NEW ZEALAND ALUMINIUM SMELTERS LIMITED

APPLICATION AND ASSESSMENT OF EFFECTS ON THE ENVIRONMENT

DISCHARGES ONTO AND INTO LAND AT THE NZAS LANDFILL

5 SEPTEMBER 2003

APPLICATION

environment SOUTHLAND

Cnr North Road and Price Street
(Private Bag 90116)
Invercargill

Telephone (03) 215 6197
Fax No. (03) 2158081
Southland Freephone No. 0800 76 88 45

Application for Resource Consent

This application is made under Section 88 of the Resource Management Act 1991

For Office Use Only
Received:
Application No:
Job No:
Officer in Charge:

To: The General Manager
Environment Southland
Private Bag 90116
Invercargill

Full name, address and contact details of applicant *(In whose name consent is to be issued)*

Applicant: New Zealand Aluminium Smelters Limited

Address: Private Bag 90110, Invercargill

Attention: Kevin Duke E-mail: Kevin.Duke@comalco.riotinto.com.au

Telephone No: (__)_____ *Private* (03) 218 5999 *Business* Fax: (03) 218 9747

Signed _____ Date 5/9/03.
(Signature of applicant or person authorised to sign on behalf of applicant)

Address for Service of Applicant *(if different from above e.g. consultants)*

Contact Name/ Agent _____

Address _____

_____ E-mail _____

Telephone No: (__)_____ *Private* (__)_____ *Business* Fax: (__)_____

NOTES TO APPLICANTS

a. The appropriate fee set out in the attached schedule must accompany your application. If, when your application has been processed, the actual costs incurred by Environment Southland are different from the amount paid, you will be invoiced or refunded the balance.

b. This form may be used for all types of resource consents for which Environment Southland (the Southland Regional Council) has responsibility. For many types of activities, Environment Southland has prepared separate question sheets, which will assist you with the preparation of the mandatory assessment of environmental effects. If the form has insufficient space, please attach additional pages, including plans, as necessary.

c. If your application does not contain the necessary basic information and the appropriate fee, Environment Southland may return the application to you. Processing will not commence until a complete application is lodged.

d. Section 128 of the Resource Management Act 1991 sets out the circumstances in which a consent authority may review the conditions of a resource consent. Under S128 (1)(c) Environment Southland may undertake a review if the application contains inaccuracies, which may materially have influenced the decision made.

e. In accordance with S94 of the Resource Management Act 1991, an application need not be publicly notified if the adverse effects on the environment are minor and if written approval has been obtained from every person who, in the opinion of the consent authority, may be adversely affected by the granting of the resource consent (unless, in Environment Southland's opinion, it is unreasonable to require the obtaining of every such approval). Environment Southland provides a form **" Written Approval of a Potentially Affected Party"** to help you obtain such approvals. The documented approval of persons who could be adversely affected by your proposed activity could assist your application, even if it is publicly notified. Please ensure that they sight your application in full.

Please answer the following questions

1. **Type of consent** – please tick the appropriate box(s)

Land Use Consents

- ☐ Burning
- ☐ Dam
- ☐ Tree planting
- ☐ Gravel extraction
- ☐ River bed activity (Including structures)
- ☐ Stopbank

Discharge Permit

- ☐ To air
- ☐ To water
- ☑ To land

Water Permit

- ☐ Dam water
- ☐ Divert water
- ☐ Use water
- ☐ Take surface water
- ☐ Take underground water

Coastal

- ☐ Occupy
- ☐ Disturb foreshore or seabed
- ☐ Deposit substances
- ☐ Remove natural materials
- ☐ Structures
- ☐ Reclaim/drain
- ☐ Marine farming
- ☐ Surface water activity
- ☐ Discharge
- ☐ Introduce plants
- ☐ Other

2. **Have you had a previous consent for this activity**

Yes ☑ No ☐ if Yes, state consent number: 94460

3. The names and addresses of the **owner /occupier** (if other than the applicant) of any land to which the application relates are as follows

Owners/Occupier name and address

Comalco New Zealand Limited
PO Box 1665
Wellington

Telephone No(s)

(04) 471 1527

( )

Fax

(04) 427 8081

4. **Location** – the location to which the application relates is:

Number or name of house/street/road: South western end of Tiwai Peninsula

Nearest locality (e.g. settlement): Near Tiwai Point

Nearest town: Bluff

Map Reference (NZMS 260 Series): At or about NZMS 260 E47;553:915

Legal Description: CT 11B 2686

District or City Council the property is located in: Invercargill City Council

5. **Description** – a description of the activity to which this application relates is:

Note: a site and/or location plan will be required to accompany your application

Discharges at the NZAS landfill:
a) To discharge onto or into land in circumstances which may result in that contaminant (or any other contaminant emanating as a result of natural processes from that contaminant) entering water; and, or
b) To discharge from any industrial or trade premises onto or into land.

6. **Consents required from other authorities** – the following additional resource consents are required in relation to this proposal

Consent required	Authority
NIL	
	Applied Yes ☐ No ☐

7. **Assessment of effects on the environment –** Please attach an assessment of any actual or potential effects that the proposed activity may have on the environment, prepared in accordance with the fourth schedule of the Resource Management Act 1991. *See over for a copy of the fourth schedule.*

Note: The council has additional question sheets available for various consent activities. These question sheets will assist you with preparing an assessment of effects on the environment. For activities with effects greater than minor the council will require a more detailed assessment.

8. **Adjacent owners and occupiers** – list the names and postal addresses of all neighbours who share a boundary with your proposed consent activity:

NIL	

9. **Potentially Affected Parties** - have you obtained written approval from any potentially affected parties?

Note: the Council may determine that additional approvals are required

Yes ☑ No ☐ If yes, please list and attach approvals

Invercargill City Council	Historic Places Trust (NZAA)
Bluff Community Board	Department of Conservation
Te Ao Marama Inc.	Public Health South
Comalco New Zealand Limited	Royal Forest and Bird Protection Society

10. *Other information* – ***I attach other information (if any) required to be included in the*** **Application by the regional plan or regulations:** ☑

The following have been included with this application

☑	A sketch of the locality and activity points.
☐	Written approval from all potentially affected parties (Council forms and advice are available).
☑	Payment of the required fee.
NA	A plan of any structures for which the application is being made.

Resource Management Act 1991

Fourth Schedule

Assessment of Effects on the Environment

1. Matters that should be included in an assessment of effects on the environment

Subject to the provisions of any policy statement or plan, an assessment of effects on the environment for the purpose of section 88(6)(b) should include:

a. a description of the proposal:
b. where it is likely that an activity will result in any significant adverse effect on the environment, a description of any possible alternative locations or methods for undertaking the activity:
(Clause 1(c) repealed by Resource Management Amendment Act 1993)
d. an assessment of the actual or potential effect on the environment of the proposed activity:
e. where the activity includes the use of hazardous substances and installation, an assessment of any risks to the environment which are likely to arise from such use:
f. where the activity includes the discharge of any contaminant, a description of –
   i. the nature of the discharge and the sensitivity of the proposed receiving environment to adverse effects; and
   ii. any possible alternative methods of discharge, including discharge into any other receiving environment:
g. a description of the mitigation measures (safeguards and contingency plans where relevant) to be undertaken to help or prevent or reduce the actual or potential effect:
h. an identification of those persons interested in or affected by the proposal, the consultation undertaken, and any response to the views of those consulted:
i. where the scale or significance of the activity's effects are such that monitoring is required, a description of how, once the proposal is approved, effects will be monitored and by whom.

2. Matters that should be considered when preparing an assessment of effects on the environment

Subject to the provisions of any policy or plan, any person preparing an assessment of effects on the environment should consider the following matters:

a. any effect on those in the neighbourhood and, where relevant, the wider community including any socio-economic and cultural effects:
b. any physical effect on the locality, including any landscape and visual effects:
c. any effect on ecosystems, including effects on plants or animals and any physical disturbance of habitats in the vicinity:
d. any effect on natural and physical resources having aesthetic, recreational, scientific, historical, spiritual, or cultural, or other special value for present and future generations:
e. any discharge of contaminants into the environment, including any unreasonable emission of noise and options for the treatment and disposal of contaminants:
f. any risk to the neighbourhood, the wider community, or the environment through natural hazards or the use of hazardous substances or hazardous installations.

WRITTEN APPROVALS OF POTENTIALLY AFFECTED PARTIES

SOUTHLAND REGIONAL COUNCIL

For Office Use Only
File No: _____
Officer in Charge: _____

To: The General Manager
Southland Regional Council
Private Bag 90116
Invercargill

WRITTEN APPROVAL OF A POTENTIALLY AFFECTED PARTY

Approval by Person(s) Potentially Affected by an Application for a Resource Consent

To be completed by the person requesting approval:

APPLICANT: New Zealand Aluminium Smelters Limited.

TYPE OF RESOURCE CONSENT: Discharge Permit for the discharge of contaminants onto or into land (including in circumstances where contaminants may enter water) and/or Discharge Permit for the discharge of contaminants from an industrial or trade premise onto or into land.

PROPOSED ACTIVITY: Discharge of waste materials (contaminants) onto and into land at an expanded NZAS landfill over a 20 year period. The source of the waste materials will be the NZAS operations and related activities, and the dross waste powder that has been stored since the closure of the Haysom's processing plant

LOCATION: Comalco New Zealand Ltd land (CT 11B 268) on Tiwai Peninsula at about map reference NZMS 260; E47, 553: 915.

To be completed by the person giving his or her approval:

Organisation: Comalco New Zealand Limited

Street/Road Address: Level 16, ASB Bank Tower, 2 Hunter Street
GPO Box 1665, Wellington

- ☐ I/we have sighted all the attached plans and supporting information for the above activity.
- ☐ I/we hereby give approval for the proposal to be considered by the Council without public notification.
- ☐ I/we understand that, if I give my approval, the Southland Regional Council shall not take into account any effects that the proposed activity may have on me, when considering the application (Section 94(4) of the Resource Management Act 1991).

Note: If you do not understand what this form is, or details about the application associated with this form, do not sign it.

Barbara Elliott
(Signature)

1/Sep/2003
(Date)

Managing Your Environment

SOUTHLAND REGIONAL COUNCIL

For Office Use Only	
File No:	
Officer in Charge:	

To: The General Manager
Southland Regional Council
Private Bag 90116
Invercargill

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LOCATION: Comalco New Zealand Ltd land (CT 11B 268) on Tiwai Peninsula at about map reference NZMS 260; E47, 553: 915. *

To be completed by the person giving his or her approval:

Name: Karl Gillies

and/or Organisation: NZAA Southland Filekeeper

Street/Road Address: C/- Southland Museum

- ☐ I/we have sighted all the attached plans and supporting information for the above activity.
- ☐ I/we hereby give approval for the proposal to be considered by the Council without public notification.
- ☐ I/we understand that, if I give my approval, the Southland Regional Council shall not take into account any effects that the proposed activity may have on me, when considering the application (Section 94(4) of the Resource Management Act 1991).

* No recorded archaeological sites within the near proximity of this grid reference

Note: If you do not understand what this form is, or details about the application associated with this form, do not sign it.

(Signature) 12/8/03 (Date)

Managing Your Environment

SOUTHLAND REGIONAL COUNCIL

For Office Use Only
File No:
Officer in Charge:

To: The General Manager
Southland Regional Council
Private Bag 90116
Invercargill

WRITTEN APPROVAL OF A POTENTIALLY AFFECTED PARTY

Approval by Person(s) Potentially Affected by an Application for a Resource Consent

To be completed by the person requesting approval:

APPLICANT: New Zealand Aluminium Smelters Limited.

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LOCATION: Comalco New Zealand Ltd land (CT 11B 268) on Tiwai Peninsula at about map reference NZMS 260; E47, 553: 915.

To be completed by the person giving his or her approval:

Name: RICHARD WILLIAM KING C.E.O

and/or Organisation: INVERCARGILL CITY COUNCIL

Street/Road Address: 101 ESK ST INVERCARGILL

☑ I/we have sighted all the attached plans and supporting information for the above activity.

☑ I/we hereby give approval for the proposal to be considered by the Council without public notification.

☑ I/we understand that, if I give my approval, the Southland Regional Council shall not take into account any effects that the proposed activity may have on me, when considering the application (Section 94(4) of the Resource Management Act 1991).

Note: If you do not understand what this form is, or details about the application associated with this form, do not sign it.

(Signature)

5/9/03
(Date)

Managing Your Environment

SOUTHLAND REGIONAL COUNCIL

For Office Use Only	
File No:	
Officer in Charge:	

To: The General Manager
Southland Regional Council
Private Bag 90116
Invercargill

WRITTEN APPROVAL OF A POTENTIALLY AFFECTED PARTY

Approval by Person(s) Potentially Affected by an Application for a Resource Consent

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APPLICANT: New Zealand Aluminium Smelters Limited.

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PROPOSED ACTIVITY: Discharge of waste materials (contaminants) onto and into land at an expanded NZAS landfill over a 20 year period. The source of the waste materials will be the NZAS operations and related activities, and the dross waste powder that has been stored since the closure of the Havsorn's processing plant

LOCATION: Comalco New Zealand Ltd land (CT 11B 268) on Tiwai Peninsula at about map reference NZMS 60: E47, 553: 915.

To be completed by the person giving his or her approval:

Name: REX WILLIAM POWLEY (CHAIRMAN)

and/or Organisation: BLUFF COMMUNITY BOARD

Street/Road Address: GORE STREET BLUFF

- I/we have sighted all the attached plans and supporting information for the above activity.
- I/we hereby give approval for the proposal to be considered by the Council without public notification.
- I/we understand that, if I give my approval, the Southland Regional Council shall not take into account any effects that the proposed activity may have on me, when considering the application (Section 94(4) of the Resource Management Act 1991).

Note: If you do not understand what this form is, or details about the application associated with this form, do not sign it.

R W Powley
(Signature)

25/7/2003
(Date)

Managing your Environment

CURRENT DISCHARGE PERMIT
(CONSENT NUMBER - 94460)

Application no. A1323

Consent no. 94460

SOUTHLAND REGIONAL COUNCIL

Private Bag 90116
Telephone (03) 215-6197
Fax No. (03) 215-8081

Cnr North Road and Price Street
Waikiwi
Invercargill

DISCHARGE PERMIT

Pursuant to Section 105(1) of the Resource Management Act 1991, a resource consent is hereby granted by the **Southland Regional Council**

to N Z A S Limited (called the "consent holder")

of Private Bag 90110, Invercargill

from 30 October 1995

PLEASE READ THIS CONSENT CAREFULLY AND ENSURE THAT ANY STAFF OR CONTRACTORS CARRYING OUT ACTIVITIES UNDER THIS CONSENT ON YOUR BEHALF ARE AWARE OF ALL THE CONDITIONS OF THE CONSENT.

DETAILS OF PERMIT

Purpose for which permit is granted: -		To discharge contaminants onto or into land including in circumstances where contaminants may enter water.
Location	- site locality :-	Tiwai Peninsula
	- map reference :-	E47:552:914
	- receiving environment :-	Land
	- catchment :-	Tiwai
Legal description of land at site :-		The south western end of Tiwai Peninsula, near Tiwai Point, as shown in application, Part CT 2A/78
Expiry date :-		26 April 2006

SCHEDULE OF CONDITIONS

1. The types of materials to be deposited shall generally be as described in the application and the operation of the landfill shall be in accordance with the Management Plan for the landfill, as amended from time to time.

2. The materials shall be deposited within the landfill boundaries as defined on the attached plan.

3. The consent holder shall estimate the amount and type of materials that have been deposited at the landfill at two yearly intervals, with the first two yearly interval ending on 31 December 1997.

4. Stormwater within the landfill site shall be managed so as to minimise the production of leachate. In particular, the consent holder shall:

   (i) divert clean stormwater away from the landfill site;
   (ii) within the landfill site, divert stormwater away from the tipping face;
   (iii) minimise the amount of uncovered areas and oversow areas that will not be worked for over 6 months; and
   (iv) contour the cover material to prevent ponding.

5. The consent holder shall monitor groundwater as follows:

(i) in two bores north east (upstream) of the landfill site;
(ii) in two bores south east and two bores west (downstream) of the landfill site; and
(iii) by taking a representative sample from each bore and analysing for:

pH
total Kjeldahl nitrogen
total ammoniacal nitrogen
nitrate nitrogen
nitrite nitrogen
alkalinity
carbonaceous BOD_5
potassium
boron
fluoride
sulphate
temperature
conductivity
total iron
manganese
vanadium
nickel
total petroleum hydrocarbons
weak acid dissociable cyanide
naphthalene
anthracene
phenanthrene
fluoranthrene

(iv) the samples shall be taken once in each quarter for the first calendar year from the commencement of the consent with the frequency being assessed annually. The monitoring frequency may be changed to a minimum of once every two years with the approval of the Council's Director of Planning and Resource Management.

6. The parameters specified in condition 5(iii) shall be analysed in accordance with the most recent edition of APHA "Standards Methods for the Examination of Water and Wastewater" or by methods approved by the Council's Director of Planning and Resource Management.

7. The selection of the bore sites to be monitored in accordance with condition 5 of this permit is to be approved by the Council's Director of Planning and Resource Management.

8. (i) The results of analyses, carried out in accordance with condition 5 of this permit, shall be supplied to the Council no later than 20 working days from the end of each quarter, with the first quarter ending on 31 March 1996.

(ii) Any monitoring results obtained in accordance with Condition 5 of this permit which indicate a significant change from previous results shall be supplied to the Council within 10 working days of the consent holder receiving the results.

(iii) The methods of analyses are to be specified with the results.

9. The consent holder shall provide the Southland Regional Council with a report, annually by 31 March each year, which shall include:

- a summary of monitoring results over the previous twelve months and an interpretation of the results;
- an outline of the proposed operation at the landfill for the next twelve months;
- at two yearly intervals, the estimates required by condition 3 of this permit.

JV

Application no. A1323 Consent no. 94460

10. Except where the Council's laboratory acts as the consent holder's agent, the Council may once every calendar year, audit the consent holder's monitoring methods and analyses by obtaining split samples of two of the groundwater samples taken in accordance with condition 5 above. The cost of the audit is to be met by the consent holder.

11. The Council may, in accordance with the conditions of this permit, and in accordance with sections 128 and 129 of the Act, serve notice at 2, 5 and 8 years from the commencement of this consent of its intention to review the conditions of this consent for the purpose of dealing with any adverse effects on the environment which may arise from the exercise of this consent which were not anticipated when the consent was granted.

12. The consent holder may, in accordance with section 127 of the Act, apply to the Council at 2 yearly intervals, with notice to be given within 2 months of the anniversary from the commencement of this consent, for a review of the consent conditions for the purpose of a change or cancellation of any condition of this consent.

