.

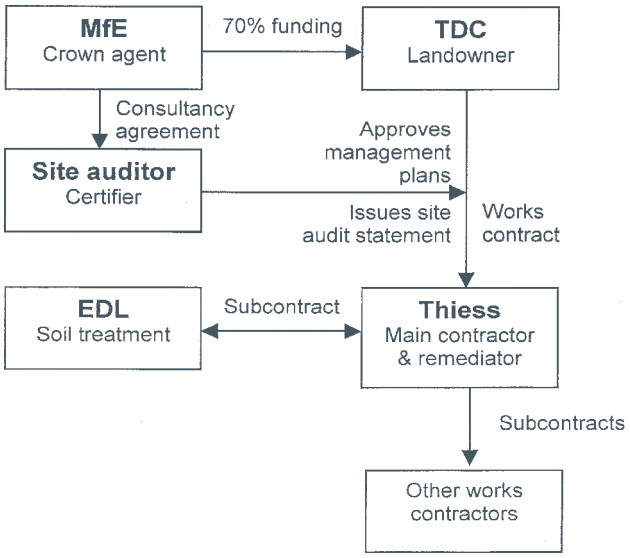
The meetings were a forum to report and discuss operational matters such as health and safety, the performance of the plant and any problems. It appears, however, that some major matters – including the complete loss of the carbon filter in March 2005 – went entirely unreported at these meetings.

Changing roles

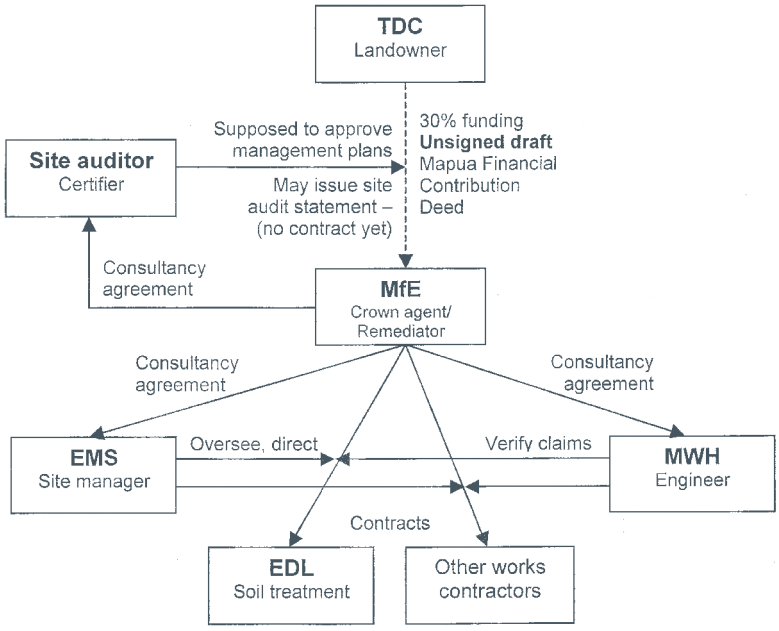
The changing roles of the various parties are outlined in Figure 4, which shows that MfE's decision to take over Thiess's role had major implications for project management.

Figure 4: Project management structures for Mapua remediation works

Original structure January 2004



After Thiess withdrawal September 2004



2.3 Issues

The various 'hats' worn by the parties involved in the Mapua remediation and the complexity of the relationships led to a number of issues related to both governance and management of the project. These, in turn, had implications for the remedial work.

The resource consent process

The original (1997) successful resource consent application was to 'cap and contain'. TDC's concept for the future of this site was to include mixed (including residential) development. Under this resource consent (which would have involved capping the site with clay and constructing an underground clay wall to lower the water table on the site), no building would have been allowed on the cap, so residential development would not have been possible.

The second resource consent application was publicly notified in June 2003. A total of 38 submissions were received and the consent hearing took place in August 2003 before commissioners. The consent was granted, but appealed by the Royal Forest and Bird Protection Society of New Zealand Incorporated and Greenpeace New Zealand. The main concerns of these parties were that:

- the role and capability of the Peer Review Panel (Peer Review Panel) should be broader
- some consent conditions lacked certainty and were unenforceable[16]
- the conditions of the air discharge consent did not adequately protect the environment.[17]

After mediation, the seven resource consents for the remedial works were granted by consent order on 21 November 2003.[18] In summary, the response to what appear to be well-founded concerns was that the definition and role of the Peer Review Panel was broadened and made consistent across all of the seven resource consents. Various conditions across all the resource consents were also harmonised with each other and some were modified, in particular those concerning the monitoring of the proof of performance trials.

There appear to have been significant omissions and/or errors made in the development of the final resource consent conditions, particularly in the atmospheric and air quality area (as detailed later in this report). It appears that insufficient expertise in this area was available during the consenting process, which may have meant that the conditions applied were inadequate for controlling potential site risks that were reasonably foreseeable.

Effectiveness of the Peer Review Panel

TDC formed the Peer Review Panel in February 2004. Its role is defined in the resource consent conditions.

The Peer Review Panel raised and discussed operational and environmental issues. The TDC Compliance Officer then requested MfE action. MfE financially supported the Peer Review Panel and was part of its discussions. MfE would have had to weigh up the risks or issues raised by the panel against its budget constraints, then acted accordingly.

Meeting minutes show that much time and thought was spent on key issues, particularly once a specialist air quality scientist joined the panel. The Peer Review

Panel process was clearly useful for debating technical issues and then getting them addressed. However several serious risks raised by the panel were not acted upon in a timely manner. These risks are the potential for dioxin generation in the soil drier,[19] the calculation of the Total Hazard Index for dust,[20] and groundwater investigations and quality.[21]

Resource consent conditions

As detailed elsewhere, some of the resource consent conditions were of themselves flawed.

TDC, as regulatory authority, took formal enforcement action on just one occasion during the works (see below). There appear to be a number of potential breaches of consent conditions during the remedial works including:

- The Remedial Action Plan and Project Management Plan were not approved before works started, contrary to general resource consent conditions.[22]
- Foreshore sediments do not appear to meet acceptance criteria following remedial works, contrary to general condition 10(j).
- The soil drier appears to have been run at an inlet temperature considerably higher than 120°C, contrary to RM030523:22.
- Emission tests from the discharge stack do not appear to have been carried out quarterly, contrary to RM030523:23(a).
- Based on complaints, it appears that dust was generated at levels that were objectionable beyond the site boundary from time to time during the works, contrary to RM030523:37(c).
- Groundwater quality has not consistently met consent thresholds, but the source of contamination has not been identified, and no effective corrective action has been taken, contrary to RM030525:27.

A number of consent conditions requiring a high standard of performance from the consent holder may also not have been met, including:

- adopting best practicable options to minimise the discharge of fugitive dust from the site, under condition RM030523:20
- taking all practicable steps to limit the discharge and migration of contaminants in groundwater (RM030524:30, RM030525:28, and RM030527:25)
- avoiding discharge of contaminated stormwater to areas of coastal sediment as far as practicable (RM030524:33 and RM030526:19)
- in the event of a discharge of groundwater exceeding criteria, adopting the best practicable option to prevent or mitigate any likely adverse effect on the environment (RM030527:23)
- adopting the best practicable option to ensure that activities were carried out in a way that minimised deterioration in groundwater quality (RM030527:24).

A record of correspondence or meeting minutes exists for many of these examples, but the level of these exchanges in the Enforcement Protocol adopted by TDC means that they were not seen or recorded as breaches.

Consistency with the AEE

General condition 17 of the resource consent package provided that "…the consent shall be carried out in general accordance with the Consent Holder's Assessment of Environmental Effects (AEE) dated May 2003, supporting documentation lodged with the AEE and the evidence presented at the consent hearing". Any differences between the AEE and actual performance, therefore, could also be considered breaches of consent.

Also, following RMA section 128(c), if the consent application contained inaccuracies that materially influenced the decision to grant consent, then the conditions of consent could have been reviewed, or the consent(s) cancelled.

MfE believes that general condition 17 of the resource consent package is too uncertain. Legal advice obtained by the PCE office would suggest that it is largely enforceable, despite room for argument as to what "in general accordance" means in any particular circumstance. MfE may be correct, however, in believing that the reference to evidence presented at the consent hearing is probably unenforceable. The reference is not linked to any specific part of the evidence, and evidence presented at a hearing generally tends to be in conflict, as the different parties present evidence supporting their various positions.

This report identifies several areas where the remedial works appear to have deviated substantially from the description in the AEE, including:

- changing the order of the components of the air emissions control system, particularly the carbon filter arrangement
- changing MCD process reagents, to include copper sulfate and diammonium phosphate
- decreasing overall destruction efficiency of DDX and ADL, apparently to less than the target of 90 percent
- blending treated soils that did not comply with criteria with less contaminated material, on two occasions, rather than re-treating.

Enforcement and compliance

In January 2007, TDC issued an abatement notice to EDL (as a subcontractor to MfE) for alleged non-compliance with land-use consent RM030521, particularly the noise conditions. This action appears to have been taken only after repeated requests from the TDC Compliance Officer to cease Sunday work. The Compliance Officer's report for March 2007 noted that noise-generating maintenance on Sundays continued despite the abatement notice.

A number of apparent breaches of resource consent conditions occurred throughout the project (as detailed elsewhere in this report); however TDC issued just the one abatement notice, as noted above. TDC has suggested that the implications of the consent holder (MfE) holding Crown immunity prevented it from exercising its powers of enforcement.

TDC was not able to take direct enforcement action against MfE, as s4(5) of the RMA specifically excludes the issuing of an enforcement order, abatement notice, excessive noise direction or information against the Crown. TDC could also, of course, have sought a declaration under s310(c) of the RMA to put MfE and/or its contractors on notice of a breach or potential breach of the Act, although the costs and resources required for this approach would have been significant.

TDC did have other more reasonable ways of exercising its enforcement role, for example:

a. serving abatement or enforcement notices on the contractors, rather than the consent holder, as was done for the one abatement notice served

b. bringing a prosecution against the contractor for failure to comply with any issued abatement or enforcement notices

c. using provisions in RMA s128, or general condition 3 of the resource consents, to review and/or tighten consent conditions, for example to require additional monitoring

d. working with the consent holder to vary conditions under s127. This is possible where the consent holder and consent authority cooperate and this provision was used to modify RM030023:22 – moving the temperature cut-off on the drier.

If there had been a contractual relationship between TDC and MfE (as between TDC and Theiss), then TDC could have used the terms of that contract to ensure compliance. The (unsigned) Mapua Financial Contributions Deed may (and probably should) have contained appropriate terms. Yet TDC allowed work to begin without this being in place.

Councils have many methods of facilitating and enforcing compliance, ranging from verbal instruction, letter or notice, through to abatement notices and prosecution. TDC did write to MfE about several matters and was unable to obtain the actions it required to achieve compliance. It could be considered that this left TDC with no alternative but to move another step up the ladder of its enforcement protocol (possibly using some of the routes described above). It is surprising, then, that during the term of the works, and the many issues over which TDC emailed or wrote to MfE, that just one abatement notice was issued.

Managing conflicts of interest

The relationship between TDC and Thiess was two-fold: consent authority to consent holder, and landowner to main contractor.

When MfE became consent holder, it retained the consent authority-consent holder relationship with TDC, although TDC felt partially constrained in its RMA enforcement role by MfE's Crown immunity.

However, the second aspect, that of landowner to main contractor, no longer existed as MfE did not take over Thiess's contract to TDC for the remedial works.

The commercial relationship between TDC and MfE appears to have been based on a proposed Mapua Financial Contribution Deed. If this Deed did set out the commercial relationship and the desired environmental outcomes for the work, then MfE could have been compelled to deliver according to those provisions. If the Deed did not contain such material, then this is a serious omission.

In any event, works proceeded without the Deed being finalised and signed. Under the original contract TDC could have compelled Thiess to deliver the desired environmental outcomes by enforcing either resource consent conditions or contractual terms. But, in dealing with MfE, TDC was uncertain[23] if it could effectively enforce the resource consent conditions, and lacked a commercial contract, giving it little effective control over MfE's performance.

TDC's initial position was not straightforward because it (as consent authority) was setting controls on a remedial exercise that it was part funding (as landowner). In theory, TDC was in a position where it could have minimised compliance costs associated with the remediation, and hence minimised its own expenditure. However, TDC does seem to have taken reasonable steps to manage the risks posed by potential conflicts, such as holding a Commissioner Resource Consent Hearing.

Conversely, once MfE became responsible for remedial works, in theory TDC could have optimised the environmental benefit to its land at the Crown's risk and expense, by its interpretation and enforcement of conditions of consent. A signed Deed would have helped the management of this conflict.

The potential for conflict of interest is also evident in the case of the site auditor, who originally developed site-specific remedial criteria for OCPs at Mapua in 1997. He revised the criteria in 2001 for Egis Consulting Australia Pty Ltd, and they were reviewed in 2003 by GHD Ltd, who by that stage had acquired both Egis Consulting and the services of the site auditor.

Originally the site auditor was paid by MfE to certify aspects of Thiess's proposed remedial works to TDC, a straightforward setup. Subsequently he proposed remedial criteria for other potential contaminants in soils and groundwater.

But after MfE took on the role of consent holder, it was then engaging the site auditor to certify its own performance to TDC. This potential conflict is manageable. However, if the Mapua Financial Contribution Deed requires the site auditor to go further and assess the site's suitability for proposed use (rather than merely assessing compliance with consent conditions), this would pose a problem, as illustrated by the NSW *Guidelines for the Issue of Certificates and Statements of Environmental Audit* under which he is accredited:

> *The auditor must not place him or herself in a position where he or she (or his or her employer) may benefit...or where the auditor is required to audit their own work.*
>
> *Auditors must not issue a Certificate or Statement for any site where they:*
>
> *... have been directly involved in the design or implementation of clean-up or management of the site; this requirement includes any clean-up or management designed or implemented by a company with which the auditor is, or was at the time, associated.*

Remediation planning

Under the Mapua resource consent package, a number of management plans were to be submitted[24] and (by implication[25]) approved by the site auditor, the TDC Compliance Officer and the Peer Review Panel before works began. The key plan was the Remedial Action Plan.

Two Remedial Action Plans were prepared and submitted for the Mapua site: the first by Thiess in 2004 and a replacement by MfE that was continually revised throughout the works and submitted in October 2007. Neither Remedial Action Plan was complete or approved as of April 2008, about six months after the major works on the site had ended.

Community consultation

Thiess undertook extensive consultation with the Mapua community during the planning stages of the project, including organising public meetings, newsletter articles, meetings with residents and groups of residents, and so on. This comprehensive consultation created high expectations within the community about the level of ongoing engagement, and the steps that would be taken to mitigate the impacts of the remedial works on the residents. As shown by correspondence received from members of the community, these expectations were not met.

The site management team (EMS) was available to the community to complain to or to request information about the remediation. Information about the remedial works was also provided at public meetings, through newsletters and monthly progress reports, and on the MfE and TDC websites. However, most site neighbours spoken to in this investigation felt the level of information shared and the mechanisms for sharing it, were insufficient. In particular:

- Some members of the community affected by the remedial works were not aware of public meetings, and others felt the venue for these meetings was not appropriate.
- People were unaware that the monthly progress reports were available in the local library. No interpretation of monitoring results was provided in these reports.
- Newsletters updating residents on progress were infrequent, and meant that neighbours of the site found out about issues at the site through the local media rather than through official channels.

While MfE took a number of steps to provide information to the community, it did not seek assess the effectiveness of the communication.

The EMS site management team was diligent in responding to complaints made by site neighbours about noise, dust, odour and vibration. Action was taken to address the complaints, but there were allegedly frequent breaches of the resource consent conditions, particularly related to dust and noise emissions.[26] Monitoring for dust emissions, noise and vibration was not undertaken in accordance with the resource consent.

During the planning stages of the project, it was identified that properties near the site should not use groundwater as a source of drinking water because of the risk that it could be contaminated with pesticides from the site. Arrangements were made for MfE to provide properties with an alternative drinking water source. Unfortunately, one property, which was using rainwater during the consent process, later pumped groundwater into their rainwater tank. MfE discovered this problem and, following requests by TDC,[27] took action.

3 Soil remediation

The aim of remedial works at Mapua was to reduce the concentrations of the principal contaminants of concern in the soil, namely the organochlorine pesticides DDX and ADL, to levels suitable for proposed future use of the land. This section discusses issues surrounding the soil remediation. A detailed technical review is available in the Soil Technical Annex available on the PCE website.

3.1 The remediation process

Soil acceptance criteria for the Mapua site were developed by the site auditor, and set in resource consent conditions.

These criteria vary across the three parts of the site:

- The East Area must meet criteria for commercial use of the land or open space.
- The West Area must meet criteria for residential use of the land.
- The Landfill Area must meet criteria for recreational use of the land.