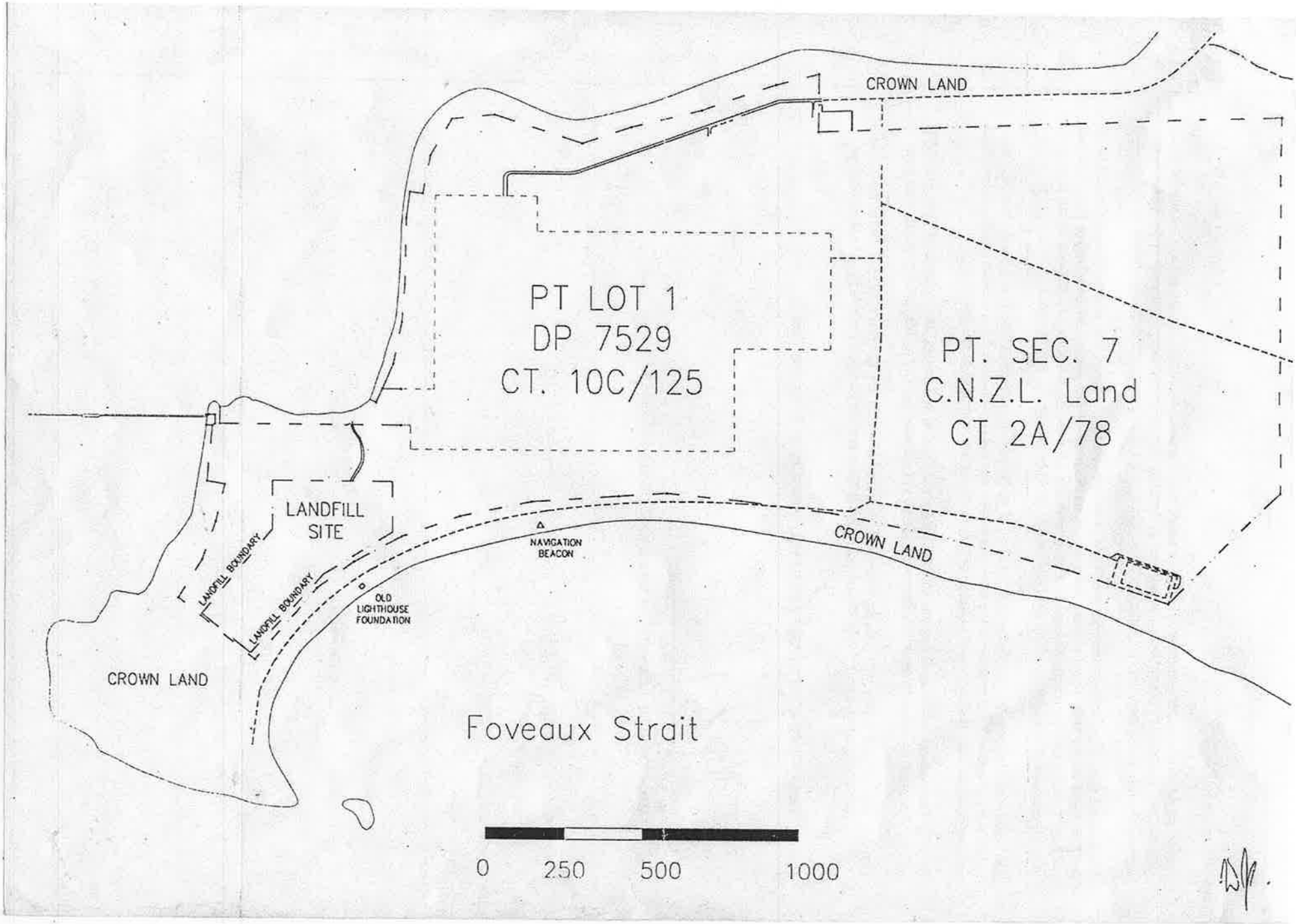
13. (i) The consent holder shall pay the Southland Regional Council an administration charge of $100 plus GST (or other figure set by Special Order under the Act) in advance, payable on the first day of July each year.

(ii) The consent holder will also be monitored in accordance with the Council's Special Order for consent monitoring on an annual basis, the cost of which is fixed in that Order and payable by the consent holder.

For: **THE SOUTHLAND REGIONAL COUNCIL** on 30 October 1995

W J Tuckey
DIRECTOR OF PLANNING AND RESOURCE MANAGEMENT

SRC.08/93


CROWN LAND
PT LOT 1
DP 7529
CT. 10C/125
PT. SEC. 7
C.N.Z.L. Land
CT 2A/78
LANDFILL
SITE
LANDFILL BOUNDARY
LANDFILL BOUNDARY
NAVIGATION
BEACON
OLD
LIGHTHOUSE
FOUNDATION
CROWN LAND
CROWN LAND
Foveaux Strait
0
250
500
1000

ASSESSMENT OF EFFECTS ON THE ENVIRONMENT

TABLE OF CONTENTS

ASSESSMENT OF EFFECTS ON THE ENVIRONMENT

1. INTRODUCTION

This assessment of effects on the environment has been prepared to support the application for a replacement of Discharge Permit No. 94460 to allow the NZAS landfill to continue to operate for 20 years plus to allow the landfilling of the dross waste powder that has been stored since the closure of Haysom's Metal Industries plant.

New Zealand Aluminium Smelters Limited (NZAS) commenced operations in November 1971. The NZAS landfill was first used during the initial construction of the smelter, probably in 1970. Discharge Permit No. 94460, granted by Environment Southland, authorises discharges at the NZAS landfill of "contaminants onto or into land, including in circumstances where contaminants may enter water".

This Discharge Permit expires on 26 April 2006. An early application for a replacement Permit has been made to assist in the resolution of the stored dross waste powder issue.

2. THE NZAS SMELTER

The smelter is owned by New Zealand Aluminium Smelters Limited (NZAS), a New Zealand registered company owned by Comalco New Zealand Limited (79.36%) and Sumitomo Chemical Company (20.64%).

The smelter is located on the western end of Tiwai Peninsula, approximately 20 km from Invercargill. It is 3.5 km north east of Bluff being separated by Bluff Harbour.

The main production facilities at the smelter are on a 91.86 hectare site that is freehold land owned by NZAS. Comalco New Zealand Limited owns 312.72 hectares of land surrounding the NZAS site and several smelter related activities are conducted on this land, including the NZAS landfill.

NZAS is one of the largest aluminium smelters in the world, producing 333,000 tonnes of primary aluminium and generating NZ$1 billion in export earning per annum. NZAS currently employs 793 permanent staff and has 150 contractors, on a full time equivalent basis. Vacation employment is provided to approximately 55 students. In addition, many of the goods and services to support the NZAS operations are sourced from local suppliers.

3. ALUMINIUM SMELTING PROCESS

Commercial operation of aluminium is by the Hall-Heroult process. In this process alumina (Al_2O_3) is electrolytically reduced to aluminium. The reduction process occurs in cells (also known as pots). Each cell consists of a carbon lined steel shell acting as the cathode. The carbon lined shell contains molten electrolyte (bath), which is a modified cryolite (Na_3AlF_6). Alumina is dissolved in this bath.

Carbon anodes are suspended from superstructures above the cells. The anodes are immersed in the bath. A high electrical current flows between the anodes and the cathode, maintaining the cell and its contents at an operation temperature of approximately 970° C and providing the energy for the cell reaction. The anodes are consumed in the reduction process by the reaction with oxygen to form carbon dioxide, hence the anodes are replaced regularly.

The cells are connected in electrical series with the completed series called a Potline. NZAS has four Potlines with three of the Potlines containing 208 cells in each and the other Potline containing 48 cells, giving a total of 672 cells. However, all the NZAS cells may not be operating depending on electrical energy availability or process requirements.

The molten aluminium formed by the reduction process collects at the bottom of the cells. It is normally removed daily, using siphoning or suction, and then transferred to casting facilities. Suction is used at NZAS to remove the aluminium.

The carbon anodes are manufactured at NZAS using petroleum coke, coal tar pitch (liquid) and reused anode material. The components are heated, mixed and vibrated into blocks. These blocks are then baked in furnaces at temperatures typically 1100° C to 1200° C.

The molten aluminium from the cells is transferred to casting furnaces to achieve the correct casting temperature and conditions. Often other metal alloys are added. The aluminium is then cast into shapes and products to suit the customers' requirements. Water is used to cool the aluminium during casting.

4. WASTE MINIMISATION, REUSE AND RECYLING AT NZAS

4.1. Waste Minimisation

The ongoing process improvement initiatives at NZAS include seeking opportunities for minimising waste generation and consequently reducing the amount of waste requiring disposal. Improved raw material containment during transport and handling, advances in process control to minimise process scrap, and changes in packaging methods have contributed to reductions in the amount of waste being generated.

4.2. Reuse

Defining "reuse" as the return of waste or scrap material to its source operation, the process design at NZAS results in a significant amount of material being reused. Examples of the reuse of materials are:

- Anode carbon material that is not consumed in the reduction cells is reused in the production of new anodes, currently about 90,000 tonnes per year,
- The reduction cell electrolyte (bath) that adheres to the unconsumed anodes is processed and returned to the reduction cells,
- Bag house dust collectors are installed on the transfer points on raw materials conveyors and the dust is fed back into the raw materials,
- Off cuts and out of specification aluminium products from the casting operation are returned to the casting furnaces for remelting,
- Clean fill from excavations is stockpiled for future use as landscaping and landfill cover,
- Refractory bricks are used as on-site fill and road base,
- Mail envelopes used for internal NZAS mail, and
- Wooden pallets either returned to the suppliers or modified to be suitable for NZAS use.

4.3. Recycling

NZAS also segregates waste materials so that others can recycle them. Examples of materials that are recycled are:

- Cardboard, after collected in designated cages,
- Leger paper, after segregation in offices and designated bins,
- Excess refractory bricks as off site clean fill and road base,
- Concrete as clean fill,
- Aluminium sheet and structural material is sent to secondary aluminium processors as it cannot be remelted at NZAS,
- Aluminium dross containing aluminium metal is sent to secondary aluminium processors,
- Non – ferrous metals, iron and steel are segregated by type and sent to a scrap metal contractor,
- Timber is used by Southland Enterprises Ltd, and
- Printer toner cartridges for refilling.

5. EXISTING LANDFILL

5.1. Landfill Site

The existing NZAS landfill is operated on a 15.59 hectare site located on Tiwai Peninsula to the south west of the NZAS site, at about map reference NZMS 260; 552:914. The location is shown in Appendix 1. The land occupied by the landfill is owned by Comalco New Zealand Limited (CT 11B 268).

The landfill site is largely contained by low ridges to the north, east and south. Natural swampy areas separate the landfill from Bluff Harbour to the west. The natural ground beneath the landfill ranges from approximately 8 metres above mean sea level at the northern end to 3 – 4 metres above mean sea level at the southern end.

5.2. Landfill Operations

The NZAS landfill was first used during the initial construction of the smelter, probably in 1970. Materials were placed on the pea gravel surface. A second and third layer of materials have been placed over some parts of the landfill. Both NZAS waste and clean fill have been landfilled at the NZAS landfill.

Extensive upgrading work and improved operating procedures have been implemented since 1991. These activities have included segregating specific wastes in the landfill, minimising the landfill open face, improved landfill cover, and landscaping and revegetation. Waste management practices have also significantly improved in the NZAS operations during this period, details are given in Section 4.

Prior to the granting of Discharge Permit No. 94460 (current Discharge Permit) in October 1995, four surveys of the amount and type of materials being landfilled were conducted plus an assessment of the landfill volume was made from an aerial photograph. The landfill volume was assessed at 440 000 cubic metres, this equates to approximately 220 000 tonnes of material having been landfilled during the 25 years up to this time. An area of 8.80 hectares had been filled.

The management practices at the NZAS landfill have minimised the additional area covered by the landfill over the past 8 years. The landfill area that has been filled is now 9.75 hectares.

Annual surveys of waste materials have been conducted since the current Discharge Permit was granted. These surveys are conducted over a one month period providing data on amounts, sources and types of materials being landfilled. The current Permit was granted on 30 October 1995 and it is estimated that 50 000 tonnes of material has been landfilled since that time (to end August 2003). Details of the types and amounts of material landfilled during this period are given in Appendix 2.

The NZAS landfill is operated in accordance with the Landfill Management Plan (Appendix 13) that was prepared to provide the details specified by Rule 4.5.2 of the Regional Solid Waste Plan for Southland. The NZAS landfill is also approved for disposing of asbestos, although very little asbestos waste is now generated from NZAS.

All the monitoring and reporting requirements of Discharge Permit No. 94460 have been complied with.

6. PROPOSED ACTIVITY

It is proposed to continue discharging waste materials (contaminants) at the NZAS landfill for the next 20 years in a similar manner to the activities authorised by the existing Discharge Permit No. 94460, with the following changes:

- Extending the landfill area from 15.49 to 18.84 hectares, and
- In addition to the NZAS wastes, landfilling the dross waste powder that has been stored since the closure of Haysom's Metal Industries plant.

6.1. Future Landfill Site

It is proposed to extend the NZAS landfill site by 3.35 hectares to the north east. This additional land is also owned by Comalco New Zealand Limited (CT 11B 268). The landfill location is shown in Appendix 1 and a plan of the existing landfill site and proposed extension is shown in Appendix 3.

The existing landfill site was described in detail in the Assessment of Effects on the Environment (AEE) dated 31 March 1995, that was submitted to support the application for the current Discharge Permit. In future, it is proposed to:

- continue some of the landfill activities on the area already filled,
- use the area at the south part of the existing landfill site for carbon fines material,
- use the area at the north west part of the existing landfill site for general (non classified) waste, and
- use the extended area to the north east of the existing landfill site for future carbon fines material and the dross waste powder that has been stored since the closure of Haysom's Metal Industries plant.

Most of the vegetation cover has been cleared from the area at the south part of the existing landfill site and landfilling of carbon fines material has extended into this area. The remaining habitat varies and comprises of rough grass, flax, ferns, rushes, bracken and small shrubs (coprosma, matagouri and small manuka trees). The land surface is typically 4 – 5 metres above mean sea level. The shallow geology is pea gravel with sand, occasional boulders and peat to approximately 7 metres below ground level. Below 7 metres there are green/grey silts and clays with bedrock at approximately 9 metres.

Landfilling of general (non classified) material has commenced in the area at the north west part of the existing landfill site. The habitat is rough grasses, flax, bracken and shrubs (matagouri and small manuka trees). The habitat transforms to tall manuka at the landfill boundary to the west. The land surface is typically 4 – 5 metres above mean sea level. The shallow geology is unconsolidated dark grey silty sand to approximately 5 metres below ground level, a thin layer of peat, then pea gravel down to approximately 7 metres and then bed rock.

The bedrock under the existing landfill site is a hard, dense, tight, poorly fractured, fine grained rock. This rock has been identified as being consistent with thermally metamorphosed recrystallised intermediate intrusive which probably belongs to the Greenhills Group (Watters *et. al.*, 1968).

The habitat in the proposed extension to the existing landfill to the north east varies with large areas of rough grass and other areas containing *acaena* (bidi bid), rushes, minor amounts of mosses and lichens, flax, bracken on ridges and shrubs (stunted totara, coprosma and matagouri). Patches of dead gorse are present as a result of the NZAS plant pests control program. The land surface is undulating and is typically 3.5 – 5.5 metres above mean sea level.

The shallow geology is typically unconsolidated pea gravel with some fine sand to approximately 4 metres below ground level at the west end and over 6 metres at the east end. There is bed rock below 4 metres at the west end of the proposed extension, while the east end is more typical of most of Tiwai Peninsula where the pea gravel is underlain by unconsolidated fine sand with some intermingled gravels to approximately 13 metres depth. Mudstone deposits of unknown thickness are present below 13 metres, and these are probably on top of the Greenhills Group rock.

6.2. Proposed Types of Discharges

It is proposed to continue landfilling at an extended NZAS landfill site for the next 20 years. Landfilling will continue in a similar manner as authorised by the current Discharge Permit. Included in the proposed discharges at the extended NZAS landfill site are:

- carbon fines material at the south part of the existing landfill site,
- general (non classified) waste to the north west part of the existing landfill,
- a small amount of aluminium dross powder to be added to the dross stockpile at the north east part of the existing landfill,
- any asbestos material requiring disposal in the existing designated asbestos disposal area (middle of east side of existing landfill),
- bioremediation of hydrocarbon materials in the central part of the existing landfill,
- truck washing at the north end of the existing landfill,
- use of non oily water containing minor amounts of contaminants for dust suppression on general landfill areas,
- concrete, gravel and other clean fill when no other suitable use is available,
- carbon fines material (at a later date) at the western part of the landfill extension (to the east of the existing landfill), and
- dross waste powder that has been stored since the closure of Haysom's Metal Industries plant at the eastern part of the landfill extension (to the east of the existing landfill).

The proposed layout of the landfill is shown in Appendix 3.

6.3. Characteristics of the Proposed Discharges

The results of a comprehensive study of the characteristics of the NZAS wastes were detailed in a report prepared by Woodward-Clyde (1994). These results were presented in the Assessment of Effects on the Environment (AEE) dated 31 March 1995, that was submitted to support the application for the current Discharge Permit. Subsequent further analyses on some of the NZAS waste have confirmed the suitability of the Woodward-Clyde (1994) data for assessing the current effects on the environment of the NZAS landfill in this AEE.

The leachable components of materials are commonly used to assess the possible environmental effects if the materials are landfilled. A widely accepted approach is a batch leachability test, the toxicity characteristic leaching procedure (TCLP). Some regulatory authorities, eg USEPA, specify the use of a weak acid leaching solution to assimilate the conditions in municipal landfills containing putrefying wastes. Other authorities, eg NSWEPA, make provision for the use of other leaching solutions if they are more relevant to the characteristic of the disposal site.

Almost all of the waste materials deposited at the NZAS landfill are non putrescible, so the pH of the rain water passing through the waste is mainly dependent on the characteristics of the waste materials. It is more appropriate to use deionised water in the TCLP when assessing the leachable components in wastes to be disposed of at the NZAS landfill.

Woodward-Clyde (1994) used the deionised water variation of the TCLP when assessing the leachable components in the NZAS wastes. The current NZAS wastes characteristics are similar to those reported in by Woodward-Clyde (1994), apart from ESP tar that is not stored at the landfill and pitch which is only a very small component of the NZAS waste. The Woodward-Clyde (1994) results are given in Appendix 4, Tables A4.1, A4.2, A4.3 and A4.4, minus the ESP and pitch results.

The characteristics of the dross waste powder that has been stored since the closure of Haysom's Metal Industries (Haysom's DWP) was reported by Woodward-Clyde (2000). The leachable components were assessed by the TCLP using weak acid, as this waste was being considered for disposal at a municipal landfill. Deionised water TCLP data is available for some components. The Haysom's DWP data is given in Appendix 5.

Reference criteria are given in the tables in Appendices 4 and 5 to assist in the interpretation of the results. These reference criteria have been updated since the Woodward-Clyde (1994) report and are:

- NSW Environmental protection Agency (NSWEPA) 1999 Environmental Guidelines: Assessment and Management of Liquid and Non-Liquid Wastes, and
- the Maximum Acceptable Values (MAVs) and Guideline Values in the Drinking Water Standards for New Zealand, 2000.

The NSWEPA Guidelines specify maximum limits for leachable components for non-liquid waste categories of "Inert", "Solid" and "Industrial". The guideline provides the following descriptions of the waste types:

- Inert – this waste type is the least likely to undergo environmental significant transformations; therefore, it should not release significant quantities of greenhouse gases or leachates contaminated with nutrients and/or chemicals,
- Solid – this waste type can include putrescible waste and is considered to pose a higher environmental risk than inert waste, and consequently needs to be managed with greater care,
- Industrial – this waste type can contain somewhat higher (four times) levels of contaminants than solid waste, and needs to be managed with more stringent environmental controls than solid waste.

The Landfill Guidelines, Centre for Advanced Engineering (CAE) (2000), includes the NSWEPA Guidelines limits for "solid waste" as an acceptance criterion for designed landfills. The USEPA TCLP limits are also included in the CAE Landfill Guidelines. The USEPA TCLP list contains less contaminants and in most cases the limits are the same as the NSWEPA Guidelines for solid waste.

The TCLP results for the NZAS wastes given in Tables A4.3 and A4.4 show that most of the leachable components are below the NSWEPA Guidelines "inert waste" limits. The two exceptions are nickel in Carbon Rodding Room dust that would be classified as "solid waste", and fluoride in many of the materials that would be classified as "solid waste" or at the lower end of "industrial waste" range.

The TCLP results for the Haysom's DWP given in Table A5 show that most of the leachable components are below the NSWEPA Guidelines "inert waste" limits. The only exception is fluoride that would be classified as "solid waste". In addition, the Haysom's DWP has been classified as "non-hazardous" by Landcare Research on behalf of the Ministry for the Environment, see Appendix 6.

The New Zealand Drinking Water Maximum Acceptable Values (MAVs) are primarily shown for comparison purposes rather than guidelines to be applied. However, TCLP limits of 100 times the

drinking water standards are sometimes used as a guide for landfill acceptance criteria for municipal landfills. The results in Tables A4.3, A4.4 and A5 show that, apart from fluoride in some of the NZAS waste, the leachable components in the NZAS waste and the Haysom's DWP would comply with such a guideline. The NZAS landfill is not near an aquifer used for potable water or other uses of water. It is extremely unlikely that water for any use would be abstracted near the landfill.

6.4. Proposed Landfill Management

The existing NZAS landfill has been managed so as to avoid significant adverse effects on the environment. This management has been possible due to NZAS:

- having control over the sources, amounts and types of materials being landfilled,
- selective placement of material in the landfill,
- knowing the site hydrology, geology and contaminant migration characteristics, and
- minimising the active landfilling areas, and
- covering and revegetating closed landfill areas.

The proposed future NZAS landfill management is to continue with the existing practice of landfilling onto the land surface by vegetation clearing, surface levelling and excavation of 1 – 2 metres where necessary. Landfill covering with gravel and the revegetation program will continue.