To this end, a soil remediation process was implemented, which comprised:

- sampling before work began to classify soils by degree of contamination
- excavating soils and foreshore sediments that did not meet criteria for their location
- the MCD treatment of any soil not meeting criteria for future commercial use of the land
- treatment for residential use (see below)
- shipping some buried pesticides and very highly contaminated soil to Europe for destruction, rather than putting them through the MCD process
- filling soils and treated material into excavations, in such a way that soils in each area of the site then met the required criteria.
- providing a 0.5 metre thick capping layer of residential quality soil over the whole site
- validation sampling and reporting.

This was a very complex exercise, in which over 8,000 soil samples were analysed and more than 60,000 m^3 of soil excavated.

This remediation process is a 'belt-and-braces' exercise, in which future planned land uses were protected both by a reduction in contaminant concentrations, and a capping layer of 'clean soil'. The residential criteria were not met by means of MCD treatment, but by moving contaminated soil out of the residential zoned area and replacing it with 'clean' material. Much of the 'clean' capping material was made up of the least-contaminated site soil.

MfE has commissioned a Validation Report to detail the results of remedial works, and a partial draft exists, dated September 2007.[28] This draft report shows that remedial criteria have been met across the East Area. Results are not yet shown for the West and Landfill Areas.

However, it appears from the draft Validation Report and from an investigation for MfE by CH2M Hill (2007)[29] that foreshore sediments do not yet meet criteria, even after excavation and backfill with imported clean material. Also, sampling of edible mud snails on the foreshore has found that their pesticide content renders them unsuitable for human consumption. Because the CH2M Hill investigation indicates that contamination of the foreshore decreases with distance from site, it appears likely that the imported backfill has been recontaminated by a site source, most likely particulates in run-off. Results of recent monitoring indicate that DDX and ADL concentrations in the snails seemed to have reduced significantly.

3.2 Destruction efficiency

The Assessment of Environmental Effects[30] (AEE) supporting the resource consent application for the works stated that the MCD process would be operated so as to destroy 90 to 95 percent of the mass of DDX and ADL in treated soils. This was reflected in EDL's contract to MfE, which prescribed a minimum 90 percent destruction efficiency.

EDL's Close-out Report to MfE[31] estimated that soil passed through the MCD plant during the works contained a total of 21,177 kilograms of DDX and ADL. Around 45 kg of pesticide was also sent off-site for destruction. The output treated soil was estimated to have contained a total of 2,588 kilograms of pesticide. Therefore the destruction efficiency was approximately 88 percent, slightly less than the minimum of 90 percent predicted in the AEE.

It is difficult to discriminate between overall destruction efficiencies of 88 percent and 90 percent; the MCD was generally successful in destroying OCPs. However, destruction efficiencies in some individual batches of soil were as low as 20 percent, bringing the overall average down. Instead of enforcing the original target, MfE varied EDL's contract in December 2006 to reduce the target to 80 percent. The basis of this decision is not known; if these soils had been treated for longer, the 90 percent target could have been met.

3.3 Time and cost pressures

Site works were planned to take 18 months, but actually took more than three years. MfE has advised that its initial budget for the remedial works was approximately $6 million; the out-turn cost is approximately $12 million. So both the duration and the cost of the works were almost double the predictions.

There seem to have been two main reasons for this:

- Data supplied in EDL's Close-out Report shows that about 8,000 m^3 of soil was processed through the MCD reactor over approximately 580 working days

between February 2005 and July 2007. This equates to production of just 83 m^3 in a full six-day working week, approximately 23 percent less than EDL's contractual target of 108 m^3 per week. This figure does not include the initial period of approximately 70 days between mid-October 2004 and January 2005, in which little or no soil was successfully treated. Even after effective production began, a further 55 days were lost to reprocessing soils that did not meet criteria after one treatment, and 90 days were lost to plant stoppages, perhaps not surprising for such a new technology. With all these delays taken into account, overall production rates were more than 40 percent below target.

Principal causes of slow production seem to have included excessive moisture content in soils to be treated, especially in winter, and mechanical breakdowns. The treatment plant was shut down altogether for maintenance for an extended period between 26 July and 20 September 2005.

- It was originally estimated that 6,161 m^3 of soil would be treated, but the final total treated volume was 8,067 m^3, an increase of more than 30 percent. There was also a shortfall in soil suitable for use as 'clean' capping material, which led to more than 12,000 m^3 of topsoil, clay and gravel being brought onto the site.

As the volume of soil needing treatment was significantly greater than expected, it appears that characterisation of contamination conditions before the works began was insufficient. Because as-built drawings are not yet available, it is not clear where the extra excavation occurred, but it appears that there was little sampling below a depth of 0.5 metres or in the Landfill Area (see Figure 1). There were also some unexpected finds of buried drums and other highly pesticide-contaminated material, particularly along the southern boundary of the residential-zoned FCC West Area.

A minor consequence of time and cost pressure appears to have been that, in mid-2005, two batches of treated soil that did not meet criteria were mixed with less contaminated material instead of being re-treated. Although the site auditor approved this, nonetheless, consistent with good practice overseas, it had been undertaken in the AEE (section 5.2) that this would never be done.

3.4 Inadequate assessment of copper sulfate use

The MCD process, as operated by EDL, used a proprietary mixture of reagents to enhance treatment. At some time between April 2004 when the trials ended and April 2005, the reagent mix was changed to include copper sulfate. Based on advice from EDL, at least 13 tonnes of copper was added to site soils in this way.

Copper is highly toxic to marine ecosystems so it poses a particular hazard on the coastal Mapua site. Its use should have been controlled by a resource consent, but no application was ever made. The site auditor and the Engineer to the Contract warned MfE and EDL on several occasions that they had serious concerns over the use of copper sulfate. Although the amount of copper sulfate was gradually reduced by about a third during the works, a large amount of copper remains.

Two of 58 validation samples from treated soils exceeded copper criteria set by the site auditor for protection of human health in future commercial use, although the actual risk to future users should be effectively minimised by the cover layer of untreated, residential-quality soil. There may still be significant risks to the estuarine environment and to plant life on the site, but no site-specific assessment criteria have been set for these receptors, so these risks have not been formally evaluated.

3.5 Inadequate suites of analysis specified in resource consents

Sampling of soil during the remedial work was concentrated on the contaminants known to be widespread at the Mapua site, mainly DDX and ADL. However, many different pesticides and herbicides were produced at the Mapua site, several in quantities of more than 50 tonnes per year. Some of these other products could also have been present in site soils.

Fortunately, most of these other pesticides and herbicides break down readily in soils, so only trace concentrations should remain on-site since it is at least two decades after production ceased. Further, MCD treatment should also break down most of these compounds along with DDX and ADL. Limited sampling has been undertaken for a wide range of these other contaminants. However, as expected, only trace concentrations were found.

The exceptions appear to be organomercury pesticides manufactured at the site from the 1940s until 1962, in smaller quantities than the OCPs. Metal content of these compounds cannot be broken down. They are very persistent in the environment, so should have been considered contaminants of concern and controlled appropriately in the resource consent package.

Almost all mercury concentrations reported in the draft Validation Report were below acceptance criteria. Only a fraction of soil and water samples, however, were analysed for mercury, so it is uncertain whether there would have been any small 'hotspots' of contamination, especially in the Landfill Area. (For perspective, the total number of soil samples analysed for mercury equates to about one for every 270 m^3 of soil excavated.)

If any such mercury 'hotspots' were present, it is not clear what might have happened to them during the remedial works. If they were excavated, then mixing with other soils would have reduced concentrations, but there would also have been a potential for discharge of mercury in dust and runoff. If mercury-containing soil was treated in the MCD process, the mercury content would not be reduced, but the air emissions control system should have effectively prevented any discharges of mercury as dust.

Any soil containing elevated mercury should pose a minimal risk if (reburied beneath the cover layer); however, if such soil met residential criteria for DDX and ADL it could have been used as capping material.

Alternatively, if mercury wastes were never discharged to land at the Mapua site, they must have been disposed of somewhere else.

3.6 Import of contaminated fill

Approximately 80 m^3 of contaminated soil were brought onto the Mapua site from another nearby site owned by TDC. From TDC's evaluation, it seems likely that DDX was the contaminant of concern in this material, which was found around a DDT dump. This soil was tested for DDT and ADL, and found to contain moderately low concentrations. It appears to have been buried in the East Area.

This import of contaminated fill did not specifically contravene any resource consent. However, it is not recorded in the final volume balance diagram, nor in the draft Validation Report, nor is there any reference to it in the minutes of site management meetings or Peer Review Panel meetings, or in monthly project

reports. While TDC advises it has extensive files on this material, the matter should have been addressed in Mapua project documentation.

It was sensible to take advantage of a rare opportunity to have DDX-contaminated soil treated. But there does not appear to have been any effective control over this process, and it is very poorly documented.

3.7 Summary

Pending the final Validation Report and the site auditor's report, the main purpose of the Mapua remediation – to reduce DDX and ADL concentrations to levels suitable for future use – appears to have been met.