It is proposed to not fully utilise the western part of the existing NZAS landfill area, to take advantage of the dense manuka stands to screen the landfill from Bluff, and to minimise any contaminant transport to the more sensitive intertidal regions of Bluff Harbour.

The Haysom's DWP is currently contained in bulker bags (approximately 1 tonne each). It is proposed to landfill the DWP by clearing the surface vegetation, excavating to approximately 1 metre, depositing the bulker bags of DWP on the land surface along with any loose DWP, and covering the area with gravel. The area will be included in the general revegetation program for the NZAS landfill.

The Management Plan for the proposed extended landfill, prepared to provide the details specified by Rule 4.5.2 of the Regional Solid Waste Plan for Southland, is given in Appendix 13.

Currently there is a project to examine opportunities for recovering some of the landfilled NZAS dross material for use as a raw material by other industries. The Haysom's dross waste powder is not suitable for this application. Potential opportunities for recovery of other landfilled materials will continue to be sought, as they have in the past.

7. ASSESSMENT OF EFFECTS ON THE ENVIRONMENT

7.1. Hydrogeology

Historic testing data established a mean (geometric mean) hydraulic conductivity of 1.1×10^{-5} m/s for the unconsolidated material in the NZAS landfill area (Woodward-Clyde, 1994). The data indicates that the hydraulic conductivities on the eastern (south coast) side of the existing landfill at 2.5×10^{-5} m/s are slightly greater than those on the western side of the existing landfill at 5.5×10^{-6} m/s.

Cores and an inspection of the outcrop at the north of the existing landfill indicate that the permeability of the rock body is substantially less than the unconsolidated materials, probably in the order of 1×10^{-7} m/s (Woodward-Clyde, 1994).

Piezometric contours are given in Appendix 7 (Figure A7.1). The contours in Figure A7.1 show that the groundwater below the existing NZAS landfill flows down gradient to both the southern and western coastlines and discharges to both Foveaux Strait and the beach inside Bluff Harbour. The hydraulic gradients are generally low and are flatter on the western side of the existing landfill towards Bluff Harbour, and are steeper on the eastern and south coast sides of the existing landfill.

The piezometric contours shown in Figure A7.1 include data from the proposed extension to the NZAS landfill. The hydraulic gradients in the proposed extension to the landfill are more variable and lower than the existing landfill area. The groundwater flows down gradient to the south coast (Foveaux Strait). Recharge from the NZAS south drain is inferred to be influencing the piezometric surface in this area.

7.2. Groundwater Modelling

The following groundwater modelling approach was used by URS (2003) to assess the effects of the existing NZAS landfill and the proposed extension to the landfill:

- The Hydrological Evaluation of Landfill performance (HELP) model was used to determine the leachate production. This output is combined with leachate composition data.
- A two dimensional saturated/unsaturated finite element groundwater flow model (SEEP/W) is used to determine the groundwater flows discharging to the marine receiving environment. This model has been calibrated against the actual piezometric data for the site, which provides verifications of the input data (aquifer properties, rainfall infiltration and leachate production);
- A contaminant fate and transport model (CTRANS/W) has been used to assess the effects of dispersion and diffusion within the vadose zone and groundwater system. This provides a prediction of the contaminant concentrations in groundwater discharge without the effects of chemical attenuation processes;
- A geochemical equilibrium model (PHREEQC) is then used to assess the significance of the geochemical processes in reducing the contaminant concentration within the groundwater system.

The models were calibrated on the effects from the existing landfill and then used to predict the effects of the proposed discharges into and onto land at an extended NZAS landfill.

7.3. Contaminant Migration

The leachate production estimates from URS (2003) using site specific climate data are as follows:

- The existing and proposed areas of carbon fines material and the proposed disposal area for the Haysom's DWP are estimated to produce in the order of 23% of rainfall as leachate which equates to 7 m^3/ha/d; and,
- The existing and proposed future general waste areas of the landfill, which contain more permeable wastes, will produce in the order of 32% of rainfall as leachate that equates to 10 m^3/ha/d.

The migration of the contaminants leached from the existing and proposed extended NZAS landfill is shown in Appendix 8. Table A8.1 shows the rate at which the groundwater from under the landfill migrates to the south coast of Tiwai Peninsula and the east coast of Bluff Harbour. Table A8.2 shows how much groundwater is discharged at the coasts and Table A8.3 shows the predicted concentrations of key contaminants in the groundwater immediately under the landfill areas and at the coasts.

Bioresearches (1996) assessed the potential effects on the environment from an investigation of the suitability of the land immediately south of NZAS for a landfill. It was reported that groundwater seepage flowing through the intertidal beach would be diluted several thousand times in the immediate seepage area. The effects of the migration of leachates from the existing and proposed extended NZAS landfill are discussed in sections 7.4 and 7.5.

7.4. Effects on Groundwater

Existing Landfill Area

The ground water surrounding the existing NZAS landfill has been extensively monitored at six monthly intervals since 1996. Groundwater from six monitoring wells have been analysed for a wide range of analytes (Appendix 9, Table A9.1). The concentrations of leachate constituents in the groundwater in the vicinity of the existing landfill have been influenced by the leachate discharges from the existing landfill.

In general there has been variable and minor influences upon the groundwater as a result of leaching of contaminants from materials deposited at the landfill. Trends in the quality of groundwater are summarised in Appendix 9, Table A9.2 and graphically depicted in Figures A9.3 to A9.8.

The receiving groundwater is of relatively low value as a groundwater resource due to low natural quality (Woodward-Clyde, 1994). The nearest user of groundwater is the NZAS well field approximately 1.5 kilometres to the East and upstream of groundwater flow.

The effects on groundwater quality of the existing landfill are therefore considered to be minor (URS 2003).

Extension to Landfill Area

The groundwater beneath the proposed eastern carbon fines area and the Haysom's DWP storage area has been characterised using base-line analysis data from monitoring wells (URS, 2003). Baseline water quality data is summarised in Appendix 10 (Table A10.1).

The effect upon groundwater of leachate from the proposed eastern carbon fines area is anticipated to be similar to the effect upon groundwater from the existing western carbon fines area. There are no foreseeable changes in the nature of the carbon material that would alter current groundwater quality.

Ammonia, aluminium, fluoride and vanadium have been identified as potential leachate contaminants of concern within the Haysom's DWP (Woodward-Clyde, 2000). Leachate studies on untreated Haysom's DWP and the effects upon groundwater have been estimated by modelling (URS, 2003). The initial concentrations of analytes in the groundwater have been identified and are summarised in Appendix 10 (Table A10.2 and Figure A10.3).

The proposed deposition of carbon fines material and Haysom's DWP, in the extension to the existing landfill area, is predicted to have only a minor impact upon the groundwater quality (URS, 2003).

7.5. Effects on the Coastal Marine Area

Groundwater from the landfill site moves primarily (94%) to the south coast with a minor amount entering Bluff Harbour (6%) (Woodward-Clyde, 1994).

South Coast

There is no surface water from the existing landfill towards the south coast. The groundwater with leachate constituents is likely to be of a similar density to groundwater and will therefore discharge with groundwater through the intertidal zone of the beach. The high permeability of the beach sediments along the south coast is likely to result in discharge at or about the tidal water level.

Wave action and run-up on the permeable beach sediments is likely to result in significant increases in salinity within groundwater in the vicinity groundwater discharge.

Previous assessment of the marine environment along the south coast indicates the intertidal zone north of Tiwai Rocks consists of a very steeply sloping beach with coarse sand and gravel surficial sediment (Bioresearches, 1996). Studies of the area (Bioresearchers, 1996) along the south coast have identified the following dilution mechanisms:

- Wave action that occurs for most of the time on the south coast. The wave uprush on the beach will result in large volumes of seawater passing over the groundwater seepage zone, and
- Coastal currents, which have a general pattern of westward movement during falling tide periods and eastward movement during rising tide periods as the result of a large eddy in the bay east of Tiwai Rocks.

Bioresearchers (1996) showed that seepage was diluted several thousand times in the vicinity of the seepage point into marine waters. While the instantaneous dilution of seepage will be very high, there is a possibility of build-up of seepage constituents in the coastal water moving slowly past the seepage area.

Bioresearchers (1996) also indicated that for a discharge of 270 m^3/d along 905m of coast this would have seepage dilutions well in excess of 1000 times under assumed worst case conditions.

Table A11.1 in Appendix 11 summarises the predicted concentrations of potential contaminants of concern in groundwater discharge against the relevant receiving water criteria.

The Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC, 2000) trigger values for marine waters are considered the appropriate criteria against which to consider the groundwater discharges from the site to the south coast.

From the values presented in Table A11.1 (Appendix 11), which are conservative in that they use the maximum predicted concentrations in groundwater discharge and use a minimum likely dilution. It can be seen that the discharges from the proposed and existing activities at the NZAS landfill are:

- within the relevant ANZECC marine trigger levels for the 95% level of protection and the more conservative 99% level of protection; and,
- where guideline criteria are not available, concentrations are comparable to or below the background concentrations in seawater after reasonable mixing.

Therefore, the existing and proposed activities at the NZAS Landfill are therefore unlikely to result in adverse environmental effects on the south coast marine receiving environment.

Bluff Harbour

There is no discharge of surface water from the existing landfill side towards Bluff Harbour.

Surface water in the vicinity of the existing landfill has been previously characterised (URS, 2003). This study indicated that there is an area of swamp located immediately to the west of the existing landfill, which is fed by incident rainfall and drainage from the immediate surroundings. Discharge from the swamp is via seepage through the low dunes that line the western coast. This discharge of surface water appears to occur as a broad front at or below the low tide mark. There were also three localised areas identified in the previous investigations, where seepage occurs from the base of the dunes above the high tide mark (URS, 2003).

Surface water sampled west of the landfill, at sites separated from the landfill by swampy ground, showed low levels of components sourced from the landfill (fluoride, ammonium-N and cyanide).

Previous investigations indicate that some infiltration of swamp to the groundwater system is occurring between the landfill and the western coastline (URS, 2003). As such some mixing of groundwater and surface water is inferred beneath the dune with a combined groundwater surface water as a broad front at or below the low tide mark rather than as a series of discrete zones.

Tidal currents past this discharge area are likely to be significant as it forms the eastern margin to the entrance to Bluff Harbour.

The marine environment between the Smelter and the rock shore of Tiwai Point on the harbour side of the peninsula has previously been assessed as follows:

- There is a shallow embayment with a relatively steeply sloping beach above mid-tide level and an extensive, gently sloping sand flat between mid-tide level and low spring tide level;
- Fauna is sparce on the upper tidal level beach apart from anthropods associated with algae at the drift line. On the lower intertidal flats cockles were dominant together with wedge shells and areas of eel grass;
- The hard rock habitats of Tiwai Point and Tiwai Rocks were exceptionally rich and support high densities of a variety algae and associated invertebrates (URS, 2003).

Discharge of groundwater to the Bluff Harbour coast is below the low tide mark. While the instantaneous dilution of seepage will be less significant than along the south coast due to less wave action, the build-up of seepage constituents in the water moving slowly past the seepage area is assessed in a similar manner.

Given the tidal current and the smaller volume of groundwater discharge in this area, it is considered that a dilution of at least 100 times would occur during low tide periods.

Table A11.2, in Appendix 11, summarises the predicted concentrations of potential contaminants of concern in groundwater discharge against the relevant receiving water criteria.

The existing and proposed activities at the NZAS Landfill are therefore unlikely to result in adverse environmental effects on the Bluff Harbour marine receiving environment.

7.6. Effects on Flora and Fauna

The use of 15.49 hectares for discharges at the NZAS landfill site is authorised by Discharge Permit No. 96440. At this stage not all the vegetation on the unused parts of the existing landfill site has been cleared. Most of the vegetation cover has been cleared from the area at the south of the existing landfill site with the 0.28 hectares of remaining natural habitat being varied and comprising of rough grass, flax, ferns, rushes, bracken and small shrubs (coprosma, matagouri and small manuka trees). It is proposed to clear the remaining 0.28 hectares to allow the landfilling of carbon fines material to continue.

Tall manuka trees dominate the unused part at the western side of the existing landfill site, an area of 3.01 hectares. It is proposed to leave this habitat as it is, taking advantage of the taller vegetation for landfill screening. It is proposed to clear an area of 0.78 hectares at the north west part of the existing landfill site to allow the continued landfilling of general (non classified) material. The habitat in this area is rough grasses, flax, bracken and shrubs (matagouri and small manuka trees).

The habitat in the proposed 3.35 hectare extension to the existing landfill to the north east varies with large areas of rough grass and other areas containing *acaena* (bidi bid), rushes, minor amounts of mosses and lichens, flax, bracken on ridges and shrubs (stunted totara, coprosma and matagouri). Patches of dead gorse are present as a result of the NZAS plant pests control program. It is proposed to clear the vegetation in stages to allow the landfilling of the Haysom's DWP and future NZAS waste materials. This type of habitat is common along the south coast of Tiwai Peninsula so its clearance is considered to be only a minor loss of habitat.

The proposed future discharges at the extended NZAS landfill will result in an additional 4.41 hectares of habitat being cleared. However, it is proposed not to clear the 3.01 hectares of manuka on the western side of the existing landfill that could have been cleared under the current Discharge Permit. Completed landfill areas will be revegetated using species native to the area.

The effects on the vegetation from the proposed discharges at the extended NZAS landfill are considered to be minor.

The AEE (30 March 1995) prepared to support the application for the current Discharge Permit reported the following findings for the study by Woodward-Clyde (1994):

- no bird species were identified which were being adversely affected by the presence of the landfill or by the landfill operations,
- no birds attracted to the landfill by the wastes that are disposed of,
- no adverse effects on other animals as a result of the landfill were observed,
- the area occupied from the landfill represented a loss of habitat that was not considered to be significant, and
- progressive revegetation of the landfill will create new habitats for wildlife.

The Woodward-Clyde (1994) findings are considered to be relevant to the existing and proposed landfill operations. The proposal to clear 4.41 hectares of habitat for the landfill extension and not to clear the 3.01 hectares of manuka on the western side of the existing landfill is a minor disturbance to habitat for fauna. The revegetation of completed landfill areas will create new habitat.

7.7. Historic and Archaeological Sites

There is no evidence of historic or archaeological sites in immediate vicinity of the extended NZAS landfill area. No sites were identified during consultation with Te Ao Marama and the archaeological file keeper at the Southland Museum. Reference to Te Whakatu Kaupapa O Murihiku and the Invercargill City District Plan did not identify any sites.

In the unlikely event that skeletal remains or evidence of a possible historic or archaeological site are discovered, NZAS will contact the local Rununga and the archaeological file keeper at the Southland Museum.

8. ALTERNATIVES TO THE DISCHARGE

The existing and future NZAS waste minimisation initiatives, reuse and recycling are unlikely to completely eliminate the need to landfill some waste from the NZAS operations. In addition, many years of investigation has failed to establish a viable disposal option for the Haysom's DWP other than landfilling.

Consideration of an alternative site on Tiwai Peninsula is restricted to Comalco or NZAS owned land due to land ownership issues and the Conservation Act and ICC City District Plan provisions. Such an alternative site is not considered to have an advantage over the proposed extended NZAS landfill. The disadvantages include:

- it would be separated from the existing landfill infrastructure,
- it could be closer to the potable water bores,
- access roads and fencing would be required,
- it is likely to have a less suitable hydrological profile,
- more land clearance and vegetation disturbance is likely to be required, and
- the effects on the environment are likely to be similar or more than the proposed extended NZAS landfill.

The use of another landfill remote from the NZAS operation is not considered a suitable option. The disadvantages include:

- potential environmental issues from transportation of some of the material (dusts),
- considerable additional costs that are not considered to be justified due to the limited effects of the proposed extended NZAS landfill,
- delays in the resolution of the stored Haysom's DWP due to the closest alternative landfill unlikely to be available until late 2004.

The proposed future NZAS landfill management is to continue with the existing practice of landfilling onto the land surface by vegetation clearing, surface levelling and excavation of 1 – 2 metres where necessary. Landfill covering with gravel and the landfill revegetation program will continue. The proposal is to manage the landfilling of the Haysom's DWP in the same manner. The use of another design of landfill is not considered to provide a net advantage, the reasons for this include:

- significantly more land disturbance will be required,
- the considerable costs involved is not justified due to the limited effects on the environment, and
- the time delay will further delay the resolution of the stored Haysom's DWP.

Continuation of the current NZAS landfill management practice for an extended landfill is considered to be the most appropriate option.

9. MITIGATION MEASURES

Effects from the disturbance of land and vegetation will be mitigated by continuing the current NZAS Landfill management practices of minimising the area disturbed, covering and profiling the completed landfill areas, and revegetating these areas. These actions will also contribute to the mitigation of the visual aspect of the landfill. Limiting the active face of the landfill and not fully utilising the western area of the landfill to take advantage of the screening by the tall manuka trees will further mitigate the visual aspects.

The detailed knowledge of the amounts and characteristics of materials being landfilled, and studies of the geology and hydrology of the area mean that the limited effects on the surrounding coastal marine area will continue in the future. Continuation of the current management practices at the NZAS Landfill, including covering and revegetation of closed areas, will minimise the amount of rain leaching from the materials.

Recycling and reuse of materials will continue at NZAS. Opportunities to reduce the amount of material being landfilled or to recover already landfilled materials will continue to be sought.

In the unlikely event that an adverse effect on the environment occurs as a result of the discharge of contaminants onto or into land at the extended NZAS landfill that is significantly greater than the effects predicted in this AEE, then NZAS will either:

- remove some or all of the material(s) causing the adverse effects to another suitable location for disposal, and/or
- change the landfill management practices to reduce the adverse effects caused by the material(s).

10. CONSULTATION

The following parties have been consulted with regard to this application.

- *Bluff Community Board* - Signed paper in support of application attached. No issues raised.
- *Comalco New Zealand Limited* - Signed paper in support of application attached. No issues raised.
- *Invercargill City Council* - Signed paper in support of application attached. No issues raised.
- *Historic Places Trust* - Signed paper in support of application attached. No issues raised.
- *Public Health Southland* - Have been consulted and visited on a number of occasions. Neil Cavaney was provided with a draft application document containing the completed AEE section on Wednesday 3rd September. No issues have been raised. Public Health Southland have provided copies to Watercare Services and ESR consultants for a review of content. Providing no issues or concerns are raised, they expect to sign in support within two weeks.
- *Te Ao Marama* - Have been consulted on a number of occasions, no issues have been raised. Michael Skerrett was provided with a draft application document containing the completed AEE section on Wednesday 3rd September. They expect to sign in support in the near future.
- *Forest and Bird* - Have been consulted on a number of occasions, no issues have been raised. Craig Carson was provided with a draft application document containing the completed AEE section on Wednesday 3rd September. They expect to sign in support in the near future.
- *Department of Conservation* - The CEO of the Ministry for the Environment took a lead role in providing a solution to the long-standing issue of dross waste storage in Bluff. He advised that he had consulted with DOC at both local and national level and had reached an in-principle agreement to the landfill proposal and to relocating the dross waste to the extended NZAS landfill. In light of this, NZAS has asked Kevin O'Connor at the Southland Conservancy Office to sign in support of this application. Subsequent to this, Ken Murray from DOC has requested further information about the proposed extension to the landfill from NZAS, which we have provided. We have had no written support of the proposal back from DOC. No issues have been raised by DOC other than the request for more data.

11. PROPOSED MONITORING

The existing monitoring program has provided extensive data for assessment of groundwater quality in the vicinity of the existing landfill. This monitoring program meets the requirements of the current Discharge Permit.

Six wells are routinely sampled to monitor the quality of groundwater at the existing landfill area. These are depicted in Appendix 7, Figure A7.1 and are:

- Two wells located north east of the landfill (A20, A21)
- Two wells bores located south east towards the south coast (A6, A24) and
- Two wells located west towards Bluff Harbour (A22, A23).

Bores A20 and A21 are upstream of hydraulic groundwater flow. The remaining four bores (A6, A24, A22 and A23) are downstream of groundwater flow.

Placement of the wells ensures that sampling is representative of groundwater being impacted by the existing landfill area.

Piezometric contours of groundwater below the proposed Haysom's DWP storage area indicate that two existing wells are suitable for assessment of groundwater that would be impacted by the proposed storage of Haysom's DWP. There is no existing well able to assess groundwater quality that would be impacted by the proposed eastern carbon fines area.

The three additional groundwater monitoring wells that would be required to assess groundwater quality are:

- One well "downstream" of the Haysom's DWP cell (well T1a)
- One well "upstream" of the Haysom's DWP cell (well T1b), and
- One well downstream (South) of the proposed eastern carbon fines area (approximate location indicated and yet to be installed).

The locations of the three proposed monitoring wells are depicted in Figure A7.1 (Appendix 7).

An unnamed well to be located south of the proposed eastern carbon fines area is proposed to be included in the Schedule of monitoring six months prior to commissioning of the proposed eastern carbon fines area.

Given the groundwater is not of high quality and predominately moves seaward to the south coast with substantial dilution at the seawater tidal interface, the proposed monitoring program is sufficient in assessing impacts upon groundwater and the receiving environment.

The Schedule of Conditions includes the range of analytes and the frequency of monitoring. This is summarised in Table A12.1 (Appendix 12) and results of monitoring data collected since 1996 are summarised in Table A9.1. It is proposed that a similar Schedule of Conditions (including amendments previously granted, the additional monitoring wells referred to above and any minor amendments) constitute the replacement Discharge Permit.

12. REGULATORY REQUIREMENTS FOR THE PROPOSED ACTIVITY

12.1. Resource Management Act 1991 (RMA)

RMA s 15 – Discharges of Contaminants into Environment

This application is for a discharge permit to:

- discharge contaminant onto or into land in circumstances which may result in that contaminant (or any contaminant emanating as a result of natural processes from that contaminant) entering water – RMA s.15(1)(b), and
- discharge of contaminant from any industrial or trade premise onto or into land - RMA s.15(1)(d).

RMA s 88 – Making an Application

The application and AEE have been prepared to comply with RMA s. 88.

RMA Fourth Schedule – Assessment of Effects on the Environment

This AEE has been prepared to comply with the fourth schedule and is laid out in the same order as the requirements in the schedule.

12.2. Regional Policy Statement for Southland

There are a number of relevant Policies in the Regional Policy Statement for Southland.

Policy 1.2

This Policy recognises "Te Whakatau Kaupapa O Murihiku" as a Kai Tahu resource management reference planning document for the Region. Section 12.3 of this AEE discusses the "Te Whakatau Kaupapa O Murihiku" issues relevant to the proposed discharges at an extended NZAS landfill. In addition, consultation has been held with Te Ao Marama Inc on the proposed activity.

Policy 13.13

This Policy promotes the adoption of systems for the discharge of wastes and contaminants which have the least adverse effects. The explanation to this Policy indicates that it is more relevant to discharges direct to water.

The proposed discharges at the NZAS landfill are onto and into land, not to water. The limited effects on the environment of the proposed discharges is consistent with this Policy.

Policy 15.14

This Policy relates to the planning for a sea level rise of 35 cm by the year 2050, until such time that there is evidence that the rate of rise is higher or lower. The natural topography, tidal range and absence of severe coastal wave action indicates that a sea level rise of 35 cm is not likely to impact on the NZAS landfill.

Policy 16.1

This Policy promotes the adoption and implementation of the internationally accepted hierarchy of waste management. NZAS has an ongoing program to minimise waste and to recycle or reuse waste materials wherever viable.

Policy 16.2

This Policy related to the establishment and maintenance of an effective monitoring system for solid waste management. The data collected and reported under NZAS existing Discharge Permit should assist Environment Southland to comply with this Policy.

Policy 16.4

This Policy promotes the progressive upgrading of existing refuse disposal facilities which do not meet environmental acceptable standards, as defined in the 'National Guidelines for Landfill Management [1992]". The 1992 National Guidelines provide general guidance for landfills and NZAS considers that its landfill complies with these guidelines and has limited effects on the environment.

The 1992 Guidelines have not been updated but the Landfill Guidelines, Centre for Advanced Engineering (CAE), 2000 seem to be regarded as a proxy update. The CAE Guidelines focus on municipal solid waste landfills and provides options for managing the effects on the environment from landfills. The data in this AEE shows the limited effect on the environment from the NZAS landfill and NZAS considers that the objective of the CAE Guidelines is achieved.

Policy 16.7

This Policy relates to recognition of Maori cultural sensitivity to waste management and disposal options. Recognition of the Maori cultural sensitivities are discussed in Section 12.3 of this AEE (Te Whakatau Kaupapa O Murihiku). In addition, consultation has been held with Te Ao Marama Inc on the proposal for an extended NZAS landfill.

12.3. Te Whakatau Kaupapa O Murihiku

The Policies in Te Whakatu Kaupapa O Murihiku that NZAS considers relevant to this application are discussed below.

4.6 Koiwi o nga Tupuna – Human skeletal remains – Uru Pa

The existing NZAS landfill site was not identified as containing urupa and no urupa have been discovered during its operating life. The extension to the landfill has not been identified as containing urupa. However, in the unlikely event that skeletal remains are discovered, NZAS will contact the local Rununga and the archaeological file keeper at the Southland Museum in accordance with Policy 6.

4.7 Forests

Much of the NZAS landfill area has been revegetated using native flora representative of the area. This revegetation will continue on the existing landfill and the proposed extension to the landfill and is consistent with Policy 11.

4.16 Archaeological and Rock Art Sites

The archaeological file keeper at the Southland Museum has advised that there are no recorded archaeological sites in the near proximity of the existing and extended NZAS landfill area.

7.6 Legal personality of Ngai Tahu Whanui

Consultation has occurred with Te Ao Marama Inc on the proposal to continue the operation of an extended NZAS landfill site.

12.4. Regional Solid Waste Management Plan

The Policies and Rules in Regional Solid Waste Management Plan that NZAS considers relevant to this application are discussed below.

Policy 4.3.1 – Landfill Guidelines

This Policy relates to having regard to the "Landfill Guidelines" (Ministry for the Environment, Nov 1992, as amended or updated) when assessing new refuse disposal facilities. The 1992 National Landfill Guidelines provide general guidance for landfills and NZAS considers that its landfill complies with these guidelines and has limited effects on the environment.

The 1992 Guidelines have not been updated but the Landfill Guidelines, Centre for Advanced Engineering (CAE), 2000 seem to be regarded as a proxy update. The CAE Guidelines focus on municipal solid waste landfills and provides options for managing the effects on the environment from landfills. The data in this AEE shows the limited effect on the environment from the NZAS landfill and NZAS considers that the objective of the CAE Guidelines is achieved.

Policy 4.3.4 – Recycling, Composting and Bio-remediation

This Policy encourages the use of recycling, composting and bio-remediation as waste management measures. At NZAS, suitable materials are segregated for reuse and recycling (see Sections 4.2 and 4.3) to avoid them being landfilled. Bioremediation has been successfully used in the past at the NZAS landfill and it is proposed to use this technique in the future. Very little material suitable for composting is landfilled at NZAS.

Rule 4.5.2

Rule 4.5.2 specifies that the discharge of solid waste onto or into a refuse disposal facility is a discretionary activity. The current Discharge Permit No. 94460 is for a discretionary activity. This AEE has been prepared to support an application for a Discharge Permit for a discretionary activity to replace the current Permit.

13. STATUS OF ASSOCIATED APPROVALS

13.1. Discharges to Air

The discharges of contaminants into air from the NZAS smelter operations, including its landfill, are a discretionary activity under Rule 5.5.2 of the Regional Air Quality Plan. The discharges, including those from the landfill, are authorised by Coastal and Discharge Permit No. 93566 granted on 26 April 1994 and expiring on 26 April 2006.

Condition F6 of this permit required open burning at the landfill site to be discontinued from 31 December 1994, with exemptions for Ministry of Agriculture and Fisheries border control requirements and for emergency training requirements.

Condition F4, change of place or method of discharge of air pollutants, and Condition F5, notification of incident causing substantial air pollution, are also relevant to the landfill operations.

13.2. Land Use

NZAS landfill is on land owned by Comalco New Zealand Limited, and is in the Invercargill City District. The Invercargill City District Plan authorises the land use aspects of the disposal of waste at the NZAS landfill by Rule 4.33 for the Smelter sub-area:

- the disposal of waste from the NZAS operations is a permitted activity being included in the definition of Aluminium Smelting, and
- the disposal of the Haysom's DWP is a permitted activity being included in the definition of Industrial Activity.

The disposal of waste from the NZAS operations is also authorised by Land Use Consent (reference Property T3/3) for Aluminium Smelting and related and/or ancillary activities granted on 19 December 1994.

13.3. Health and Safety in Employment (Asbestos) Regulations 1998

The Land Use approvals in section 13.2 provide the approval required by the Health and Safety in Employment (Asbestos Regulations 1998, section 13(3)(a)).

14. REFERENCES

Application and Assessment of Effects on the Environment (1995), Discharges onto and into Land, NZAS Landfill, New Zealand Aluminium Smelters Limited, 30 March 1995.

Bioresearches (1996), Proposed Landfill Effects on Groundwater, Notes by M Larcombe 24.9.96, Appendix E of Spent Cathode Lining Stage 2 Landfill Siting Investigation, Woodward-Clyde, 1996.

Centre for Advanced Engineering (2000), Landfill Guidelines, University of Canterbury, April 2000.

Invercargill City Council District Plan (Proposed Updated with Council Decisions and Variations) (2002), 24 July 2002.

Ministry of Health (2000), Drinking Water Standards for New Zealand; August 2000.

Ministry for the Environment (1992), Resource Management – Landfill Guidelines, 1992.

NSWEPA (1999), Environmental Guidelines Assessment, Classification & Management of Liquid & Non-liquid Wastes.

Te Whakatau Kaupapa O Murihiku (1997), Ngai Tahu Resource Management Strategy for the Southland Region, February 1997.

Regional Policy Statement for Southland (1997), Southland Regional Council, December 1997.

Regional Solid Waste Management Plan for Southland (1996), Southland Regional Council, 1 April 1996.

Watters, W.A. Speden, I.G. and Wood, B.L. (1968), Sheet 26 Stewart Island (1st Edition). "Geological Map of New Zealand 1:250,000".

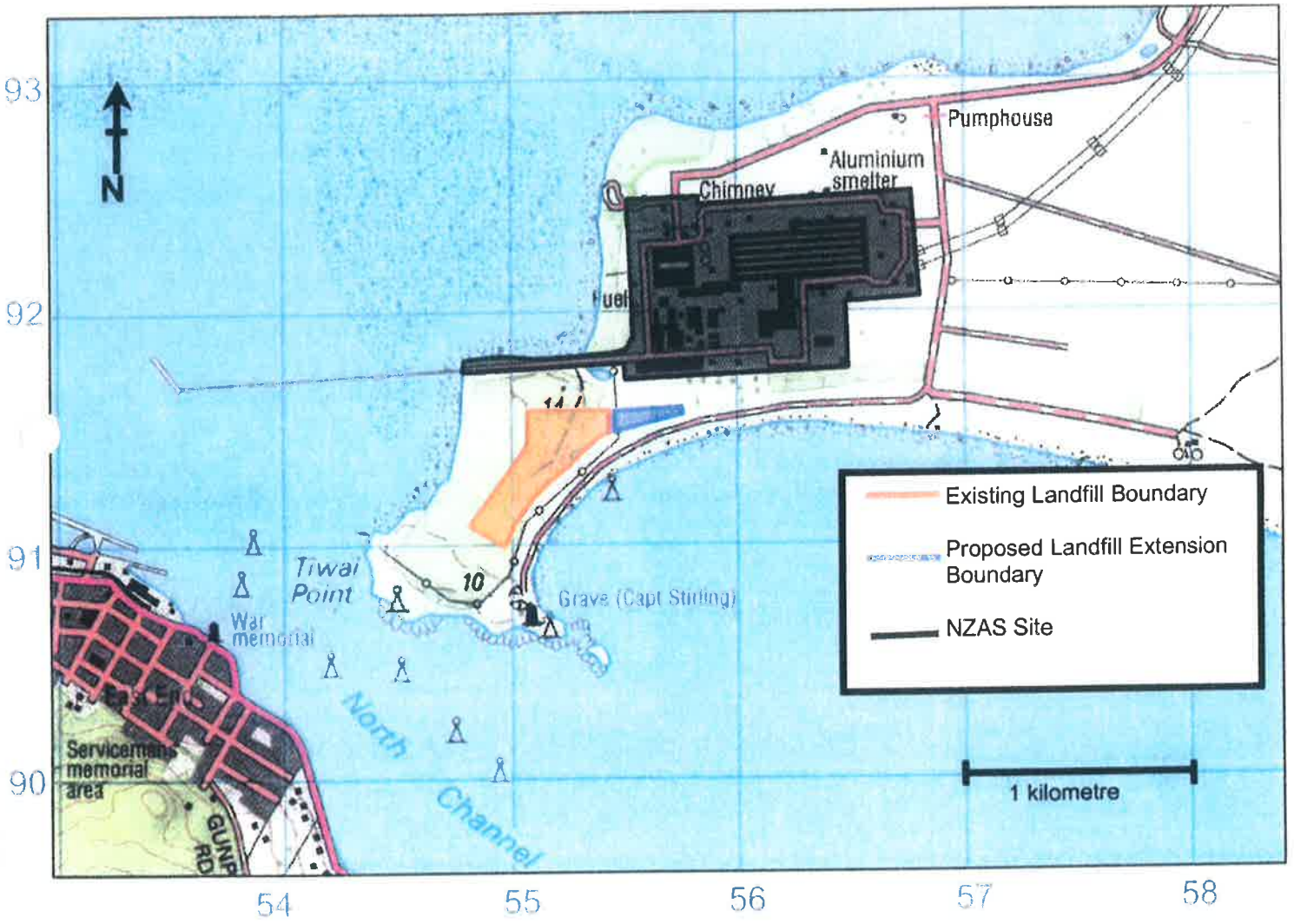
Woodward-Clyde (1994), Landfill Study, NZAS, May 1994.

Woodward-Clyde (2000), Haysom's Aluminium Dross Waste Characterisation, 27 March 2000.

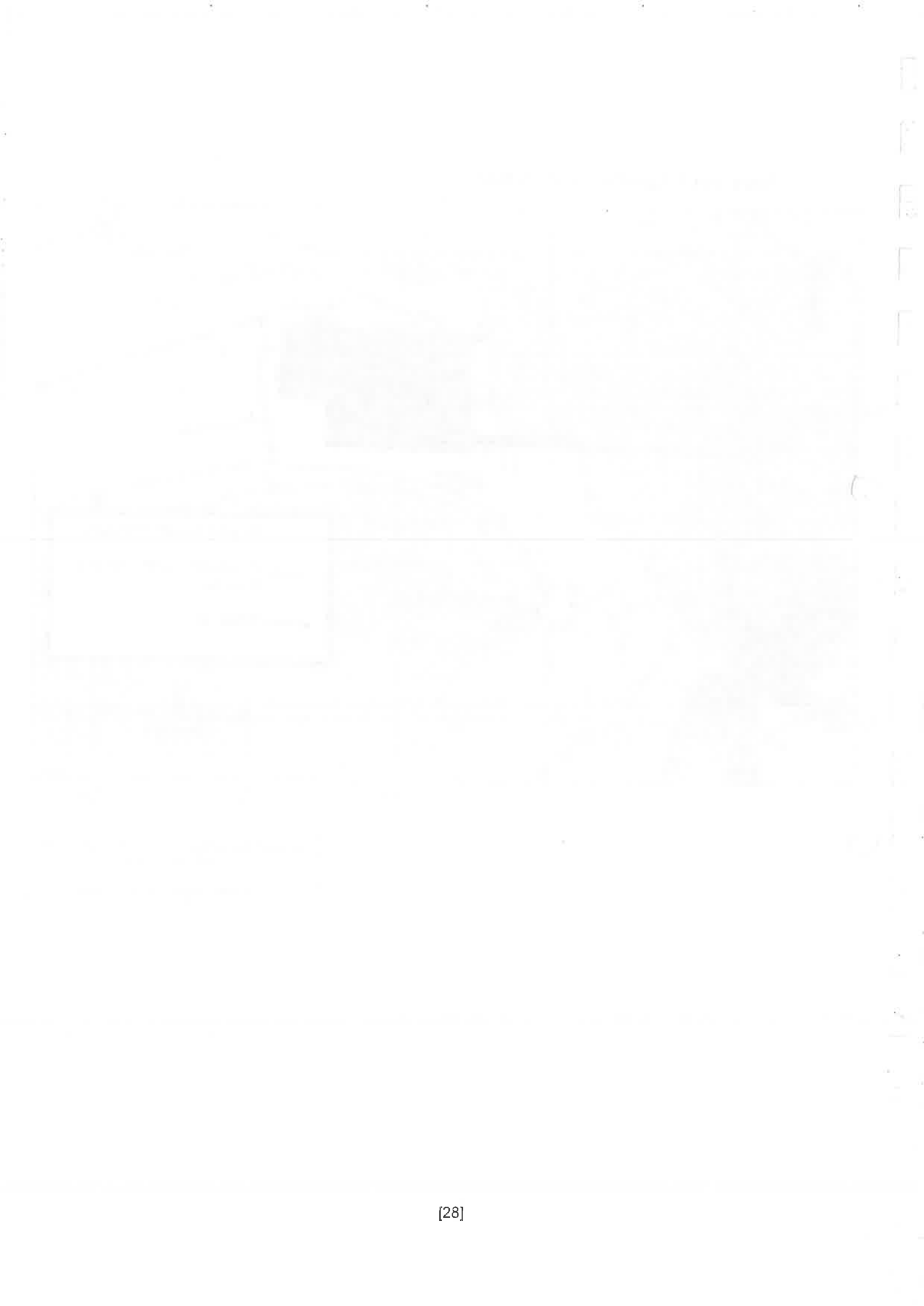
URS (2003), Tiwai Landfill and Haysom's Dross Cell, Assessment of Environmental Effects – Groundwater, 29 August 2003.

APPENDICES

Appendix 1: Landfill Location Map



Adapted from NZMS 260 E47, D47: Bluff Edition 1, 2001 (not to scale)

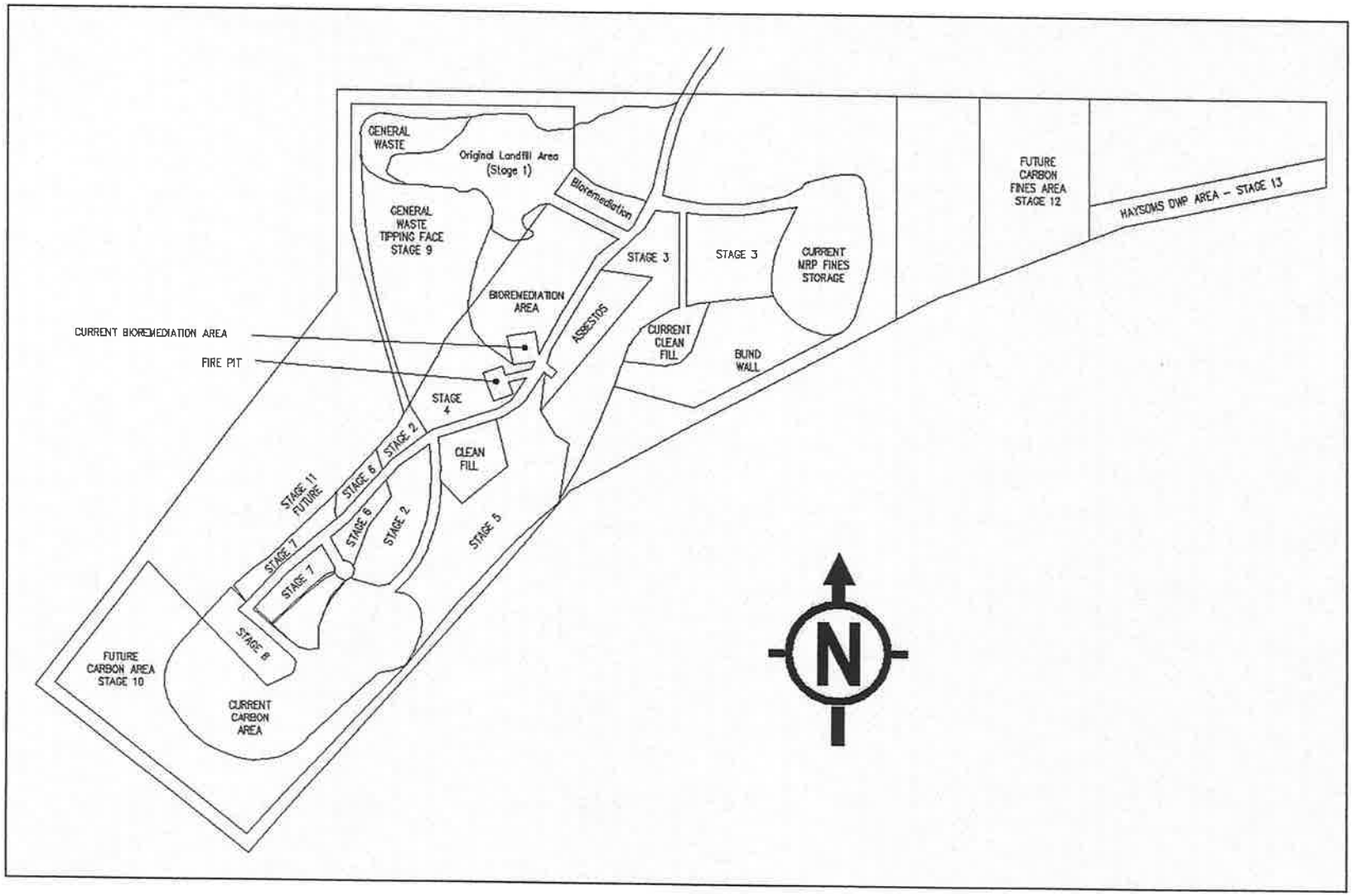


Appendix 2: Types and Amounts of Materials Landfilled

Type of Waste	Tonnes per Annum						
	1996	1997	1998	1999	2000	2001	2002
Process dust							
• Carbon fines	1668	2949	2384	2636	2981	3199	3359
• Dross fines (MRP fines)	2029	1827	2160	1429	1348		
• Other fines (alumina etc)	285	132	211	247	316	210	120
Iron slag and pieces	367	242	220	93	27	289	144
Cleanfill							
• Concrete	82	282	350	71	207	101	0
• Bricks	1373	1029	361	242	596	334	182
• Other fill (sand, gravel)					153	0	19
Anode butts	605	155	0				
Resistor coke	199	141	128	239	67	110	110
Plastic	88	94	62	13	11	22	142
Timber	54	0		116	39	94	101
Mineral fibre (MMMF)	0	38	0				
Asbestos						<1	0
Paper and cardboard	0	4		20	19	28	159
Steel (bulk)							5
Organic (includes grass)					0	3	3
General non classified	1462	1380	994	1010	537	818	221
Total	8212	8273	6870	6116	6301	5199	4565

* Note: the change in the amount of general non classified waste is probably due to more detailed classification during more recent surveys.