However, the works fell short of the commitments made in the AEE in several respects, particularly when MCD process reagents were changed to include a large quantity of an ecotoxic copper compound.

The Mapua site handled many other pesticides and herbicides, most of which are not expected to remain in soils because they break down naturally. However, organomercury compounds, manufactured on-site from the 1940s until 1962, should have been contaminants of concern. There is no evidence of significant contamination with mercury, but sampling has been limited, and the potential for small 'hotspots' of metal contamination exists. 'Hotspot' soil may be buried beneath the cover layer where it would pose little risk to future users, but may also have been used as capping material.

4 Discharges to air

Serious concerns exist around the discharges to air that arose from the operations on the site. A detailed Air Technical Annex is available on the PCE website.

The resource consent conditions aimed at controlling discharges to air were focused on two matters:

a) the use of a Total Hazard Index (THI) to assess whether people on and around the site were exposed to harmful doses of toxins

b) the management of the process.

4.1 Problems with the consent conditions

In our view, the consent conditions themselves were inadequate:

- The specification of the THI calculation in the resource consent does not list all the relevant exposure pathways or toxins.
- Sampling of Total Suspended Particulates (TSP) was specified, but the methodology for sampling of gases was not.
- The requirement to analyse only a quarter of the particulate samples is likely to have resulted in underestimation of the insoluble dust portion by a factor of two to four. The THI has since been reviewed and the latest version corrects this flaw.

These errors may be due to a lack of specialist air quality knowledge available to TDC during the resource consenting process, but it is surprising that MfE or its consultants did not identify these problems when they engaged operationally with the project.

4.2 The Total Hazard Index (THI)

The THI was designed to assess the likely dose of toxins received by persons on and around the site, monthly to six monthly,[32] using data measured on the site, and modelled deposition and fine dust data. If the value of the THI exceeded 1.0 for any period, then work had to cease until the situation was resolved.

To effectively protect people exposed to emissions to air, the THI:

- must include all the relevant exposure pathways
- must include all the relevant toxins
- must be calculated with input data that is robust and valid.

Each of these issues is explored below.

Exposure pathways

The THI did not initially include all relevant exposure pathways. MfE, on the advice of the Peer Review Panel, funded some work to improve the THI. This was completed in May 2007. TDC and Nelson Marlborough District Health Board have since funded further work to add additional exposure pathways and correct other deficiencies. The methodology for the calculation of the THI, in terms of exposure pathways and adjustments to allow for deficiencies in monitoring data, is now on a firmer footing.

Relevant toxins

The resource consent specified the same suite of substances to be analysed in the dust samples and in the stack samples. However, the suite of substances prescribed for the sampling is very limited.

Discharges to air from the *MCD process* could be expected to include contaminants known to be present in the soil (but not destroyed by the process), reagents added to the MCD process, substances possibly formed during the process itself (especially those detected in the trials), and obvious breakdown products. These would reasonably seem to include dioxins and compounds mercury.

Discharges to air from the *general site operations* might be expected to include contaminants known to be present in the soil (and which persisted), and obvious breakdown products. These might reasonably include OCPs, dioxins, mercury compounds, and possibly PCBs. While less likely, they may also include atrazine, pentachlorophenol and arsenic.

From the resource consent,[33] 10 substances were required to be tested for in the particulate samples, representing a suite of OCPs and three metals. But the suite required to be tested for was very narrow, given both the known history of the site, and the form of what had been discovered (i.e. drums and large amounts of pure substances).

The most notable omissions included dioxins and mercury compounds. The concern is that these other substances were neither measured nor included in the THI, so it is impossible to work out what exposure (if any) people had to them.

It is not possible to know for certain whether toxins other than those measured were emitted from the site. If there were such emissions, the THI will under-represent the dose of toxins people have received from the site. This is a significant concern.

The robustness and validity of data

To be effective the THI must also be calculated with robust and valid data.

Particulate sampling

Three months into the sampling (January 2005), new air quality consultants realised that sampling of gases as well as sampling of particulates would be required to better assess the emissions to air. To achieve this, the standard aerosol samplers (which measure particulates) were replaced by polyurethane foam (PUF) samplers.

However, while the PUF samplers can be effective for monitoring volatile organics, they are not as effective for monitoring particulates.[34] For technical reasons, the PUF samplers were likely to have sampled very few particulates larger than 10 microns in diameter, that is, the minority of the particulate mass. The likely outcome of this

inadequate sampling of particulates by the PUF samplers is an *over-estimation* of contaminant loads (see Air Technical Annex).

By changing the samplers from aerosol samplers to PUF samplers, rather than using both types of samplers, it appears that the consent holders breached their conditions because they did not measure TSP as required[35] and potentially compromised the calculation of the THI. However, the result would have been to make the THI higher and therefore more protective for the substances measured. This does not affect the problem of the substances not measured.

Under consent condition 25,[36] the consent holders were required to measure PM_{10} concentrations at the beginning of the remediation. This was done. Condition 26 required them to measure PM_{10} "...on at least ten days of maximum site remediation operations[37]..." and, contingent on the results, potentially further measurements. On the basis that the results from the initial proof-of-performance testing measurements were low, this was not done, and appears to be a breach of condition 26 (see Air Technical Annex).

Gaseous sampling

It appears that the PUF samplers were used over an extended period – for periods of about a month, as opposed to the design period of 24 hours. By using them in this way, it is possible the pesticides adsorbed on the sampler may have subsequently desorbed over the period, so when analysed, the sampler would have indicated lower average concentrations than were actually present in the air over the period of the monitoring.

To test whether this was the case, TDC asked MfE to commission radioactively labelled 'spike tests' on the samplers. This involves adding a known amount of a mix of radioactively labelled pesticide to the sampler, then running the sampler for an extended period of time (comparable to that for which the samplers were actually deployed), and assessing how much of the labelled pesticides remained on the sampler.

This was a reasonable request as samplers pre-loaded with labelled pesticides are available in New Zealand. In August 2007, the spike testing was carried out, but radioactive labelling was not used. Without radioactive labelling, it is not possible to subtract background concentrations of pesticides.

The results of the spike tests were thus of very limited use, and gave inconsistent recoveries of 0.08 percent to 80 percent for different pesticides, with the more volatile pesticides having the poorest recoveries.

Because the spike testing was not reliable, two other proxy methods were used to shed light on the efficiencies of the PUF samplers (see Air Technical Annex). Neither of these alternative methods gave an unequivocal result. However, the degree of correspondence between the different methods suggests that the data has some credibility, although is likely to be under-sampled. This, in turn, implies that the THI calculations based on this data are probably a little lower than they should be; that is, the THI slightly underestimates the doses people received.

There are methodological shortcomings in both the particulate and gaseous sampling undertaken at the site. While some of these deficiencies have been estimated (allowing adjustment of the THI), the gaseous samples, in particular, do not seem correctable with any degree of certainty.

However, given the maximum average range of the THI was 0.25 to 0.46,[38] the THI probably remained below the protective value of 1.0 for the substances measured. Again, this does *not* include any substances *not* measured.

4.3 Management of the process

The Remedial Action Plan specified not only what actions should be carried out but, more importantly, *how* those actions should be carried out in order to comply with the conditions of the resource consents. As noted earlier in this report, the Remedial Action Plan has still not been approved.

General site works

Many complaints were made during the course of the works – mainly about dust, noise and odour. It would not have been possible to stop dust leaving the site. Dust generation was obviously worse on windy days and was generally proportional to work rate.

The plant processed more soil that was envisaged in the resource consent, was generally unable to process soil at the rate required in the Proof of Performance, and was shut down during the work for longer periods than had been envisaged. All these factors incentivised EDL to work the plant harder and permission to run the plant for more hours each week was granted more than once.[39] Accordingly, site management on the ground (EMS) may have had limited room for manoeuvre to reduce the rate of work (and hence the dust) during adverse conditions.

It is also likely that the analysis of the dust deposition gauges was compromised (see Air Technical Annex), not showing site management the true nature of the situation.

Taking all this into account, it seems unlikely that dust emissions from the site were "minimised",[40] and were likely to have been in breach of the conditions much more often than it appears from the record.

The MCD process

For the MCD process to function efficiently, the soil being decontaminated must be dry. However, if contaminated soil particles in the drier come into contact with air above 250°C, organochlorine pesticides (OCPs) in the soil may be converted to form dioxin. This happened in one of the Proof-of-Performance trials, so specific precautions were included to prevent this situation arising during normal operations. In essence, the condition required the hottest part of the drier (the inlet) to be fitted with a temperature cut-off, which would shut the drier down if the temperature exceeded 120°C. This was to reduce the volatilisation of OCPs, and prevent the de novo formation of dioxins.