Appendix 3: Plan of Existing and Proposed NZAS Landfill



Appendix 4: NZAS Landfill Waste Characteristics

Contents of Appendix 4

Table A4.1: Sample Locations (Woodward-Clyde, 1994)

Sample No.	Description
1	17 to 18 year old refractory bricks taken from NW corner of landfill (near previously used ESP Tar storage area), 1 m below the surface.
2	10 year old refractory bricks taken from near the Asbestos storage area, SE side of landfill, 1 m below the surface.
3	New refractory bricks from the landfill face, when at S end of landfill.
4	Two year old Carbon Rodding Room dust taken from 500 mm below the surface.
5	Carbon Rodding Room dust taken from a face exposed by the new enclosed placement area excavations, 1.5 metres below the surface, probable age 5-8 years.
6	Three week old Carbon Rodding Room dust from surface of new enclosed placement area.
7	Coke taken from just below the surface at one of two areas in which coke was placed in 1988/9 after it was accidentally mixed with pitch.
8	MRP fines comprising a composite of samples taken from eight locations around the dross pile, just below the surface. (Multiple sampling was undertaken to obtain a representative sample).
9	Large fragments from the MRP fines comprising a composite of samples taken from eight locations around the rejects pile, at or just below the surface. (Multiple sampling was undertaken to obtain a representative sample).
10	Screened MRP fines comprising a composite of samples taken from eight locations around the pile at or just below the surface. (Multiple sampling was undertaken to obtain a representative sample).
11	Pitch from Pitch Store (no pitch located in the landfill).
12	ESP tar from storage boxes and the ground (original storage site now removed).

Table A4.2: Organic Compounds Investigated in Deioned Water Leachates from NZAS Waste Samples (Woodward-Clyde, 1994)

PARAMETER	DETECTION LIMIT (gm^{-3})
VOLATILE ORGANICS	
Benzene	<0.001
Toluene	<0.001
Ethyl benzene	<0.001
Xylenes, total	<0.001
1,1-Dichloroethene	nd
Methylene chloride	nd
1,1-Dichloroethane	nd
Chloroform	nd
Carbon tetrachloride	nd
Trichloroethene	nd
1,2-Dichloropropane	nd
Chlorobenzene	nd
Acetone	nd
2-Butanone	nd
4-Methyl-2-pentanone	nd
2-Hexanone	nd
trans-1,2-Dichloroethene	nd
cis,1,2-Dichloroethene	nd
1,1,1-Trichloroethane	nd
Bromodichloromethane	nd
cis-1,3-Dichloropropene	nd
trans-1,3-Dichloropropene	nd
Tetrachlorethene	nd
Dibromochloromethane	nd
Styrene	nd
Bromoform	nd
1,1,2,2-Tetrachloroethane	nd
Trimethylbenzene	*

Table A4.2: Organic Compounds Investigated in Deionised Water Leachates from Waste Samples (Woodward-Clyde, 1994), continued

PARAMETER	DETECTION LIMIT (gm^{-3})
SEMI-VOLATILE ORGANICS	
Basic & Neutral Compounds	
bis(2-chloroethyl)ether	<0.006
1,3-Dichlorobenzene	<0.002
1,4-Dichlorobenzene	<0.002
Benzyl alcohol	<0.003
1,2-Dichlorobenzene	<0.002
n-Nitroso-di-n-propylamine	nd
Hexachloroethane	<0.002
Nitrobenzene	<0.005
Isophorone	<0.002
bis(2-Chloroethoxy)methane	<0.006
1,2,4-Trichlorobenzene	<0.002
Naphthalene	<0.001
Hexachlorobutadiene	<0.001
2-Methylnaphthalene	<0.001
Hexachlorocylopentadiene	nd
2-Chloronaphthalene	<0.002
Dimethyl phthalate	<0.002
Acenaphthylene	<0.001
Acenaphthene	<0.001
Dibenzofuran	<0.001
Diethyl phthalate	<0.002
Fluorene	<0.001
4-Chlorophenyl phenyl ether	<0.002
N-Nitrosodiphenylamine	<0.005
4-Bromophenyl phenyl ether	<0.002
a-BHC	nd
b-BHC	<0.005
c-BHC (Lindane)	<0.005
Phenanthrene	<0.001
Anthracene	<0.001
d-BHC	nd
Heptachlor	<0.002
Di-n-butyl phthalate	<0.002
Aldrin	<0.002
Heptachlor epoxide	<0.002
Fluoranthene	<0.001
Pyrene	<0.001
4,4'-DDE	<0.006
Dieldrin	<0.003
Endosulfan II	nd
4,4'-DDD	<0.003
Butyl benzyl phthalate	<0.003
Endosulfan sulphate	<0.006
Methoxychlor	<0.006

Table A4.2: **Organic Compounds Investigated in Deionised Water Leachates from Waste Samples (Woodward-Clyde, 1994), continued**

PARAMETER	DETECTION LIMIT (gm^{-3})
Basic & Neutral Compounds, continued	
Endrin ketone	nd
Benzo(a)anthracene	<0.001
4,4'-DDT	<0.005
Chrysene	<0.001
Bis(2-Ethylhexyl) phthalate	<0.003
Dibenzo(a,h)anthracene	<0.001
Benzo(g,h,i)perylene	<0.001
Isoindole-1,3-dione	*
1,2-dihydroacenaphthalene	*
Fluoren-9-one	*
Xanthen-9-one	*
Benzo(c)cinnoline	*
Anthracenedione	*
Carbazole	*
	*
Acidic Compounds	
Phenol	<0.001
2-Chlorophenol	<0.002
2-Methylphenol	<0.002
4-Methylphenol	<0.002
2-Nitrophenol	<0.002
2,4-Dimethylphenol	<0.002
2,4-Dichlorophenol	<0.002
4-Chloro-3-methylphenol	<0.002
2,4,6-Trichlorophenol	<0.002
2,4,5-Trichlorophenol	<0.002
Pentachlorophenol	<0.005
Benzopyran-2-one	*
Benzoic acid	*
Phthallic acid derivatives	*
Naphthalenol	*
Naphthalenecarboxylic acid	*
Fluoren-9-one	*

nd = not detected (detection limit has not been determined).
* = non-target compounds tentatively detected.

Table A4.3: Results from Investigation of Organic Compounds in Deionised Water Leachates from NZAS Waste Samples

Parameter	Sample	Concentration (gm^{-3})	Reference Criteria, (gm^{-3})	
			NSWEPA (1999) Guidelines - Waste	NZ Drinking Water Standard MAVs
Volatiles				
Toluene	Composite of Samples 4-12	0.002	Inert = 1.44, Solid = 14.4, Industrial = 57.6	0.8
Xylenes - total	Composite of Samples 4-12	0.002	Inert = 5, Solid = 50, Industrial = 200	0.6
Semi Volatiles				
Naphthalene	Composite of Samples 4-12	0.002	-	-
Acenaphthylene	Composite of Samples 4-12	0.001	-	-
Acenaphthene	Composite of Samples 4-12	0.001	-	-
Dibenzofuran	Composite of Samples 4-12	0.004	-	-
Fluorene	Composite of Samples 4-12	0.002	-	-
Fluoranthene	Composite of Samples 4-12	0.009	-	0.004
Pyrene	Composite of Samples 4-12	0.006	-	-
Anthracene	Composite of Samples 4-12	0.022	-	-
Total PCA's	Composite of Samples 4-12	0.047	-	-
Acidic Compounds				
Phenol	Composite of Samples 4-12	0.002	Inert = 1.44, Solid = 14.4, Industrial = 57.6	-

Table A4.4: Results from Investigation of Inorganic Compounds in Deionised Water Leachates from NZAS Waste Samples

Parameter	Sample	Concentration (gm^{-3})	Reference Criteria, (gm^{-3})	
			NSWEPA (1999) Guidelines - Waste	NZ Drinking Water Standard MAVs
Aluminium	1 (Old bricks, NW corner)	0.2	-	Guideline = 0.15
	2 (Refractory material, SE side)	5.9		
	3 (New refractory bricks)	0.63		
	4 (Two year old C Rodding Room dust)	183		
	5 (Rodding Room dust : exposed)	153		
	6 (Three week old Rodding Room dust)	24.5		
	7 (Coke mixed with Pitch)	3.9		
	8 (Dross composite)	6.3		
	9 (Dross - large fragments)	3.1		
	10 (Dross - screened)	1.5		
	13 (Duplicate of No. 6)	24.0		
	Blank	0.03		
	Test Pit C1	18.5		
	Test Pit C1, C2, C3 (composite)	5.1		
	Blank	<0.02		
Arsenic	1 (Old bricks, NW corner)	<0.03	Inert = 0.5, Solid = 5, Industrial = 20	0.01
	2 (Refractory material, SE side)	<0.04		
	3 (New refractory bricks)	<0.03		
	4 (Two year old C Rodding Room dust)	<0.04		
	5 (Rodding Room dust : exposed)	<0.03		
	6 (Three week old Rodding Room dust)	<0.03		
	7 (Coke mixed with Pitch)	<0.04		
	8 (Dross composite)	<0.03		
	9 (Dross - large fragments)	<0.03		
	10 (Dross - screened)	<0.03		
	13 (Duplicate of No. 6)	<0.04		
	Blank	<0.03		
	Test Pit C1	<0.04		
	Test Pit C1, C2, C3 (composite)	<0.03		
	Blank	<0.04		

Table A4.4: Results from Investigation of Inorganic Compounds in Deionised Water Leachates from Waste Samples, continued

Parameter	Sample	Concentration (gm^{-3})	Reference Criteria, (gm^{-3})	
			NSWEPA (1999) Guidelines - Waste	NZ Drinking Water Standard MAVs
Boron	1 (Old bricks, NW corner)	0.009		1.4
	2 (Refractory material, SE side)	0.03		
	3 (New refractory bricks)	0.01		
	4 (Two year old C Rodding Room dust)	0.03		
	5 (Rodding Room dust : exposed)	0.03		
	6 (Three week old Rodding Room dust)	0.01		
	7 (Coke mixed with Pitch)	0.02		
	8 (Dross composite)	2.4		
	9 (Dross - large fragments)	2.4		
	10 (Dross - screened)	3.4		
	13 (Duplicate of No. 6)	0.02		
	Blank	0.01		
	Test Pit C1	0.17		
	Test Pit C1, C2, C3 (composite)	0.15		
	Blank	0.006		
Cadmium	1 (Old bricks, NW corner)	<0.003	Inert = 0.1, Solid = 1, Industrial = 4	0.003
	2 (Refractory material, SE side)	<0.004		
	3 (New refractory bricks)	<0.003		
	4 (Two year old C Rodding Room dust)	<0.004		
	5 (Rodding Room dust : exposed)	<0.003		
	6 (Three week old Rodding Room dust)	<0.003		
	7 (Coke mixed with Pitch)	<0.004		
	8 (Dross composite)	<0.003		
	9 (Dross - large fragments)	<0.003		
	10 (Dross - screened)	<0.003		
	13 (Duplicate of No. 6)	<0.004		
	Blank	<0.003		
	Test Pit C1	<0.004		
	Test Pit C1, C2, C3 (composite)	<0.003		
	Blank	<0.004		

Table A4.4: Results from Investigation of Inorganic Compounds in Leachates from Waste Samples, continued

Parameter	Sample	Concentration (gm^{-3})	Reference Criteria, (gm^{-3})	
			NSWEPA (1999) Guidelines - Waste	NZ Drinking Water Standard MAVs
Calcium	1 (Old bricks, NW corner)	2.2		Guideline for Ca & Mg hardness = 200
	2 (Refractory material, SE side)	5.4		
	3 (New refractory bricks)	1.1		
	4 (Two year old C Rodding Room dust)	17.7		
	5 (Rodding Room dust : exposed)	40.0		
	6 (Three week old Rodding Room dust)	4.7		
	7 (Coke mixed with Pitch)	1.1		
	8 (Dross composite)	0.27		
	9 (Dross - large fragments)	0.45		
	10 (Dross - screened)	0.25		
	13 (Duplicate of No. 6)	4.7		
	Blank	0.06		
	Test Pit C1	1.4		
	Test Pit C1, C2, C3 (composite)	2.7		
	Blank	0.04		
Chromium	1 (Old bricks, NW corner)	<0.003	Inert = 0.5, Solid = 5, Industrial = 20	0.05
	2 (Refractory material, SE side)	<0.004		
	3 (New refractory bricks)	<0.003		
	4 (Two year old C Rodding Room dust)	<0.004		
	5 (Rodding Room dust : exposed)	<0.003		
	6 (Three week old Rodding Room dust)	<0.003		
	7 (Coke mixed with Pitch)	<0.004		
	8 (Dross composite)	<0.003		
	9 (Dross - large fragments)	<0.003		
	10 (Dross - screened)	<0.003		
	13 (Duplicate of No. 6)	<0.004		
	Blank	<0.003		
	Test Pit C1	<0.004		
	Test Pit C1, C2, C3 (composite)	<0.003		
	Blank	<0.004		

Table A4.4: Results from Investigation of Inorganic Compounds in Leachates from Waste Samples, continued

Parameter	Sample	Concentration (gm^{-3})	Reference Criteria, (gm^{-3})	
			NSWEPA (1999) Guidelines - Waste	NZ Drinking Water Standard MAVs
Cobalt	1 (Old bricks, NW corner)	0.005		
	2 (Refractory material, SE side)	<0.004		
	3 (New refractory bricks)	0.03		
	4 (Two year old C Rodding Room dust)	0.04		
	5 (Rodding Room dust : exposed)	0.05		
	6 (Three week old Rodding Room dust)	<0.003		
	7 (Coke mixed with Pitch)	<0.004		
	8 (Dross composite)	<0.003		
	9 (Dross - large fragments)	<0.003		
	10 (Dross - screened)	<0.003		
	13 (Duplicate of No. 6)	<0.004		
	Blank	<0.003		
	Test Pit C1	<0.004		
	Test Pit C1, C2, C3 (composite)	<0.003		
	Blank	<0.004		
Copper	1 (Old bricks, NW corner)	<0.003		2
	2 (Refractory material, SE side)	<0.004		
	3 (New refractory bricks)	<0.003		
	4 (Two year old C Rodding Room dust)	0.03		
	5 (Rodding Room dust : exposed)	0.008		
	6 (Three week old Rodding Room dust)	<0.003		
	7 (Coke mixed with Pitch)	<0.004		
	8 (Dross composite)	<0.003		
	9 (Dross - large fragments)	<0.003		
	10 (Dross - screened)	<0.003		
	13 (Duplicate of No. 6)	<0.004		
	Blank	<0.003		
	Test Pit C1	0.04		
	Test Pit C1, C2, C3 (composite)	<0.003		
	Blank	<0.004		

Table A4.4: Results from Investigation of Inorganic Compounds in Leachates from Waste Samples, continued

Parameter	Sample		Reference Criteria, (gm^{-3})	
			NSWEPA (1999) Guidelines - Waste	NZ Drinking Water Standard MAVs
Iron	1 (Old bricks, NW corner)	0.10		Guideline = 0.2
	2 (Refractory material, SE side)	0.02		
	3 (New refractory bricks)	0.02		
	4 (Two year old C Rodding Room dust)	0.02		
	5 (Rodding Room dust : exposed)	0.07		
	6 (Three week old Rodding Room dust)	0.09		
	7 (Coke mixed with Pitch)	0.05		
	8 (Dross composite)	0.19		
	9 (Dross - large fragments)	0.21		
	10 (Dross - screened)	0.06		
	13 (Duplicate of No. 6)	0.05		
	Blank	0.01		
	Test Pit C1	0.66		
	Test Pit C1, C2, C3 (composite)	0.05		
	Blank	0.01		
Lead	1 (Old bricks, NW corner)	<0.02	Inert = 0.5, Solid = 5, Industrial = 20	0.01
	2 (Refractory material, SE side)	<0.02		
	3 (New refractory bricks)	<0.02		
	4 (Two year old C Rodding Room dust)	<0.02		
	5 (Rodding Room dust : exposed)	<0.02		
	6 (Three week old Rodding Room dust)	<0.02		
	7 (Coke mixed with Pitch)	<0.02		
	8 (Dross composite)	<0.02		
	9 (Dross - large fragments)	<0.02		
	10 (Dross - screened)	<0.02		
	13 (Duplicate of No. 6)	<0.02		
	Blank	<0.02		
	Test Pit C1	<0.02		
	Test Pit C1, C2, C3 (composite)	<0.02		
	Blank	<0.02		

Table A4.4: Results from Investigation of Inorganic Compounds in Leachates from Waste Samples, continued

Parameter	Sample	Concentration (gm^{-3})	Reference Criteria, (gm^{-3})	
			NSWEPA (1999) Guidelines - Waste	NZ Drinking Water Standard MAVs
Magnesium	1 (Old bricks, NW corner)	0.09		Guideline for Ca & Mg hardness = 200
	2 (Refractory material, SE side)	0.55		
	3 (New refractory bricks)	0.07		
	4 (Two year old C Rodding Room dust)	0.26		
	5 (Rodding Room dust : exposed)	0.83		
	6 (Three week old Rodding Room dust)	0.53		
	7 (Coke mixed with Pitch)	0.13		
	8 (Dross composite)	0.93		
	9 (Dross - large fragments)	2.0		
	10 (Dross - screened)	3.3		
	13 (Duplicate of No. 6)	0.47		
	Blank	<0.02		
	Test Pit C1	1.1		
	Test Pit C1, C2, C3 (composite)	3.3		
	Blank	<0.03		
Manganese	1 (Old bricks, NW corner)	0.006		0.5
	2 (Refractory material, SE side)	0.15		
	3 (New refractory bricks)	0.02		
	4 (Two year old C Rodding Room dust)	3.8		
	5 (Rodding Room dust : exposed)	13.0		
	6 (Three week old Rodding Room dust)	0.79		
	7 (Coke mixed with Pitch)	0.03		
	8 (Dross composite)	0.003		
	9 (Dross – large fragments)	0.02		
	10 (Dross – screened)	0.02		
	13 (Duplicate of No. 6)	0.83		
	Blank	0.002		
	Test Pit C1	0.02		
	Test Pit C1, C2, C3 (composite)	0.07		
	Blank	<0.0005		

Table A4.4: Results from Investigation of Inorganic Compounds in Leachates from Waste Samples, continued

Parameter	Sample	Concentration (gm^{-3})	Reference Criteria, (gm^{-3})	
			NSWEPA (1999) Guidelines - Waste	NZ Drinking Water Standard MAVs
Molybdenum	1 (Old bricks, NW corner)	<0.003	Inert = 0.5, Solid = 5, Industrial = 20	0.07
	2 (Refractory material, SE side)	<0.004		
	3 (New refractory bricks)	<0.003		
	4 (Two year old C Rodding Room dust)	<0.004		
	5 (Rodding Room dust : exposed)	<0.003		
	6 (Three week old Rodding Room dust)	0.004		
	7 (Coke mixed with Pitch)	<0.004		
	8 (Dross composite)	0.01		
	9 (Dross – large fragments)	<0.003		
	10 (Dross – screened)	0.004		
	13 (Duplicate of No. 6)	0.005		
	Blank	<0.003		
	Test Pit C1	<0.004		
	Test Pit C1, C2, C3 (composite)	<0.003		
	Blank	<0.004		
Nickel	1 (Old bricks, NW corner)	0.02	Inert = 0.2, Solid = 2, Industrial = 8	0.02
	2 (Refractory material, SE side)	0.005		
	3 (New refractory bricks)	0.03		
	4 (Two year old C Rodding Room dust)	0.88		
	5 (Rodding Room dust : exposed)	1.7		
	6 (Three week old Rodding Room dust)	0.14		
	7 (Coke mixed with Pitch)	0.02		
	8 (Dross composite)	<0.003		
	9 (Dross – large fragments)	<0.003		
	10 (Dross – screened)	<0.003		
	13 (Duplicate of No. 6)	0.15		
	Blank	<0.003		
	Test Pit C1	0.02		
	Test Pit C1, C2, C3 (composite)	<0.003		
	Blank	<0.004		

Table A4.4: Results from Investigation of Inorganic Compounds in Leachates from Waste Samples, continued

Parameter	Sample	Concentration (gm^{-3})	Reference Criteria, (gm^{-3})	
			NSWEPA (1999) Guidelines - Waste	NZ Drinking Water Standard MAVs
Phosphorous	1 (Old bricks, NW corner)	0.07		
	2 (Refractory material, SE side)	<0.05		
	3 (New refractory bricks)	<0.05		
	4 (Two year old C Rodding Room dust)	<0.05		
	5 (Rodding Room dust : exposed)	<0.05		
	6 (Three week old Rodding Room dust)	<0.05		
	7 (Coke mixed with Pitch)	<0.05		
	8 (Dross composite)	<0.05		
	9 (Dross – large fragments)	<0.05		
	10 (Dross – screened)	<0.05		
	13 (Duplicate of No. 6)	<0.05		
	Blank	<0.05		
	Test Pit C1	<0.05		
	Test Pit C1, C2, C3 (composite)	<0.05		
	Blank	<0.05		
Potassium	1 (Old bricks, NW corner)	0.15		
	2 (Refractory material, SE side)	0.4		
	3 (New refractory bricks)	0.21		
	4 (Two year old C Rodding Room dust)	1.3		
	5 (Rodding Room dust : exposed)	2.8		
	6 (Three week old Rodding Room dust)	0.77		
	7 (Coke mixed with Pitch)	0.48		
	8 (Dross composite)	45.		
	9 (Dross – large fragments)	11.1		
	10 (Dross – screened)	10.		
	13 (Duplicate of No. 6)	0.55		
	Blank	<0.1		
	Test Pit C1	2.8		
	Test Pit C1, C2, C3 (composite)	1.6		
	Blank	<0.11		

Table A4.4: Results from Investigation of Inorganic Compounds in Leachates from Waste Samples, continued

Parameter	Sample	Concentration (gm^{-3})	Reference Criteria, (gm^{-3})	
			NSWEPA (1999) Guidelines - Waste	NZ Drinking Water Standard MAVs
Selenium	1 (Old bricks, NW corner)	<0.03	Inert = 0.1, Solid = 1, Industrial = 4	0.01
	2 (Refractory material, SE side)	<0.04		
	3 (New refractory bricks)	<0.03		
	4 (Two year old C Rodding Room dust)	<0.04		
	5 (Rodding Room dust : exposed)	<0.03		
	6 (Three week old Rodding Room dust)	<0.03		
	7 (Coke mixed with Pitch)	<0.04		
	8 (Dross composite)	<0.03		
	9 (Dross – large fragments)	<0.03		
	10 (Dross – screened)	<0.03		
	13 (Duplicate of No. 6)	<0.04		
	Blank	<0.03		
	Test Pit C1	<0.04		
	Test Pit C1, C2, C3 (composite)	<0.03		
	Blank	<0.04		
Silica	1 (Old bricks, NW corner)	0.12		
	2 (Refractory material, SE side)	0.35		
	3 (New refractory bricks)	0.14		
	4 (Two year old C Rodding Room dust)	0.37		
	5 (Rodding Room dust : exposed)	0.57		
	6 (Three week old Rodding Room dust)	0.71		
	7 (Coke mixed with Pitch)	0.27		
	8 (Dross composite)	0.13		
	9 (Dross – large fragments)	0.21		
	10 (Dross – screened)	1.3		
	13 (Duplicate of No. 6)	0.26		
	Blank	0.16		
	Test Pit C1	0.71		
	Test Pit C1, C2, C3 (composite)	0.35		
	Blank	0.14		

Table A4.4: Results from Investigation of Inorganic Compounds in Leachates from Waste Samples, continued

Parameter	Sample	Concentration (gm^{-3})	Reference Criteria, (gm^{-3})	
			NSWEPA (1999) Guidelines - Waste	NZ Drinking Water Standard MAVs
Sodium	1 (Old bricks, NW corner)	1.9		Guideline = 200
	2 (Refractory material, SE side)	26.		
	3 (New refractory bricks)	4.6		
	4 (Two year old C Rodding Room dust)	442		
	5 (Rodding Room dust : exposed)	567		
	6 (Three week old Rodding Room dust)	188		
	7 (Coke mixed with Pitch)	12.3		
	8 (Dross composite)	592		
	9 (Dross – large fragments)	232		
	10 (Dross – screened)	229		
	13 (Duplicate of No. 6)	180		
	Blank	0.65		
	Test Pit C1	86		
	Test Pit C1, C2, C3 (composite)	99		
	Blank	0.18		
Strontium	1 (Old bricks, NW corner)	0.01		
	2 (Refractory material, SE side)	0.02		
	3 (New refractory bricks)	0.007		
	4 (Two year old C Rodding Room dust)	0.11		
	5 (Rodding Room dust : exposed)	0.23		
	6 (Three week old Rodding Room dust)	0.04		
	7 (Coke mixed with Pitch)	0.03		
	8 (Dross composite)	0.03		
	9 (Dross - large fragments)	0.02		
	10 (Dross - screened)	0.02		
	13 (Duplicate of No. 6)	0.04		
	Blank	<0.0002		
	Test Pit C1	0.03		
	Test Pit C1, C2, C3 (composite)	0.03		
	Blank	<0.0003		

Table A4.4: Results from Investigation of Inorganic Compounds in Leachates from Waste Samples, continued

Parameter	Sample	Concentration (gm^{-3})	Reference Criteria, (gm^{-3})	
			NSWEPA (1999) Guidelines - Waste	NZ Drinking Water Standard MAVs
Sulphur	1 (Old bricks, NW corner)	0.95		Guideline as SO_4 = 250
	2 (Refractory material, SE side)	2.8		
	3 (New refractory bricks)	2.6		
	4 (Two year old C Rodding Room dust)	229		
	5 (Rodding Room dust : exposed)	323		
	6 (Three week old Rodding Room dust)	89		
	7 (Coke mixed with Pitch)	2.9		
	8 (Dross composite)	16.6		
	9 (Dross - large fragments)	5.0		
	10 (Dross - screened)	5.0		
	13 (Duplicate of No. 6)	86		
	Blank	0.23		
	Test Pit C1	0.75		
	Test Pit C1, C2, C3 (composite)	6.8		
	Blank	0.03		
Tin	1 (Old bricks, NW corner)	<0.003		1
	2 (Refractory material, SE side)	<0.004		
	3 (New refractory bricks)	<0.003		
	4 (Two year old C Rodding Room dust)	<0.004		
	5 (Rodding Room dust : exposed)	<0.003		
	6 (Three week old Rodding Room dust)	<0.003		
	7 (Coke mixed with Pitch)	<0.004		
	8 (Dross composite)	<0.003		
	9 (Dross - large fragments)	<0.003		
	10 (Dross - screened)	<0.003		
	13 (Duplicate of No. 6)	<0.004		
	Blank	<0.003		
	Test Pit C1	<0.004		
	Test Pit C1, C2, C3 (composite)	<0.003		
	Blank	<0.004		

Table A4.4: Results from Investigation of Inorganic Compounds in Leachates from Waste Samples, continued

Parameter	Sample	Concentration (gm^{-3})	Reference Criteria, (gm^{-3})	
			NSWEPA (1999) Guidelines - Waste	NZ Drinking Water Standard MAVs
Zinc	1 (Old bricks, NW corner)	0.01		Guideline = 3
	2 (Refractory material, SE side)	0.02		
	3 (New refractory bricks)	0.02		
	4 (Two year old C Rodding Room dust)	0.06		
	5 (Rodding Room dust : exposed)	0.07		
	6 (Three week old Rodding Room dust)	0.02		
	7 (Coke mixed with Pitch)	0.02		
	8 (Dross composite)	0.009		
	9 (Dross - large fragments)	0.005		
	10 (Dross - screened)	0.004		
	13 (Duplicate of No. 6)	0.007		
	Blank	0.005		
	Test Pit C1	0.13		
	Test Pit C1, C2, C3 (composite)	0.02		
	Blank	0.007		

Table A4.4: Results from Investigation of Inorganic Compounds in Leachates from Waste Samples, continued

Parameter	Sample		Concentration (gm^{-3})	Reference Criteria, (gm^{-3})	
				NSWEPA (1999) Guidelines - Waste	NZ Drinking Water Standard MAVs
Ammonium-N	i	Composite of Samples 7, 11 and 12	6.4		Guideline as NH_3 = 1.5
	ii	Screened Dross - Sample 10	3.9		
	iii	Composite of Refractories - Samples 1, 2 and 3	1.12		
	iv	Composite of Carbon Dust - Samples 4, 5 and 6	6.0		
	v	Large Dross Fragments - Sample 9	13.6		
	vi	Dross Composite - Sample 8	31		
	vii	Duplicate of iv	5.5		
	viii	Test Pit C1	0.42		
	ix	Composite - Test Pits C2, C3 and C4	0.12		
	x	Blank	0.03		
Fluoride	i	Composite of Samples 7, 11 and 12	22	Inert = 15, Solid = 150, Industrial = 600	1.5
	ii	Screened Dross - Sample 10	120		
	iii	Composite of Refractories - Samples 1, 2 and 3	17		
	iv	Composite of Carbon Dust - Samples 4, 5 and 6	310		
	v	Large Dross Fragments - Sample 9	136		
	vi	Dross Composite - Sample 8	190		
	vii	Duplicate of iv	240		
	viii	Test Pit C1	58		
	ix	Composite - Test Pits C2, C3 and C4	76		
	x	Blank	0.1		

Table A4.4: Results from Investigation of Inorganic Compounds in Leachates from Waste Samples, continued

Parameter	Sample		Concentration (gm^{-3})	Reference Criteria, (gm^{-3})	
				NSWEPA (1999) Guidelines - Waste	NZ Drinking Water Standard MAVs
Total Cyanide	i	Composite of Samples 7, 11 and 12	<0.002	Inert = 1.6, Solid = 16, Industrial = 64	0.08
	ii	Screened Dross - Sample 10	0.006		
	iii	Composite of Refractories - Samples 1, 2 and 3	<0.002		
	iv	Composite of Carbon Dust - Samples 4, 5 and 6	<0.002		
	v	Large Dross Fragments - Sample 9	0.003		
	vi	Dross Composite - Sample 8	<0.002		
	vii	Duplicate of iv	0.002		
	viii	Test Pit C1	<0.002		
	ix	Composite - Test Pits C2, C3 and C4	0.002		
	x	Blank	<0.002		
Mercury	i	Composite of Samples 7, 11 and 12	<0.0001	Inert = 0.02, Solid = 0.2, Industrial = 0.8	0.002
	ii	Screened Dross - Sample 10	<0.0001		
	iii	Composite of Refractories - Samples 1, 2 and 3	<0.0001		
	iv	Composite of Carbon Dust - Samples 4, 5 and 6	<0.0001		
	v	Large Dross Fragments - Sample 9	<0.0001		
	vi	Dross Composite - Sample 8	<0.0001		
	vii	Duplicate of iv	<0.0001		
	viii	Test Pit C1	<0.0001		
	ix	Composite - Test Pits C2, C3 and C4	0.0003		
	x	Blank	0.0003		

Table A4.4: Results from Investigation of Inorganic Compounds in Leachates from Waste Samples, continued

Parameter	Sample		Concentration (gm^{-3})	Reference Criteria, (gm^{-3})	
				NSWEPA (1999) Guidelines - Waste	NZ Drinking Water Standard MAVs
COD	i	Composite of Samples 7, 11 and 12	23		
	ii	Screened Dross - Sample 10	6		
	iii	Composite of Refractories - Samples 1, 2 and 3	11		
	iv	Composite of Carbon Dust - Samples 4, 5 and 6	<6		
	v	Large Dross Fragments - Sample 9	9		
	vi	Dross Composite - Sample 8	11		
	vii	Duplicate of iv	10		
	viii	Test Pit C1	<6		
	ix	Composite - Test Pits C2, C3 and C4	<6		
	x	Blank	<6		

Parameter	Sample			Reference Criteria, (gm^{-3})	
				NSWEPA (1999) Guidelines - Waste	NZ Drinking Water Standard MAVs
pH	i	Composite of Samples 7, 11 and 12	4.1		Guideline = 7.0 – 8.5
	ii	Screened Dross - Sample 10	7.9		
	iii	Composite of Refractories - Samples 1, 2 and 3	6.8		
	iv	Composite of Carbon Dust - Samples 4, 5 and 6	5.9		
	v	Large Dross Fragments - Sample 9	8.0		
	vi	Dross Composite - Sample 8	8.9		
	vii	Duplicate of iv	7.2		
	viii	Test Pit C1	6.8		
	ix	Composite - Test Pits C2, C3 and C4	7.3		
	x	Blank	5.0		

Appendix 5: Characteristics of Haysom's Dross Waste Powder

Table A5: Results from Investigation of Compounds in TCLP (Weak Acid) Leachates from Haysom's DWP

Parameter	Concentration (gm^{-3})		Reference Criteria, (gm^{-3})			
	Weak Acid TCLP	Deionised Water TCLP	NSWEPA (1999) Guidelines – Waste (Weak Acid TCLP)			NZ Drinking Water Standard MAVs
			Inert	Solid	Industrial	
Aluminium	690	-	-	-	-	Guideline= 0.15
Ammonium - N	3	22	-	-	-	Guideline as NH_3 = 1.5
Arsenic	<1.0	-	0.5	5	20	0.01
Barium	1.5	-	-	-	-	0.7
Beryllium	<0.01	-	0.1	1	4	0.004
Boron	9	-	-	-	-	1.4
Cadmium	<0.01	-	0.1	1	4	0.003
Chromium	<0.01	-	0.5	5	20	0.05
Copper	<0.01	-	-	-	-	2
Cyanide	<0.01	-	1.6	16	64	0.08
Fluoride	24	129	15	150	600	1.5
Lead	<0.01	-	0.5	5	20	0.01
Mercury	<0.01	-	0.02	0.2	0.8	0.002
Nickel	<0.05	-	0.2	2	8	0.02
Thallium	<0.01	-	-	-	-	-
Vanadium	1.3	-	-	-	-	-
Zinc	0.3	-	-	-	-	Guideline = 3

Appendix 6: Landcare Research Classification of Haysom's DWP

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PD WM 03 04 03

7 August 2002

Mr David Scott
87 Simla Crescent
WELLINGTON

Dear David

Further to our recent telephone discussion attached are the Opus and Landcare Research reviews of the URS report to Bovis Lend Lease dated 26 March 2002.

The Opus review clearly indicated that they agree with the URS conclusions that the dross material is non-hazardous in terms of flammability and toxic gas emissions. However the Opus review did not draw any firm conclusions on whether the dross material is hazardous due to ecotoxic properties.

In response to this the Ministry undertook its own calculations on the aquatic ecotoxicity of the leachate generated from the dross, these calculations concluded that the dross material was not ecotoxic. The Ministry then contracted LandCare Research to undertake an independent assessment of these calculations and to decide whether the dross is non-hazardous from an ecotoxic perspective. The Landcare report concluded that the leachate generated from the dross is not ecotoxic to aquatic ecosystems.

It is worth clarifying the meaning of the following phrase from point 2 of the Landcare review – *"under the definition described above this mixture is not ecotoxic to organisms because it is greater than the minimum degrees of hazard."* This comment may be interpreted to mean that the dross material exceeds the HSNO minimum degrees of hazard and therefore is hazardous. However, this comment refers to the Minimum Degrees of Hazard Regulations 2001, which state that a substance is defined as ecotoxic to aquatic organisms if the LC50 is 100 mg/l or less. The calculated mixture toxicity for the dross leachate is 3578 mg/l. As the calculated dross leachate toxicity of 3578 mg/l is greater than 100 mg/l, the threshold for ecotoxicity is not exceeded and the material is therefore non-hazardous.

I look forward to working with you to find a sustainable solution for the dross material. I will be in contact with you as soon as possible after the new government has been formed.

Yours sincerely

Jaquetta (Ket) Bradshaw
Manager – Pollution and Waste Group

PD-WM-03-04 - 03

29 April 2002

Glenn Wigley
Ministry for the Environment
PO Box 10 362
Wellington

OPUS
INTERNATIONAL CONSULTANTS

350141.01

Dear Glenn,

Disposal of Haysom's Aluminium Dross

As promised, please find attached a copy of Dr Peter Nelson's report on the findings of the URS report to Bovis Lend Lease dated 26 March 2002[1].

Although the URS work shows that in terms of flammable and toxic gas emissions, the dross is not hazardous, URS' use of the HSNO Act and Regulations to investigate ecotoxicity appears to have some weaknesses (difficulty in defining the 'substance' and Dross's apparent ecotoxicity due to aluminium content) and may not be strictly appropriate. Although it is outside the scope of this work, it may be useful to ask the opinion of a toxicologist such as Dr Charlie Eason as to whether or not 100mg of Dross in one litre of water would be considered ecotoxic (and therefore a hazardous substance under HSNO assuming that the problem of substance definition can be resolved).

In addition to Dr Nelsons report, we note the following (minor) comments (page numbers refer to the URS report[1]):

1. page 4, last paragraph: strictly speaking, is a risk based assessment allowable at all under the CAE guidelines and "Management of Hazardous Waste" for a non CAE landfill (see also URS report of 3/8/01, 1st page[2]).

2. page 8, 1st paragraph: the 123ml/kg needs to be added to the gas released. For example, 123+80=303 ml/kg.h. However, this is still less than 1000ml/kg.h.

3. page 8, 3rd paragraph: The basis for the comment that fluoride concentrations were lower than those in the risk analysis is unclear. If the composites represent the dross analysed in the risk analysis the fluoride was about the same in the new samples (0.68% versus 0.56%).

4. Table 5: The 6.6% AlN figure from Stan Winter seems to have been omitted from column 'Undefined 5'.

5. ditto: We assume the Composite 1 and 2 were from samples kept from analyses for the 2000 Characterisation report.

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[1] URS NZ Ltd, Haysom's Dross Disposal, letter dated 26 March 2002, ref. 3934/0001/00001
[2] URS NZ Ltd, Haysom's Dross- Response to Peer Reviewers, letter dated 3/8/01, 13/9/01, ref. 48534.001

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6. In their report of the 3/8/01[2] section 1.1.2, URS argue that the Dross is not a primary production Slag under the New Zealand Waste List (L Code) as it has been through Haysom's secondary recovery operation, consisting of crushing, heat drying and screening. However these are only mechanical operations and are unlikely to reduce the potentially chemical hazardous characteristics of the dross, in fact the dross reactivity may be enhanced because large lumps are crushed exposing more surface to water.