Measurements of inlet temperatures in February 2006 seem to indicate that these were below the specified limit of 120°C.[41] However, these measurements were inconsistent with calculations[42] which indicate that temperatures at the drier inlet must have usually have been at least 250–380°C (the temperature depends on the water content of the soil). The design of the drier was such that, had this resource consent condition[43] regarding the temperature cut-off been implemented, the soil throughput would likely have been about 15 percent of what was actually processed. This means that the plant EDL installed was not capable of complying with the temperature consent condition and functioning at the throughput envisaged.

MfE and TDC failed to reach agreement about where the temperature should be measured until the works were close to completion. TDC argued that the temperature should be measured at the inlet of the drier, while MfE argued it should be at the (cooler) outlet. In March 2007, TDC agreed an amendment to the resource consent condition to measure the temperature at the outlet. In any event, the cut-off at the inlet of the soil drier seems never to have been fitted, although a cut-off was fitted at the outlet.[44]

Post October 2005

The argument for the amendment to the temperature condition was that even if dioxins were produced in the drier, they would have been trapped by the air emission control system (AECS). Indeed, dioxins were found in the activated carbon of the AECS in September/October 2006, and in stack samples in March 2007. The average chamber temperatures at these times were 303°C in September/October 2006 and 243°C in March 2007. (To avoid *de novo* dioxin formation, the temperature of air in contact with soil particles must be less than 250°C; at the chamber temperatures recorded, it is not possible to say if this was the case.)

For a substantial proportion of time after the dioxin test on the carbon filters, the drier operated at much hotter temperatures (chamber temperatures up to 396°C in May 2007).[45] This means that it is not certain that there was negligible dioxin formation at all times after early 2006. These chamber temperatures are well within the de novo dioxin synthesis range, but as the soil dried on its progression down the drier, it would be expected that the temperature fell. It is likely that by the time the dry soil produced dust particles (a requirement for *de novo* dioxin formation), the temperature would be much cooler, with the amount of dioxin formation remaining acceptably low. The problem is that this cannot be proved.

The stack measurement emissions programme was designed to sample, at certain intervals, emissions from plant under normal working conditions, to test whether all the various components of the system were acting to prevent emissions of key toxins. The results were reassuringly low for the substances measured, indicating that the THI estimate of toxins dose to people might give a reasonable picture of the situation from early 2006 onwards.

Pre November 2005

In the early period of the remediation (up to November 2005), the situation was potentially of much more concern. No reliable record of drier temperatures exists before February 2006. Through December 2004 to October 2005 significant problems occurred with the carbon filter in the AECS. However, given its location in the plant, it is possible that it was "almost entirely ineffective" anyway.[46, 47] Four times during that period, the carbon filters failed entirely and for some of that period the plant was running without them. Had dioxins or anything else (e.g. sulphur dioxide, hydrogen chloride) been produced in the drier, it is likely they would have been emitted from the plant.

So in the early part of the works (up to September 2005) it is possible that the plant was operated in a way that produced toxins not accounted for in the THI. This is a significant concern.

The air emissions control system

The air emissions control system (AECS) was the part of the MCD designed to prevent emissions of gases or particulates from the plant.

The AECS set up on the site differed from the system presented at the Hearing. The key differences were that:

- the carbon filter arrangement was proposed as two filters in series, but installed as a single filter, reducing the capacity and security of the carbon filter component
- the AECS installed on-site did not seem to have a packed bed scrubber, reducing its effectiveness and, potentially, its reliability.

These changes reduced the redundancy in the system, hence its reliability.

There seems to be a fundamental problem with the function of the AECS as installed. The AECS was a collection of components, each capable of performing its function in isolation. However, it is difficult to see a configuration that could have enabled these components to work effectively in the context of the AECS.

To resolve a number of serious operating problems, the design of the system was changed in September 2005 when the order of the scrubber and carbon filter was reversed, and the direction of flow through the carbon filter was also reversed. This is likely to have made the plant safer (by reducing back pressure), but at the same time compromised the efficiency of the carbon filter in a different way.[48]

Other matters

Even with the AECS working, it appears that fugitive emissions from the drier and the rest of the MCD have been assumed to be negligible.

However, the rotary-type drier employed as part of the MCD was directly connected to the outside air, and the provision of a fan to move the substances emitted from the soil into the AECS would probably not have prevented emissions directly from the drier. This is even more likely since in the early life of the plant there seem to have been back-pressure problems.[49] Under that scenario, a proportion of the emissions from the drier may have been released directly to air, not via the AECS.

The situation is further complicated in that a baffle plate between the burner flame and the soil inlet chute (designed to prevent the burner flame contacting soil dust particles) may not have been fitted for part of the period of the works.[50]

These represent serious and significant issues if a proportion of the emissions from the drier were being released directly to the atmosphere for any length of time.

4.4 Summary

Two matters stand out as being of serious significance:

1. The limited range of the substances measured means that people may have been exposed to a range of toxins, most notably dioxins as well as mercury compounds, especially between September 2004 and November 2005.
2. The design and management of the plant meant that from June 2004 until November 2005, the risk of the generation and emission of a range of toxins, most notably dioxins, was elevated.

5 Discharges to water

Water quality was a secondary consideration in the remedial works at Mapua.

Water quality in the shallow, unconfined aquifer underlying the contaminated site at Mapua and nearby properties is likely to be of concern, however, for current and future residents. Taking small quantities of water for domestic purposes is generally a Permitted Activity in Tasman District, and several properties in the vicinity already have wells for irrigation and drinking water. Groundwater use is not essential, however, because reticulated water supplies are now available to the contaminated site at Mapua and nearby properties.

Site groundwater also discharges to the Waimea Inlet, where it can pose a hazard to surface water quality, the estuarine ecosystem, and to human health through consumption of seafood. Dilution into the tidal waters of the estuary is likely to limit any impact to the vicinity of the contaminated site.

In this section groundwater quality at the contaminated site at Mapua during works, and stormwater and sediment management are discussed. A detailed Water Technical Annex is available on the PCE website.

5.1 Groundwater flow patterns

Shallow groundwater modelling carried out before and during remedial works indicates that groundwater flows into the contaminated site at Mapua site the northwest. Rainfall recharge is another important source of water.

The highest residual concentrations of contamination are in soil replaced above the groundwater table in the commercial-zoned FCC East Area. Groundwater from this area discharges to the Mapua Channel, hindered by less permeable soils and clay bunding placed along the foreshore.

The FCC West Area, where the MCD treatment plant was located during works, was remediated to a higher (residential) standard. Groundwater in this area discharges both south toward neighbouring properties down Tahi Street, and also west through the Landfill Area, along the line of the stormwater drain, and around the clay bund along the Waimea Estuary foreshore.

Before earthworks started, this general picture must have been distorted by the large number of disused sumps, drains and other buried features. These undoubtedly formed preferential flow pathways that facilitated discharge of contamination from some areas. Where found, these features were removed or blocked during the remediation.

5.2 Water quality monitoring

Before remediation began, six wells for monitoring groundwater were installed around the site boundaries, down hydraulic gradient of the works. Four down-gradient residential bores were also selected for regular monitoring.

Initially water quality on site was marginally unacceptable, with DDX and ADL often slightly exceeding groundwater threshold concentrations as set out in the resource consents for the works. Two samples taken from the West Area in 1994 would also have exceeded the consent threshold concentration for mercury. There was little impact from pesticides on residential bores, where only traces of DDE and dieldrin had been detected.

During works, samples were collected monthly from monitoring wells and quarterly from residential bores. These were mainly tested for DDX and ADL.

In mid-2005, the site auditor raised concerns about quantities of diammonium phosphate (DAP) and urea being used as MCD process additives. At least 730 tonnes of DAP and 36 tonnes of urea were added to site soils in this way. This is of concern because these nutrients are readily leachable and could be discharged to the estuary in groundwater, causing weed growth and eutrophication. Nitrate and ammoniacal nitrogen were therefore added to the groundwater testing suite later that year.

Contaminants of less concern, including other pesticides, herbicides and metals, were tested less frequently.

Groundwater monitoring results show that DDT, lindane, nitrate and ammoniacal nitrogen frequently exceeded consent threshold concentrations throughout the works, often by orders of magnitude, especially in the monitoring wells on the southern boundary. Concentrations of copper, another MCD process additive, increased erratically throughout the works, again especially on the southern boundary, and on one occasion (January 2007, Landfill Area) exceeding threshold concentration. Nitrate and sometimes DDT became elevated above threshold in the closest residential bores at 13 and 26 Tahi Street.

The actual extent of impact on estuarine water has not been investigated.

5.3 Consent compliance

Resource consents for the works required MfE as the consent holder to "take all practical steps to limit the discharge and migration of contaminants in groundwater". If contaminant concentrations in any groundwater sample exceeded threshold concentrations, MfE was required to confirm by re-testing, determine the source of contamination by sampling up-gradient groundwater, and implement corrective measures.

Groundwater monitoring showed that contamination has exceeded consent thresholds since April 2005 – that is, for more than three years and more than 30 rounds of sampling. The source of the contamination has not been identified, despite three formal requests by TDC for additional monitoring in June 2006, August 2006 and March 2007, citing the resource consents. A groundwater investigation was conducted for MfE by CH2M Hill in mid-2007, but was not done in accordance with recommendations made in May 2006 by the site auditor and Peer Review Panel and, in particular, did not include any up-gradient sampling.

MfE did remove a soakhole by the EDL pad in December 2005 at TDC's request, and replaced it with a lined impoundment pond. Also, the TDC compliance report for May 2006 commented that EMS was "altering site practices to try and minimise the amount of time [contaminated soil] is exposed and able to leach contaminants into the groundwater, both on the East and West". Nonetheless, groundwater quality did not improve, so these corrective measures cannot be considered effective.

As the remediation resource consents expired in November 2007, MfE has now ceased groundwater monitoring at the Mapua site. There appear to be no plans for further works to address groundwater quality. TDC has continued quarterly monitoring since the consent expired, although, because the Mapua Financial Settlement Deed has not been signed, it is unclear where the financial liability lies for ongoing works of this sort.

5.4 Mitigation options

The site auditor advised MfE in April 2005 that groundwater inflow from the north of the Mapua site could readily be diverted to the estuary via French drains along the northern boundaries. This would be expected to substantially reduce groundwater flow through the site. It would also be expected to lower the groundwater table, potentially breaking the contact between groundwater and soils with residual contamination, and reducing leaching of contaminants.

Overall, contaminant discharges in groundwater should be reduced, although it is not clear when or whether they would then meet threshold concentrations. This solution was one of a number of options and was not implemented at the time, but could still be undertaken at any time.

5.5 Summary

Groundwater monitoring at the Mapua site has shown that contaminants including DDT, lindane, nitrate and ammoniacal nitrogen have exceeded consent thresholds since April 2005. Nitrate and ammoniacal nitrogen appear to derive from process additives used in the remedial works. These contaminants are being discharged off-site into the Waimea Inlet and into wells on nearby residential properties, potentially affecting the estuarine ecosystem, water quality and human health.

MfE has taken no effective action to reduce contaminant discharges in groundwater, or determine their source, despite consent obligations, requests from TDC, and advice from the site auditor and Peer Review Panel.

6 Conclusions and recommendations

This is the first of two reports on the remediation of the contaminated site at Mapua. The second report will be compiled after the site auditor's statement is available.

Site auditors

The use of an experienced site auditor to provide advice to the consent holder during the remedial works no doubt reduced some of the potential environmental impacts of the work, as this complex and challenging project unfolded.

The site auditor also developed site-specific remedial criteria and monitoring schemes, and was expected to approve remedial action plans and site management plans. It would be beneficial for similar provisions to be made in future significant remediation projects. However, New Zealand has no site auditor scheme and the RMA does not include a specific framework for environmental auditing. (For Mapua, the site auditor was accredited in Australia, and the legal basis and scope of his role were poorly defined.) The RMA does seem to contain several mechanisms that could be used as a basis for environmental auditing. These include:

- the ability to set certifier requirements in National Environmental Standards, regional or district plans, or specific conditions of consent
- provisions for information requests by consent authorities, hearing committees and the Environment Court
- provisions for the Environment Court to appoint Environment Commissioners and special advisors to assist it in making decisions.

I therefore recommend that:

1. **The Minister for the Environment establishes a mechanism for appointing a pool of independent, technically expert environmental auditors to assist with the management and remediation of contaminated land; and develops guidelines for when an accredited environmental auditor may be required, and the matters that such auditors may certify.**

The National Environmental Standard for Contaminated Land currently under development by MfE would seem to be an appropriate resource for providing such guidance.

Validation Report

The Validation Report for remedial works at Mapua was due in mid-2007 and is not yet complete.

I recommend that:

2. **The Minister for the Environment directs the Ministry for the Environment to complete the validation report no later than 31 October 2008, and have it reviewed by another site auditor no later than 31 December 2008.**

Possible future use of the MCD technology in New Zealand

Pending the Validation Report, however, it seems that the novel process employed for destroying organochlorine pesticides was successful in reducing concentrations to within remedial criteria for commercial land use. This is a laudable achievement, but serious concerns exist as to the way in which the novel MCD technology was deployed at the Mapua site, particularly in regard to emissions control.

I recommend that:

3. **The Minister for the Environment issues a short technical statement outlining the experience gained from use of the MCD technology for remediating soil contaminated with OCPs for the benefit of future users of this technology.**

Discharges to air

There is a potential for hazardous substances, potentially including mercury and dioxin compounds, to have been discharged discharged as fugitive dust or in air emissions from the MCD treatment plant at Mapua. If these toxins were emitted to air, the amount may have been insignificant. As previously discussed, the problem is that inadequate monitoring systems have rendered the monitoring data of little value.

As the works have been completed and the plant decommissioned, there is little scope for conducting any further environmental monitoring (in terms of air emissions from the plant) to assess any resulting adverse effects.

Matters relating to human health, and workplace safety and health have been referred to the Ministry of Health and the Department of Labour, so I am making no specific recommendations on this point.

Further soil sampling

Small quantities of mercury-containing pesticides were produced at the Mapua site before the advent of more modern pesticides, and associated wastes may have been discharged to land. The mercury content does not break down over time, so it is possible that small volumes of site soils still contain elevated concentrations of mercury. Because sampling for these contaminants was limited, it is possible they could be present, even in site-sourced ‘clean’ cover material.

To ensure that the West Area is suitable for residential development, I recommend that:

4. **Tasman District Council, as site owner, conduct further soil sampling across parts of the site zoned for residential development, to assess whether or not any residual mercury exceeds remedial criteria in the cover layer.**

The use of copper sulfate as a reagent

The use of large quantities of copper-containing reagent in MCD treatment of soils was unsatisfactory, and should have been controlled by further resource consent. Although not constituting a human health hazard, the potential for environmental consequences was raised by the site auditor and should have been addressed during works by MfE, EDL, the Engineer to the Contract, the Peer Review Panel and TDC.

I recommend that:

5. **The site auditor's review include an assessment of the probable environmental impacts of copper use in the remedial works at Mapua, and make recommendations as to any further studies, remedial actions or covenants that may be necessary to prevent further degradation of the estuary.**

Remedial action

There is also evidence that groundwater on and adjacent to the Mapua site, and sediment quality in the estuary, fail to meet remedial criteria set out in the resource consent package.

I recommend that:

6. **The Minister for the Environment directs the Ministry for the Environment to take further remedial action as advised by the site auditor, to ensure that groundwater and sediment impacted by contaminants from the Mapua site meet remedial criteria to the extent currently achievable, before May 2009.**

Operational management capability of MfE

For its part, reflecting its principal role as a policy organisation, MfE's capacity to evaluate and respond to technical issues appeared insufficient for this operational project.

I recommend that:

7. **If MfE is to perform operational functions, the Secretary for the Environment ensures that these functions are clearly defined and supported by the appropriate in-house technical capability.**

Containment vs remediation

There are many contaminated sites in New Zealand, and the action to be taken at each will be particular to the circumstances. For many sites, containment rather than remediation may well be the best option, both environmentally and financially.