If Haysom's Dross is to be disposed of in the New River Landfill, then the other concerns raised in our previous 3 reports[3] should to be addressed and satisfied (for example concerns raised regarding measures taken to prevent dust nuisance and the adequacy of modelling undertaken). This would require input from the other team members and is outside scope of this report.

Please feel free to contact the undersigned to discuss,

Yours faithfully,

Peter Keller
Senior Environmental Engineer

[3] Opus reports "Review of Report-Haysom's Aluminium Dross Waste Characterisation (27/3/00)", "Review of Report-Haysom's Dross Cell - Site Specific Risk Assessment (4/9/00)" and "Review of Report - Haysoms Dross Trial Cell Construction and Monitoring Specifications (30/3/01)", all dated 30/6/01.

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2002-4

24 April 2002

Opus International Consultants Ltd
PO Box 12-343
Wellington

Attn: Mr Peter Keller

Dear Peter

Aluminium Dross: Comment on URS Report to Bovis Lend Lease, 26 March 2002

My Comments on this report are attached.

Yours sincerely

P E Nelson

(Consultant, Environmental Chemistry)

Aluminium Dross: Comment on URS Report (3934/0001/00001) to Bovis Lend Lease, 26 March 2002

Scope

The test work is set out in the URS Report (48534.001) to P&O Nedlloyd on 3 August/13 September 2001. It aims to characterise the dross in terms of its hazardous characteristics by

1. Sampling following accepted standard procedures;
2. Testing the samples used in the previously reported risk assessment (URS) to verify that they were representative of the waste as a whole;
3. Testing gas emissions from the dross based on the UK Special Waste Regulations (1996).

Methodology

1. The report (26 March 2002) follows the scope test work.
2. The sampling procedure is not described or validated in the report.
3. The testing to the UK Special Waste Regulations is adequate. The UK regulations explanatory note (SWEN 042) specifies Method A.12 of Annex V to the EU directive 92/69/EEC for the measurement of flammable and toxic gas evolution from wastes in contact with water. Method A.12 is identical to the UN Test Method N.5. UN Test Method N.5 is specified in the Hazardous Substances (Classification) Regulations 2001 for classifying solids that emit flammable gas when in contact with water (Class 4.3 substances). The method described in the URS report appears to be similar to Method A.12, but it is not fully described or validated. Copies of SWEN 042 and Method A.12 are attached.

Representative Nature of samples used in the URS Risk Assessment

1. The results reported for fluoride in the composite samples 2002 (Table 5) are shown as mg/kg rather than %.
2. Hazardous wastes are controlled by the RMA, not HSNO. RMA controls for hazardous wastes are established under consents issued under this Act. The MfE is currently developing landfill waste acceptance criteria (LWAC) to improve the RMA controls. Under the LWAC, wastes listed in the New Zealand Waste List (L-Code) as potentially hazardous cannot be accepted at any landfill unless it meets the design standards given in the CAE Landfill Guidelines. If these standards are met, wastes listed as potentially hazardous may be accepted if they meet TCLP criteria specified in the LWAC. A number of New Zealand landfills already have waste acceptance TCLP limits based on USEPA criteria and the NZS 9201:23:1999 Model General Bylaws Trade Waste specified in their consent conditions.
3. The New River Landfill is an older landfill and it does not meet the design standards given in the CAE landfill guidelines. Under the proposed LWAC, it cannot accept the potentially hazardous wastes listed in the L-Code. Specific TCLP limits have not been established for the New River Landfill and national LWAC have not been completed. Testing under the UK Special Wastes Regulations 1996 indicate that the Haysom dross is not hazardous in terms of its flammable or toxic gas emissions. Testing under these regulations for ecotoxicity was not done.

4. In the absence of LWAC applicable to the New River Landfill, URS has applied some of the provisions relating to ecotoxicity in the Hazardous Substances Regulations (2001) to assess the hazardous characteristics of the Haysom dross. The URS approach applies the ecotoxic limits given in Schedule 6 of the Hazardous Substances (Minimum Degrees of Hazard) Regulations 2001 in its assessment of the degree of hazard of the Haysom dross. These regulations specify, for example, that a substance is ecotoxic to aquatic organisms because data for the substance indicates that the fish LC_{50} is 100 mg or less per litre of water. The URS argument considers the Haysom dross to be a substance and relates its ecotoxicity to the individual concentration of known contaminants in the dross in 1 litre of water in contact with 100 mg of dross. From this, URS concludes that the dross is not ecotoxic.

5. This conclusion is questionable. The Haysom dross is not defined as a substance under the HSNO Act as it is a mixture of variable and only partially known composition.

6. Another way of assessing the hazardous classification under the HS Regulations is to apply the mixture rules, described in Part VII of the User Guide to HSNO Thresholds and Classification (ERMA, August 2001), to the components known to be in the Haysom dross. The ANZECC Water Quality Guidelines report the fish LC_{50} for aluminium in the range 0.6 – 106 mg/l. Aluminium is thus specified as ecotoxic (Class 9.1C: Substances that are harmful in the aquatic environment) under the provisions of Schedule 6 of the Hazardous Substances (Minimum Degrees of Hazard) Regulations 2001. The mixture rules retain the ecotoxic hazard classification if the sum of classified components exceeds 25%. The dross contains aluminium in a range of 25 – 50% (Table 2-1, Characterisation report, URS 27 March 2000). Thus the dross is ecotoxic based on its aluminium content. Other known components of the dross include fluoride, boron, vanadium, and aluminium nitride. These components, or products produced by them on contact with water, are classifiable as ecotoxic, and will add to the ecotoxic effect of aluminium.

7. While using the HSNO regulatory provisions to assess potentially hazardous wastes appears reasonable, the difficulty in defining waste composition presents a major problem. This is recognised by ERMA and the MfE. The development of the NZ Waste List and LWAC by the MfE will provide guidance to support the RMA controls on the acceptance of hazardous waste into landfills.

Conclusions

Provided that the methodology used is properly validated, the conclusions that

1. the Haysom Dross is not hazardous in terms of its flammable and toxic gas emissions is acceptable;
2. the dross samples used were representative of the dross is acceptable.
3. the Haysom dross is not ecotoxic is not acceptable (see notes 4-6 in the previous section).
4. In my opinion, hazardous waste classification for landfill acceptance using the HSNO regulatory provisions should be avoided as this is likely to conflict with hazardous waste controls under the RMA.

SPECIAL WASTE REGULATIONS 1996 (AS AMENDED)

SPECIAL WASTE EXPLANATORY NOTE

Description: **ALUMINIUM DROSSES & SLAGS & RELATED WASTES**

Hazardous Waste List Code(s):

10 03 04	**Primary smelting slags/white drosses**
10 03 08	**Salt slags from secondary smelting**
10 03 09	**Black drosses from secondary smelting**
10 03 10	**Waste from treatment of salt slags and black drosses treatment**

Scope/Interpretation:

Aluminium Dross is a material generally consisting of aluminium oxides, aluminium, aluminium alloys & metallic salts, formed from the reaction of molten aluminium with air, moisture, salt & chlorine fluxes during molten metal processing. Cooled dross may be in the form of lumps, small pieces or fine particles, with a black, grey or white mineral like appearance. Dross usually contains some entrained metallic aluminium.

The main constituents and typical composition within the drosses that may make the waste special are:

Aluminium	8 to 50%
Aluminium Oxide	30 to 90%
Aluminium Nitride	0 to 10%
Aluminium Carbide	0 to 5%

Aluminium Slag is a material generally consisting of aluminium oxides, aluminium & aluminium alloys. sodium & potassium chloride, formed during molten metal processing.
Salt slag may be in the form of lumps, small pieces or fine particles.

The main constituents and typical composition within the slags that may make the waste special are:

Aluminium	1 to 15%
Aluminium Oxide	10 to 50%
Aluminium Nitride	0 to 1%
Aluminium Carbide	0 to 1%

Reference to the European Inventory of Existing Commercial Chemical Substances (EINECS) has been made for the description and analysis.

Date of issue:	01.01.99	Version No.:	2	Doc. Ref. No.:		SWEN 042	
Drafted by:	SWAG	Approved by:		Page No.:	1	Of:	5

IMPORTANT NOTES PLEASE READ

This explanatory note is intended for SPECIFIC INTERNAL ENVIRONMENT AGENCY use to assist officers to interpret and enforce the 1996 Special Waste Regulations (as amended) the explanatory note is based on information contained in the SWR and on current understanding. This explanatory note may be subject to change in the light of regulatory changes, future Government guidance or experience of regulating this type of waste. However, in the interests of transparency, this explanatory note is available

SPECIAL WASTE REGULATIONS 1996 (AS AMENDED)
SPECIAL WASTE EXPLANATORY NOTE

Description: ALUMINIUM DROSSES & SLAGS & RELATED WAST

Hazardous Waste List Code(s):

10 03 04	Primary smelting slags/white drosses
10 03 08	Salt slags from secondary smelting
10 03 09	Black drosses from secondary smelting
10 03 10	Waste from treatment of salt slags and bla drosses treatment

Technical Assessment:

The wastes are listed on Schedule 2 Part I (the Hazardous Waste List) of the Special W: Regulations 1996 (as amended) (SWR) and therefore need to be assessed against all hazardous properties H1 to H14 given in Schedule 2 Part II of the SWR.

The waste contains substances classified as hazardous as shown below:

Substance	ASL Classification or *other data	Applicable Hazard Codes
Aluminium (as powder, stabilised)	F; R15 R10	H3A (fifth indent) -
Aluminium Nitride	A poison. Will react with water or steam to produce toxic or corrosive fumes (ammonia). [Sax 9th Edition] - (R29 assumed)	H12
Aluminium Carbide	Decomposed by water with evolution of methane. [The Merck Index 11th Edition] - (R15 assumed)	H3A (fifth indent)

To make an assessment of aluminium slags and dross the most important criteria is to look : the hazardous properties H3-A (fifth indent) and H12.

IMPORTANT NOTES PLEASE READ

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Technical Assessment Cont'd

There are two mechanisms for determining these hazards:

- test to show that the hazard is apparent, i.e., in the case of H3A (fifth indent) contact with water or damp air gives rise to 1 litre of flammable gas from 1 kg of waste in 1 hour, and in the case of H12 contact with water, air or acid gives rise to 1 litre of toxic gas from 1 kg of waste in 1 hour. The test methods are listed in Annex V;
- determine the concentration of aluminium nitride and/or aluminium carbide and calculate the threshold concentration of the substance in the waste using stoichiometric equations.

Stoichiometric equations for aluminium nitride with water to determine the H12 threshold

On contact with water aluminium nitride decomposes to release toxic ammonia gas:

$$AlN + 3H_2O \rightarrow Al(OH)_3 + NH_3\uparrow$$

Attribute molecular weights 41 3 x 18 78 17

Divide the number of grams of aluminium nitride, 41, by 22.4 (the volume in litres occupied by 1 mole of gas at NTP) and multiply by the molar ratio between aluminium nitride & the ammonia gas produced:

$$41 / 22.4 \times 1/1 = 1.8304g$$

IMPORTANT NOTES PLEASE READ

This explanatory note is intended for SPECIFIC INTERNAL ENVIRONMENT AGENCY use to assist officers to interpret and enforce the 1996 Special Waste Regulations (as amended) the explanatory note is based on information contained in the SWR and on current understanding. This explanatory note may be subject to change in the light of regulatory changes, future Government guidance or experience of regulating this type of waste. However, in the interests of transparency, this explanatory note is available

Description: ALUMINIUM DROSSES & SLAGS & RELATED WASTES

Hazardous Waste List Code(s):

10 03 04	Primary smelting slags/white drosses
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Technical Assessment Cont'd:

This amount of substance (grams) is divided by 1000 (to convert to Kg) and multiplied by 100 (to give % by weight), which will give the limiting concentration for the substance in the waste for hazard H12:

$$1.8304 / 1000 \times 100 = 0.183\%$$

Stoichiometric equations for aluminium powder to determine the H3A (fifth indent) threshold

Aluminium in powder form will readily oxidise in contact with moisture or damp air to produce Aluminium Oxide & Hydrogen:

$$2Al + 3H_2O = Al_2O_3 + 3H_2$$

The methodology given above for H12 can be used for calculating the amount of Aluminium as powder in the waste that can produce enough highly flammable gas to give the limiting concentration for the substance in the waste for hazard H3A (fifth indent):

$$= 0.08\%$$

Stoichiometric equations for aluminium carbide to determine the H3A (fifth indent) threshold

Aluminium Carbide on contact with water decomposes to release Methane:

$$Al_4C_3 + 6H_2O \rightarrow 2Al_2O_3 + 3CH_4\uparrow$$

Description: ALUMINIUM DROSSES & SLAGS & RELATED WASTES

Hazardous Waste List Code(s):

10 03 04	**Primary smelting slags/white drosses**
10 03 08	**Salt slags from secondary smelting**
10 03 09	**Black drosses from secondary smelting**
10 03 10	**Waste from treatment of salt slags and black drosses treatment**

Technical Assessment Cont'd:

Using the same methodology as given above for calculating the amount of Aluminium Carbide in the waste to produce enough highly flammable gas will give the limiting concentration for the substance in the waste for hazard H3A (fifth indent):

= 0.214%

Other considerations

This assessment does not consider any other hazards, for example H14 ecotoxic. Data on this and the other Schedule 2 Part II hazardous properties is scant but should be considered for any assessment of aluminium wastes.

Summary

Aluminium drosses and Slags that are on the Hazardous waste list will be special waste if they contain:

Aluminium Nitride at concentrations ≥ 0.18% (H12)
Aluminium in powder form at concentrations ≥ 0.08% (H3A (fifth indent))
Aluminium Carbide at concentrations ≥ 0.22% (H3A (fifth indent))

Alternatively, a test can be performed on the waste to determine if the waste will give rise to 1 litre of gas in 1 hour from 1 kg waste.

A.12. FLAMMABILITY (CONTACT WITH WATER)

1. METHOD

1.1. INTRODUCTION

This test method can be used to determine whether the reaction of a substance with water or damp air leads to the development of dangerous amounts of gas or gases which may be highly flammable.

The test method can be applied to both solid and liquid substances. This method is not applicable to substances which spontaneously ignite when in contact with air.

1.2. DEFINITIONS AND UNITS

Highly flammable: substances which, in contact with water or damp air, evolve highly flammable gases in dangerous quantities at a minimum rate of 1 litre/kg per hour.

1.3. PRINCIPLE OF THE METHOD

The substance is tested according to the step by step sequence described below; if ignition occurs at any step, no further testing is necessary. If it is known that the substance does not react violently with water then proceed to step 4 (1.3.4).

1.3.1. Step 1

The test substance is placed in a trough containing distilled water at 20 °C and it is noted whether or not the evolved gas ignites.

1.3.2. Step 2

The test substance is placed on a filter paper floating on the surface of a dish containing distilled water at 20 °C and it is noted whether or not the evolved gas ignites. The filter paper is merely to keep the substance in one place to increase the chances of ignition.

1.3.3. Step 3

The test substance is made into a pile approximately 2 cm high and 3 cm diameter. A few drops of water are added to the pile and it is noted whether or not the evolved gas ignites.

1.3.4. Step 4

The test substance is mixed with distilled water at 20 °C and the rate of evolution of gas is measured over a period of seven hours, at one-hour intervals. If the rate of evolution is erratic, or is increasing, after seven hours, the measuring time should be extended to a maximum time of five days. The test may be stopped if the rate at any time exceeds 1 litre/kg per hour.

1.4. REFERENCE SUBSTANCES

Not specified.

1.5. QUALITY CRITERIA

Not stated.

1.6 DESCRIPTION OF METHODS

1.6.1. Step 1

1.6.1.1. Test conditions

The test is performed at room temperature (circa 20 °C).

1.6.1.2. Performance of the test

A small quantity (approximately 2 mm diameter) of the test substance should be placed in a trough containing distilled water. A note should be made of whether (i) any gas is evolved and (ii) if ignition of the gas occurs. If ignition of the gas occurs then no further testing of the substance is needed because the substance is regarded as hazardous.

1.6.2. Step 2

1.6.2.1. Apparatus

A filter-paper is floated flat on the surface of distilled water in any suitable vessel, e.g. a 100 mm diameter evaporating dish.

1.6.2.2. Test conditions

The test is performed at room temperature (circa 20 °C).

1.6.2.3. Performance of the test

A small quantity of the test substance (approximately 2 mm diameter) is placed onto the centre of the filter-paper. A note should be made of whether (i) any gas is evolved and (ii) if ignition of the gas occurs. If ignition of the gas occurs then no further testing of the substance is needed because the substance is regarded as hazardous.

1.6.3. Step 3

1.6.3.1. Test conditions

The test is performed at room temperature (circa 20 °C).

1.6.3.2. Performance of the test

The test substance is made into a pile approximately 2 cm high and 3 cm diameter with an indentation in the top. A few drops of water are added to the hollow and a note is made of whether (i) any gas is evolved and (ii) if ignition of the gas occurs. If ignition of the gas occurs then no further testing of the substance is needed because the substance is regarded as hazardous.

1.6.4. Step 4

1.6.4.1. Apparatus

The apparatus is set up as shown in the figure.

1.6.4.2. Test conditions

Inspect the container of the test substance for any powder < 500 µm (particle size). If the powder constitutes more than 1 % w/w of the total, or if the sample is friable, then the whole of the substance should be ground to a powder before testing to allow for a reduction in particle size during storage and handling; otherwise the substance is to be tested as received. The test should be performed at room temperature (circa 20 °C) and atmospheric pressure.

1.6.4.3. Performance of the test

10 to 20 ml of water are put into the dropping funnel of the apparatus and 10 g of substance are put in the conical flask. The volume of gas evolved can be measured by any suitable means. The tap of the dropping funnel is opened to let the water into the conical flask and a stop watch is started. The gas evolution is measured each hour during a seven hour period. If, during this period, the gas evolution is erratic, or if, at the end of this period, the rate of gas evolution is increasing, then measurements should be continued for up to five days. If, at any time of measurement, the rate of gas evolution exceeds 1 litre/kg per hour, the test can be discontinued. This test should be performed in triplicate.

If the chemical identity of the gas is unknown, the gas should be analyzed. When the gas contains highly flammable components and it is unknown whether the whole mixture is highly flammable, a mixture of the same composition has to be prepared and tested according to the method A.11.

2. DATA

The substance is considered hazardous if:

-spontaneous ignition takes place in any step of the test procedure,

or

-there is evolution of flammable gas at a rate greater than 1 litre/kg of the substance per hour.

3. REPORTING

The test report shall, if possible, include the following information:

-the precise specification of the substance (identification and impurities),

-details of any initial preparation of the test substance,

-the results of the tests (steps 1,2,3 and 4),

-the chemical identity of gas evolved,

-the rate of evolution of gas if step 4 (1.6.4) is performed,

-any additional remarks relevant to the interpretation of the results.

4.REFERENCES

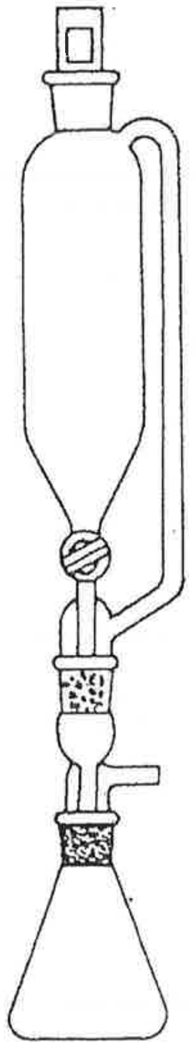
(1) Recommendations on the transport of dangerous goods, test and criteria, 1990, United Nations, New York.

(2) NF T 20-040 (SEPT 85). Chemical products for industrial use. Determination of the flammability of gases formed by the hydrolysis of solid and liquid products.

Appendix

Figure

Apparatus



Landcare review, undertaken for MfE, of ecotoxic assumptions.

PD-WM-03-04-03

Landcare Research **Memorandum**

To: Jonathan Coakley

From: Kathryn O'Halloran

Date: **3 May, 2002**

Subject: Aquatic toxicity assessment of leachate from aluminium dross

Dear Jonathan

I have reviewed your notes and calculations on the ecotoxicity of an aluminium dross sample. Specific questions have been ddressed below.