I recommend that:

8. **National and regional policy-makers recognise that a containment strategy for many contaminated sites may be optimal environmentally as well as financially.**

Glossary

2,4-D	An organochlorine pesticide
abatement notice	A formal order, issued by a regional council or local territorial authority, requiring compliance with resource consent conditions within the time specified in the notice
activated carbon	An amorphous form of carbon. Its chemical nature, high surface area and porosity make it an ideal medium for the removal of organic pollutants from liquid or gas streams.
ADL	A collective term for aldrin, dieldrin and lindane, three organochlorine pesticides
adsorbed	Gathering of gas, liquid or a dissolved substance on a surface in a condensed layer
AECS	Air Emissions Control System
AEE	Assessment of Environmental Effects: a report outlining the effects that a proposed activity might have on the environment; required under the RMA for resource consent applications
aerosol sampler	Device used to collect samples, which are analysed for specific liquid or solid particles in the air
AES Ltd.	Air quality and environmental consultants
aldrin	An organochlorine pesticide
ammoniacal nitrogen	Nitrogen combined with hydrogen
aquifer	Any geological formation containing or conducting groundwater
arsenical compounds	Arsenic bonded with various other elements
atrazine	A herbicide
backfill (verb)	The restoration of excavated gravel or earth against a structure or back into a hole
backfill (noun)	The gravel or dirt that is replaced into a hole or against a structure
back pressure	The resistance to the flow of gas or liquid through the exhaust
ball mill	A grinder for reducing hard materials to powder, where the grinding is carried out by the pounding and rolling of ceramic or steel balls within a cylinder
belt and braces	To have additional levels of protection
breakdown products	Product resulting from a chemical breaking apart into smaller pieces
bund wall	A wall erected to prevent the escape of stored liquids into the surrounding environment
cadmium	A heavy metal
capping	Placement of a covering (cap) of one or more layers of sand, silt, rock or synthetic fabric over an established layer of contaminated earth; designed to prevent pollutants from migrating into surrounding waters by providing a physical and chemical seal
carbon filter	A filter employing activated carbon to remove particles from the air
Ceres Pacific	An historic owner of the Fruitgrowers Chemical Company (FCC)
chlorophenoxyacetic acid herbicides	A class of pesticides that mimic plant hormones
CH2M Hill	Environmental and engineering consultants

clay bunding	Construction of a bund wall using clay
cleanup	Remediation of a contaminated site
Close-out Report	A report compiled at the end of a project, which determines if the expectations established as the project outcome were met
CMPS&F	Environmental consultants
consent authority	The agency whose permission is required to carry out an activity for which a resource consent is required under the RMA. The agency granting such permission may be the Minister of Conservation, a regional council, a territorial authority, or a local authority that is both a regional council and a territorial authority.
consent holder	The individual, company or agency to which a consent authority has issued a resource consent
containment	The process of keeping hazardous wastes confined to a particular location, so as to prevent their accidental release into the surrounding environment
contaminated land	Land identified as posing a significant possibility of significant harm to human health or the environment due to substances present in, or under, the ground
copper sulfate	A copper salt
Crown	Includes all Ministers of the Crown and government departments, but does not include Offices of Parliament, Crown entities (organisations listed in the Crown Entities Act 2004) or state enterprises
Crown immunity	Section 4(5) of the RMA states "no enforcement order, abatement notice, excessive noise directive, or information shall be issued against the Crown".
cut-off wall	A collar (metal, concrete etc.) placed around a culvert to prevent water flowing around the outside of the culvert
DAP	Diammonium phosphate
DDD	A breakdown product of DDT
DDE	A breakdown product of DDT
DDT	An organochlorine pesticide.
DDX	The sum of DDT and its primary breakdown products
dehalogenation	The reduction or removal of halogens from a chemical compound. Halogens are various non-metallic elements that readily combine with metals. Halogenated compounds are more likely to be toxic.
de novo	Latin: to make anew
desorbed	To remove condensate from a surface upon which a gas, liquid or dissolved substance has been adsorbed
destruction efficiency target	The agreed percentage destruction of OCP contaminants in treated soil; also known as the Destruction / Removal Efficiency (DRE) target
dieldrin	An organochlorine pesticide
dioxin	Any of a group of toxic chlorinated compounds known chemically as dibenzo-p-dioxins; produced as a by-product of chemical production or combustion and are widespread pollutants in the environment.
discharge stack	A walled enclosure extending upward to direct exhaust air vertically away from fans
down-gradient	Areas in an aquifer with lower water levels
drier	A device used to heat and dry the contaminated soil

East Area	The eastern area of the Mapua contaminated site
ecotoxic	Substances that may present immediate or delayed risks to one or more parts of the environment
EDL	Environmental Decontamination Limited
Egis Consulting	An environmental consultancy
elemental sulfur	A chemical that is a very strong acidification agent
EMS	Effective Management Service Limited
enforcement order	An order issued by the Environment Court requiring a consent holder to comply with resource consent conditions within the time specified in the order
entrained	Carried along in a current
estuarine	Found in estuaries (the mouth of a river)
eutrophication	The process by which a body of water acquires a high concentration of plant nutrients, especially nitrates or phosphates, resulting in algae growth and depletion of dissolved oxygen in the water. This natural process can be greatly accelerated by human activities.
FCC	Fruitgrowers Chemical Company
FCC East	Eastern part of the Mapua contaminated site
FCC West	Western part of the Mapua contaminated site
French drains	A perforated pipe placed in a gravel-filled pit, where liquid is poured into the drain and then permeates through into gravel
fugitive emissions	Emissions not caught by a capture system (due to factors such as equipment leaks, evaporative processes and/or wind)
governance	Exercise of authority and management, including management of accountability
Greenpeace New Zealand	An environmental lobby group
groundwater	All water which is below the surface of the ground in a saturated zone and in direct contact with the subsoil
heavy metals	Metallic elements with high atomic weights or density, such as mercury, cadmium, arsenic and lead. Many heavy metals are toxic and, since they do not easily break down, tend to accumulate in the food chain.
herbicide	Any pesticide used to destroy or inhibit plant growth
hotspots	Localised areas where the concentration of contaminants is high relative to the surrounding area
hydrocarbons	Organic compounds that contain only carbon and hydrogen
impoundment pond	An area with bunding, designed to prevent the escape of stored liquids into the surrounding environment
in situ	Latin: present at the site, in place. Refers here to the treatment of hazardous waste on site, without removing them to another location.
landfill	A site used for the disposal of solid waste
leachable	Able to be removed by the action of a percolating liquid
Lime and Marble	A mineral processing company, later known as Mintech
lindane	An organochlorine pesticide
low-lying areas	Areas of land lower than the surrounding area, into which water tends to accumulate

Manco Environmental Ltd.	Manufacturer, importer and distributor of waste collection equipment; associate company of EDL
Mapua Task Force	Group of councillors, residents and community representatives established to guide the TDC's management of site investigations and decisions on the clean-up
MCD	Mechano-Chemical Dehalogenation
metabolites	A substance that is the product of biological (metabolic) changes to a chemical
MfE	Ministry for the Environment
micron	1/1,000 of a millimetre or 1/1,000,000 of a metre
microniser	Device designed to reduce a substance to particles that are only a few microns in diameter
Mintech	A mineral processing company, formerly known as Lime and Marble
MWH	Montgomery Watson Harza Limited
National Environmental Standard	Tool provided for by the RMA; used to set nationwide standards for the state of a national resource
Nelson Marlborough District Health Board	An organisation established to protect, promote and improve the health and independence of the population in the Nelson - Marlborough District; also NMDHB
NSW	New South Wales, Australia
NZ	New Zealand
OCPs	organochlorine pesticides
organics	Natural organic materials of waste or non-waste origin, including petroleum products, pesticides, herbicides, solvents, and chemicals from decaying plants and animals
organochoride pesticides	Synthetic organic compounds containing chlorine; also known as chlorinated hydrocarbons. Includes pesticides such as DDT, aldrin, dieldrin and lindane. Found to be toxic to non-target species, persist in the environment, and have a propensity to accumulate in the food chain.
organomercury compounds	Mercury bonded with carbon; organic mercury compounds are also called organomercurials.
organophosphate	A group of organic compounds consisting of phosphorus bonded with carbon. Organophosphate pesticides break down rapidly when exposed to sunlight, air and soil.
orphaned site	Contaminated site where either no party can be fixed with legal liability, or the liable party is unable to fully fund the remediation
out-turn cost	The final cost at the end of the project
paraquat	An organochlorine pesticide
particulates	Sum of all microscopic liquid and solid particles, of human and natural origin, that remain suspended in a medium such as air for some time. Particulate matter may be in the form of fog, fumes, dust, soot or fly ash.
PCBs	polychlorinated biphenyls
PCE	Parliamentary Commissioner for the Environment
pesticide	Chemicals used to kill, control, repel or mitigate any pest; includes herbicides (to control weeds and plants), insecticides (to control insects), fungicides (to control fungi), rodenticides (to control rodents) and germicides (to control bacteria).

pentachlorophenol	A chemical, also known as PCP, historically used as an anti-sapstain fungicide for short-term protection of sawn timber surfaces
phenoxy herbicides	A group of herbicides derived from phenoxy-acetic acid
PM_{10}	Particulate matter classified as 'coarse and fine' based on the size of their aerodynamic particles
PMP	Project Management Plan
polychlorinated biphenyls	A class of chemical compounds containing benzene and chlorine atoms. Some are used for pesticides and fire-resistant coatings.
PUF	polyurethane foam sampler
pug mill	A device that mixes and grinds clay or other materials to a desired texture, using rotating paddles or blades
rainfall recharge	The process of adding water to an aquifer
RCC	resource consent condition
reagent	A substance used to react with another substance.
remediation	The clean-up or mitigation of risks from contaminants in soil
resource consent	Permission granted by a consent authority for an activity that might affect the environment and is not permitted 'as of right' in a District or Regional Plan
RMA	Resource Management Act 1991
rotary-type drier	A mixing apparatus using rotation, as opposed to other options such as kneading, pulverising or stirring
Royal Forest and Bird Protection Society of New Zealand Inc.	An environmental lobby group
run-off	That element of precipitation that finds its way into streams and rivers
slag	Waste product formed from the heating of ore in a furnace
soakhole	An excavated pit where holes have been driven into the rock and then covered over, without being filled, so that stormwater can drain into the ground
soil acceptance criteria	Soil guideline values defining the levels of contaminants that are not considered to pose an unacceptable risk to human health or the environment
soil drier	A device used to heat and dry the contaminated soil
spike tests	Identification of the amount of pesticides remaining on a sampler after extended use through the use of radioactively labelled samples
stack emissions	Emissions to the atmosphere from a chimney or stack
stormwater	Precipitation that accumulates in natural and/or constructed storage and drainage systems during and immediately following a storm event
stormwater drains	Openings leading to underground pipes or open ditches for carrying surface run-off
TDC	Tasman District Council
Thiess Services	A specialist remediation contractor
THI	Total Hazard Index
topsoil	The fertile, upper part of the soil

triazines	A group of herbicides typically used on field crops; they have a relatively high solubility and slower degradation time compared to other types of herbicide
TRMP	Tasman Resource Management Plan
TSPs	Total Suspended Particulates
unitary authority	A territorial authority carrying out the roles of both regional and district councils under the RMA
up-gradient	Areas in an aquifer with higher water levels
Validation Report	A site validation report; assesses the results of post-remediation testing against clean-up criteria for a contaminated site
venturi	A short tube with a constricted throat used to determine fluid pressures and velocities by measurement of differential pressures generated at the throat as a fluid traverses the tube
venturi scrubber	An air pollution control device in which the liquid injected at the throat is used to scrub particulate matter from the gas flowing through the tube
volatile organics	Organics that will evaporate into the air naturally from water
West Area	The western area of the Mapua contaminated site
Woodward-Clyde (NZ) Ltd.	Environmental consultants, now known as URS Corporation New Zealand

Endnotes

1 Mapua Groundwater Analysis, September 2007. Chemsearch, University of Otago for the Ministry for the Environment (November 2007).

2 Statement of Evidence in the matter of the RMA and the applications by Thiess Services for resource consents to remediate contaminated land at the old Fruitgrowers Chemical Company site at Mapua, Andrew Fenemor, chair, Peer Review Panel, 18 August 2003.

3 Statement of Evidence in the matter of the RMA and the applications by Thiess Services for resource consents to remediate contaminated land at the old Fruitgrowers Chemical Company site at Mapua, Andrew Fenemor, chair, Peer Review Panel, 18 August 2003.

4 Supplementary Estimates for Appropriation for the year ending 30 June 2003: 194.

5 Estimates of Appropriations for the Government of New Zealand for the year ending 30 June 2001: 518.

6 Original Remedial Action Plan, 2004: 3.

7 Proof of Performance Report on the MCD Technology, EDL, June 2004: 26.

8 Email from Jenny Easton, Compliance Officer, Tasman District Council to Dennis Bush-King, Head of Environment & Planning, Tasman District Council, 15 February 2005.

9 Proof of Performance Report on the MCD Technology, EDL, June 2004: 31.

10 Proof of Performance Report on the MCD Technology, EDL, June 2004.

11 Barry Carbon, Chief Executive, Ministry for the Environment, pers. comm. to Bob Dickinson, 13 July 2004. Ministry for the Environment, account of meeting between Ministry for the Environment, Tasman District Council and Thiess Pty Ltd; Chart Room, James Cook Chancellor Hotel, Wellington, 16 July 2004.

12 Then Minister for Environment Hon Simon Upton; see Statement of Evidence by Andrew Fenemor in the matter of the RMA and the applications by Thiess Services for resource consents to remediate contaminated land at the old Fruitgrowers Chemical Company site at Mapua, 18 August 2003.

13 Memo from Nigel Ironside, Sustainable Business Manager, Ministry for the Environment, to Peter Nadebaum, Mapua site auditor, 1 June 2000.

14 Memo from Nigel Ironside, Sustainable Business Manager, Ministry for the Environment, to Peter Nadebaum, Mapua site auditor, 1 June 2000.

15 Letter from P. Wylie, Chief Executive, Tasman District Council to the Parliamentary Commissioner for the Environment, 2 July 2008.

16 Royal Forest and Bird Protection Society of New Zealand, Notice to Environment Court on Decision concerning resource consents and water permits RMA 0862/03, 28 October 2003

17 Greenpeace New Zealand, Notice to Environment Court on Decision concerning resource consents and water permits RMA 0862/03, 28 October 2003.

18 Consent Order RMA 0862/03 Judge J R Jackson, 21 November 2003.

19 Letter from Dennis Bush-King, Head of Environment & Planning, Tasman District Council, to Kim Morgan, Senior Adviser, Ministry for the Environment, 15 June 2006; Letter from Parliamentary Commissioner for the Environment Dr Morgan Williams to Hugh Logan, Chief Executive, Ministry for the Environment, 26 Feb 2007.

20 Peer Review Panel minutes various, 27 February 2006 to 16 November 2006.

21 Letter from Dennis Bush-King, Head of Environment & Planning, Tasman District Council, to Kim Morgan, Senior Adviser, Ministry for the Environment, 23 March 2007.

22 Resource Consent Conditions 9–12, RM030521–RM030527.

23 Letter from P. Wylie, Chief Executive, Tasman District Council to the Parliamentary Commissioner for the Environment, 2 July 2008.

24 Resource Consent Conditions 9–12, RM030521–RM030527.

25 Resource Consent Condition 12, RM030521–RM030527.

26 Register of Complaints; List of site complaints and those made directly to PCE.

27 Peer Review Panel Minutes, 30 May 2006.

28 Site Validation Report for the former Fruitgrowers Chemical Company Site, Mapua, Sinclair Knight Merz (SKM) for MfE, version 7, project AE03255, September 2007.

29 Groundwater and sediment investigation report, former Fruitgrowers Chemical Company site, Mapua, reference 358982.01.07, CH2M Hill Australia Pty Ltd for MfE, August 2007.

30 FCC Mapua Site Remediation: Assessment of Environmental Effects, Tonkin & Taylor for Thiess Pty Ltd, ref 18777.004, May 2003.

31 Close-out report: Requirement under Part C1 Technical Specification No. 23, EDL to the Engineer to the Contract (MWH), 8 September 2007.

32 Resource Consent Conditions 31–36 of RM030523 specify frequency of calculation at different points in the project according to the results.

33 Resource Consent Condition 22 of RM30523.

34 The US specifications for the PUF method state "airborne particles may also be collected, but the sampling efficiency is not known".

35 Resource Consent Condition 24 of RM030523.

36 Resource Consent Condition 25 of RM030523.

37 Resource Consent Condition 26 of RM030523.

38 Recalculation of Hazard Indices and cancer risks for the Mapua FCC contaminated site remediation project, C. Stevenson, Senior Consultant, AES Ltd, February 2008.

39 Site Management Minutes sample: March 2005, May 2006 and October 2006 (production low); September 2005 (request to run more hours).

40 Resource Consent Condition 20 of RM030523.

41 Peer Review Panel Minutes, February 2006.

42 Comments to Peer Review Panel on the emissions testing at the Mapua Plant, C. Stevenson, Senior Consultant, AES Ltd, 2006.

43 Resource Consent Condition 22 of RM030523.

44 Letter from Dennis Bush-King, Head of Environment & Planning, Tasman District Council to Kim Morgan, Senior Adviser, Ministry for the Environment, 23 March 2007.

45 C. Stevenson, Senior Consultant, AES Ltd, Comments to Peer Review Panel on the emissions testing at the Mapua Plant, 2006.

46 Letter from T. Brady, T. Brady Consulting Ltd, to Mike Bulley, EDL, August 2005.

47 Letter from R. Cudmore, Director, Hingett-Mitchell Ltd, to Kim Morgan, Senior Adviser, Ministry for the Environment, October 2005.

48 Letter from R. Cudmore, Director, Hingett-Mitchell Ltd, to Kim Morgan, Senior Adviser, Ministry for the Environment, October 2005.

49 Bryan Black, Managing Director, EDL, response to PCE questions, 5 April 2007.

50 PCE filenote (CRFSW).

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