1. **Do you agree with the calculations for the aquatic ecotoxicity of the leachate generated by the dross?**
   Your calculations are accurate. The 'additivity' formula recommended for calculating mixture toxicity in the ERMA User Guide to the HSNO thresholds and classifications (2001) has been used, and aquatic toxicity data from a single species (rainbow trout) extracted from the published literature has been correctly applied with the concentrations of the elements measured in the 1st leach of the dross to the formula. You appear to have correctly selected the values that indicate the highest ecotoxicity obtained for that species. I have very briefly scanned the ecotoxicity databases to confirm this. It also appears that you have focused on the most sensitive species based on the available data.

   In the situation where data is not available for certain components of a mixture the ERMA guide specifies that the additivity formula can still be applied if there is convincing evidence that all other components (*of the dross leachate*), including those for which there is no specific acute ecotoxicity data available, are of low or no ecotoxicological importance and do not significantly contribute to the aquatic environmental hazard of the mixture. In the case of the aluminum dross leachate you were unable to find ecotoxicity data for boron or fluoride. In a brief search of the ecotoxicity databases I found some literature (abstracts only) that suggested that boron is not toxic to rainbow trout up to very high concentrations (936 uM ≈ 1000 mg B/L), and the literature on mammalian toxicity also suggests its toxicity is negligible (oral rat LD50 is 2660 mg/kg). I could not find any relevant ecotoxicity references for fluoride. It is plausible that these two compounds will not make a significant contribution to mixture toxicity of the dross leachate, provided there are no chemical reactions that take place between them or other components of the leachate that produce substances with ecotoxic properties.

2. **Do you agree that the dross leachate is not hazardous, based on the information presented?**
   Under the Ministry for the Environment draft definition of hazardous waste, a waste is hazardous if it exceeds the minimum degrees of hazard for hazardous substances specified by the '*Hazardous substances Minimum degrees of Hazard Regulations 2001*'. Schedule 6 (2) (1) (a) (i) in the regulations states that a substance is not hazardous for the purposes of the Act unless the substance is ecotoxic to aquatic organisms because the substance indicates that the fish LC_{50} is 100 mg or less of the

substance per litre of water over a 96-hr exposure period, as a result of exposure to the substance.....

You have calculated the mixture toxicity for the aluminium dross leachate to be 3578 mg/L. Under the definition described above this mixture is not ecotoxic to aquatic organisms because it is greater than the minimum degrees of hazard.

3. **Are there any significant gaps in the calculation that need to be resolved to determine if the dross produces a hazardous leachate?**
The mixture toxicity formula is limited by its simplicity. Assessments of mixtures based upon single chemical toxicological and analytical data may not necessarily represent the true toxicological effects of these mixtures in the environment. The effect of a mixture will be influenced by factors such as the physical and chemical properties of the mixture that are not accounted for in the formula (such as pH, or synergistic reactions between chemicals that may cause an enhanced toxicity). However, the quantitative aspects of mixture interactions is considerably complicated a represents a major challenge to scientists who have struggled to characterise the interactions in simple two or three component models, let alone five. In the absence of a suitable alternative the mixture formula is commonly applied in these kinds of desktop assessments. In this case the calculations appear robust. Effects-based biological data generated by a bioassay that specifically tests the leachate could be used to support this assessment and eliminate residual or further doubt.

I hope that my comments are helpful to you.

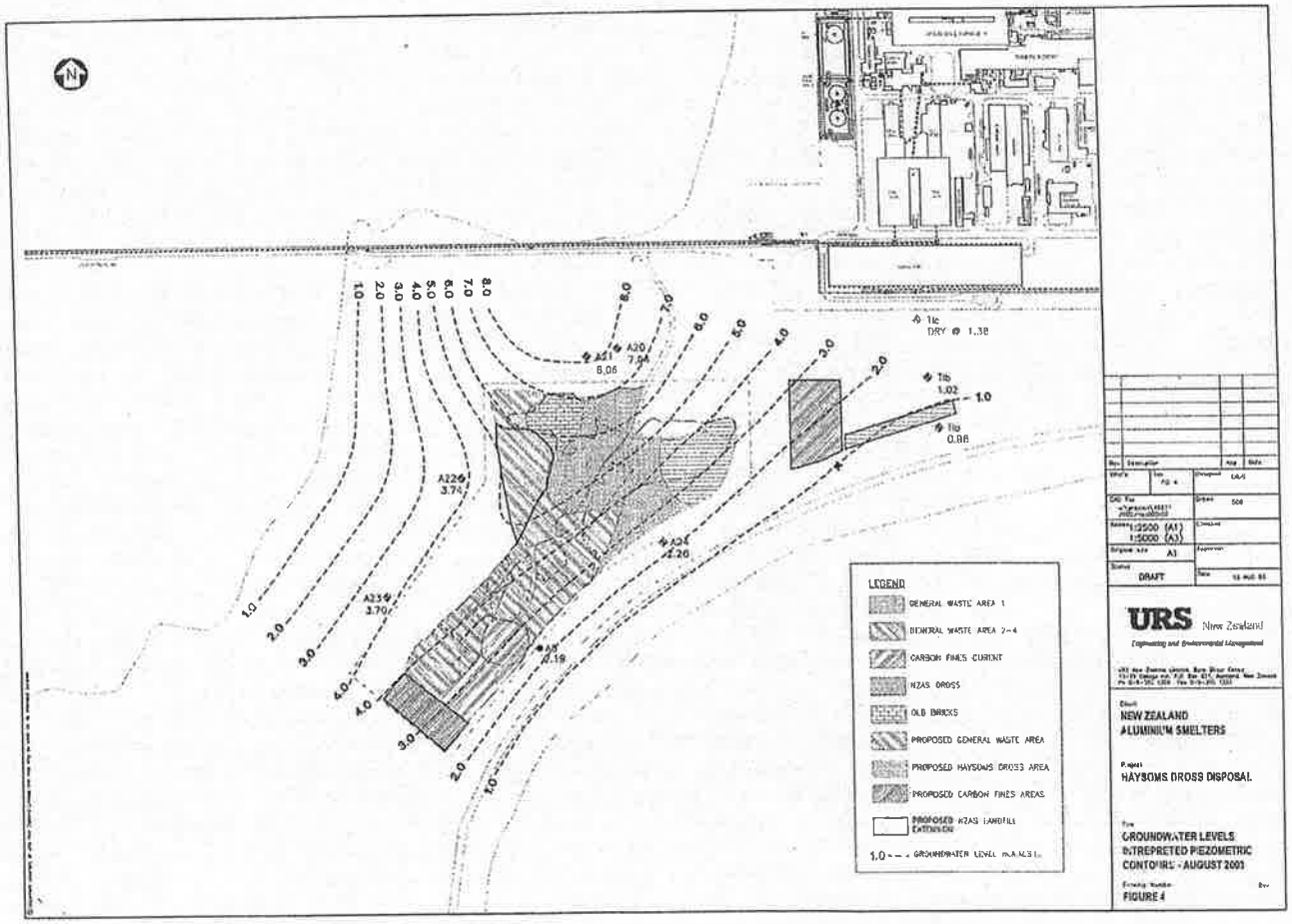
Yours sincerely,

Kathryn O'Halloran.

Dr Kathyrn O'Halloran
Environmental Toxicologist
Landcare Research

Appendix 7: Piezometric Contours and Monitoring Wells

Figure A7.1 Piezometric Contours and Location of Monitoring Wells



Appendix 8: Contaminants Leached from the existing and proposed NZAS Landfill

Table A8.1: Rate of Groundwater Migration to the Coasts

Landfill Area	Velocity *(m/d)*	Gradient *(m/m)*	Travel Time *(yrs)*	Ocean Flux *(m3/d/m)*	Harbour Flux *(m3/d/m)*
Proposed Haysom's DWP Area	0.13	0.002	3	0.5	-
Proposed Eastern Carbon Fines Area	0.17	0.002	2	0.5	-
General (Northern Part) and NZAS Dross Areas	0.10	0.009	3	0.3	-
NZAS General & Carbon Fines (Southern) Areas	0.07	0.013	8	0.15	0.01

Table A8.2: Amount of Groundwater Discharges to the Coasts

Landfill Area	Receiving Environment	Groundwater Flux *($m^3/d/m$)*	Coast Line Length *(m)*	Total Discharge *(m^3/d)*
Proposed Haysoms DWP Area	South Coast	0.5	175	87.5
Proposed Eastern Carbon Fines Area	South Coast	0.5	80	40
General (Northern Part) and NZAS Dross Areas	South Coast	0.3	300	90
NZAS General & Carbon Fines (Southern) Areas	South Coast	0.15	350	52.5
NZAS General & Carbon Fines (Southern) Areas	Bluff Harbour	0.01	400	4
Total South Coast	South Coast	-	905	270
Total Bluff Harbour	Bluff Harbour	-	400	4

Table A8.3: Predicted Concentrations of Key Contaminants

Landfill Areas		Initial Concentration in Groundwater (g/m^3)	Predicted Concentration At Receptor (g/m^3)	
			Ocean	Harbour
Proposed Haysoms DWP Area	F	1000	77	-
	Al	30	2.5	-
	V	20	1.5	-
	NH_4	35	3	-
Proposed Eastern Carbon Fines Area	F	310	105	-
General (Northern Part) and NZAS Dross Area	F	22/100	33	-
General Landfill (Southern Part)	F	22	14	2.5
Existing and Proposed Carbon Fines (Southern) Areas	F	310	160	-

Appendix 9: Groundwater Quality and Trends

Table A9.1 Groundwater Quality Data Summary

		A6			A20			A21			A22			A23			A24		
		Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min
Water Depth	mamsl	1.95	2.44	0.68	7.70	8.04	6.60	8.00	8.09	6.85	3.70	3.84	3.16	3.60	3.83	3.06	1.80	2.25	1.48
Temperature		11.9	13.5	10.3	10.5	13.4	7.5	11.0	13.7	6.5	10.2	12.1	8.6	10.4	12.5	9.0	10.9	12.8	9.4
pH		6.7	7.6	6.4	6.2	7.2	5.4	6.0	6.3	5.1	5.4	7.3	4.2	5.7	6.1	5.4	7.2	7.6	6.9
Conductivity	mS/cm	3312	5689	158	770	845	644	1147	1723	683	639	1204	354	575	745	378	2955	4410	1400
Alkalinity	g/m^3	662	943	280	67	146	8	33	160	9	44.6	294	0.5	43	60	31	949	1182	414
BOD	g/m^3	2.6	6.0	1.0	2.2	6.0	0.1	3.0	16.0	0.5	2.9	12.0	1.0	1.5	5.0	0.5	8.4	17.0	2.0
Total N	g/m^3	27.1	44.0	9.7	0.5	1.3	0.1	2.0	8.0	0.7	1.5	2.8	0.4	1.9	2.7	0.9	77.1	152.0	16.8
Ammoniacal N	g/m^3	16.0	31.5	0.2	0.1	0.2	0.0	1.0	4.6	0.1	0.2	0.5	0.1	0.9	1.4	0.1	66.3	146.0	28.2
Fluoride	g/m^3	22.3	104.0	1.5	0.1	0.3	0.0	0.0	0.8	0.2	1.5	2.4	0.4	0.1	0.4	0.0	7.1	42.9	0.5
Sulphate	g/m^3	1258	2050	480	35	47	27	69	101	29	21	44	10	4	30	0	64	312	5
Total Iron	g/m^3	14.4	22.6	4.2	6.5	16.5	0.7	24.0	94.6	2.2	2.1	3.5	0.6	8.0	13.0	4.4	19.7	29.5	8.2
TPH	g/m^3	1.5	9.2	0.3	1.9	11.6	0.3	1.0	7.3	0.3	1.7	10.7	0.3	1.3	7.2	0.3	2.3	18.6	0.3
TKN	g/m^3	18.8	23.4	14.2	0.5	0.5	0.4	4.0	6.5	0.9	1.4	1.9	0.9	2.1	2.3	1.8	75.4	83.8	67.0
Nitrate N	g/m^3	3.6	14.0	0.0	1.7	14.0	0.0	5.0	29.0	0.0	0.1	0.2	0.0	0.0	0.1	0.0	0.2	1.2	0.1
Nitrite N	g/m^3	0.080	0.170	0.004	0.000	0.014	0.001	0.000	0.028	0.001	0.000	0.042	0.000	0.000	0.019	0.001	0.200	0.632	0.010
Cyanide	g/m^3	0.063	0.100	0.013	0.100	0.100	0.001	0.063	0.100	0.001	0.100	0.100	0.001	0.100	0.100	0.000	0.100	0.100	0.005
Boron	g/m^3	1.930	2.540	0.900	0.000	0.067	0.038	0.000	0.154	0.077	0.100	0.066	0.006	0.000	0.050	0.038	5.000	5.000	4.000
Manganese	g/m^3	0.880	1.850	0.220	0.300	0.394	0.115	0.000	0.473	0.100	0.100	0.394	0.005	0.100	0.118	0.055	0.100	0.130	0.110
Nickel	g/m^3	0.011	0.022	0.005	0.000	0.010	0.002	0.000	0.007	0.003	0.000	0.010	0.001	0.000	0.002	0.000	0.000	0.010	0.000
Potassium	g/m^3	27.4	37.0	17.6	3.7	4.1	3.3	8.0	11.3	5.4	2.8	4.1	2.1	4.6	5.0	4.0	22.3	31.7	11.1
Vanadium	g/m^3	0.160	0.400	0.050	0.000	0.003	0.001	0.000	0.043	0.001	0.000	0.022	0.002	0.000	0.021	0.013	0.300	0.400	0.300
Naphthalene	mg/m^3	0.0		0.003	-	0.03	<0.0	-	0.1	<0.01	-	0.02	<0.01	-	0.03	<0.01	27.9	82	0.1
Anthracene	mg/m^3	0.02		0.08	-	0.04	<0.01	-	0.03	<0.01	-	0.05	<0.01	-	0.08	<0.01	-	0.32	<0.01
Phenanthrene	mg/m^3	0.005		0.005	-	<0.01	-	-	0.02	<0.01	-	0.03	<0.01	-	<0.01	-	-	0.18	<0.01
Fluoranthene	mg/m^3	0.005		0.005	-	<0.01	-	-	0.15	<0.01	-	0.03	<0.01	-	<0.01	-	-	0.06	<0.01

Table A9.2 Groundwater Quality Trends

Well Number	Data Trends	Data Interpretation	Figure
A6	Abrupt increase in conductivity, ammoniacal nitrogen in 1995. Trend of gradually decreasing SO_4, Total Fe, NH_3-N & Conductivity since 1995. Increasing variability in Alkalinity between 1995 and 2002. No clear trend in PAH's and F, generally more variable since 2000.	General decrease in influence of more mobile leachate constituents.	Figure A9.3
A20	Trend of gradually decreasing Alkalinity. Increasing variability in Fe and F. No overall trend in SO_4, nitrogen species or BOD_5	No clear trend. Minor leachate influence.	Figure A9.4
A21	Trend of gradually decreasing Conductivity since 1995. No overall trend but elevated concentration during 1998 and 1999 for Alkalinity, BOD_5, nitrogen species and Fe with corresponding decrease in SO_4. Increasing variability in F between 1995 and 2002. No clear trend in PAH's. Generally not detectable for 1997,1998 and 1999 and otherwise at or about limit of detection.	No clear trend. Minor leachate influence.	Figure A9.5
A22	Trend of gradually decreasing Conductivity & SO_4 since 1995. Dramatic decrease in alkalinity in 1996 and remained low since then. No overall trend in F, total Fe, & nitrogen species. Decreasing variability in BOD_5 between 1996 and 2002.	Minor leachate influence. No clear trend possible decrease in influence of more mobile leachate constituents.	Figure A9.6
A23	Trend of gradually decreasing alkalinity, conductivity, BOD_5 & SO_4 since 1995. No overall trend in nitrogen species. Increasing variability in F since 2000.	Minor leachate influence. General decrease in influence of more mobile leachate constituents.	Figure A9.7
A24	Trend of gradually decreasing alkalinity, SO_4, BOD_5 & Total Fe and until 1998, then increase in variability of results. No clear trend in until 1998, then increase in variability of Conductivity, nitrogen species and some PAH's (phenanthrene & fluoranthene). Increasing in F since 1998.	No clear trend in influence of more mobile leachate constituents. Breakthrough of Fluoride.	Figure A9.8

Figure A9.3 Groundwater Quality Trends (Bore A6)

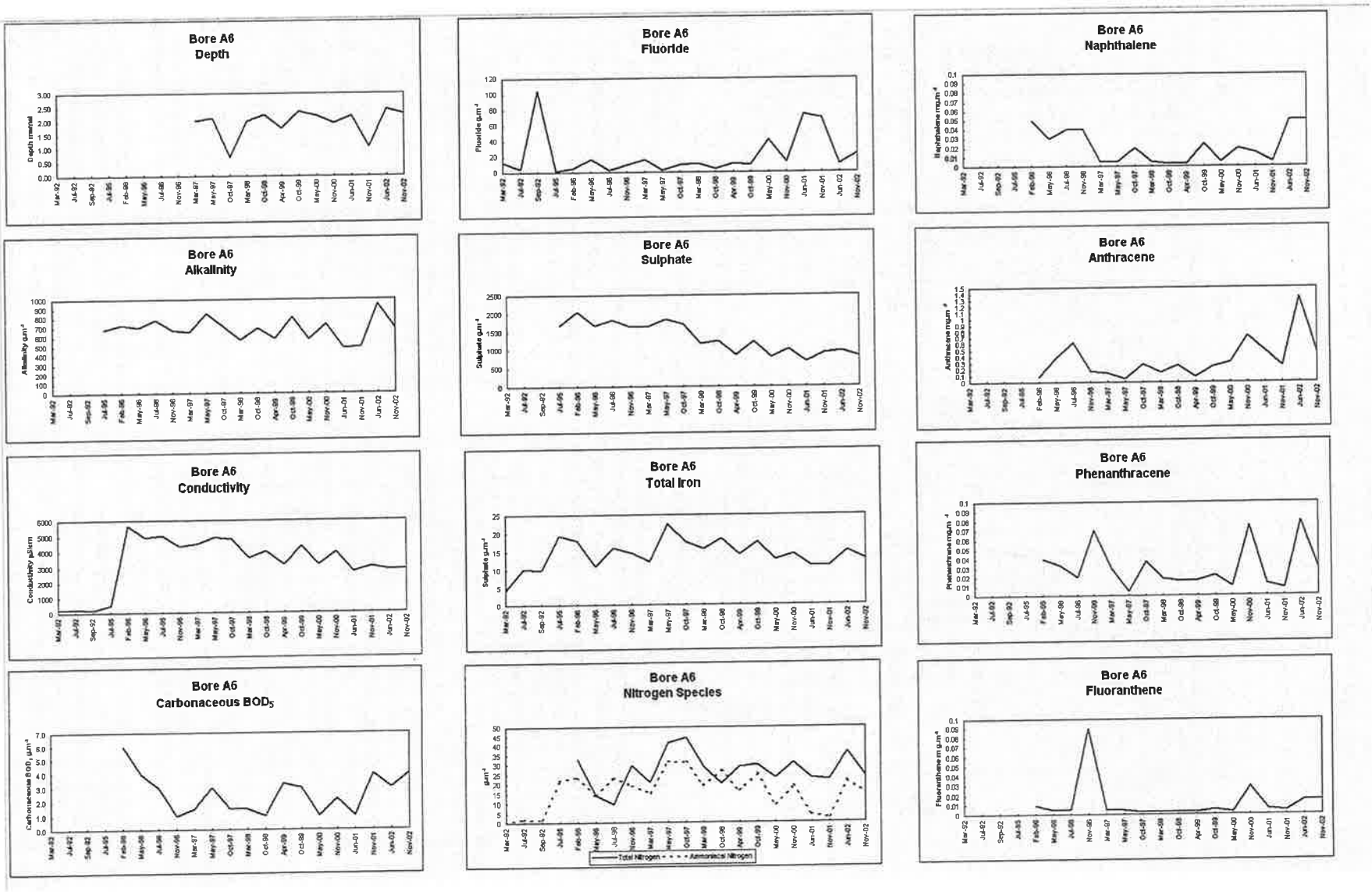


Figure A9.4 Groundwater Quality Trends (Bore A20)

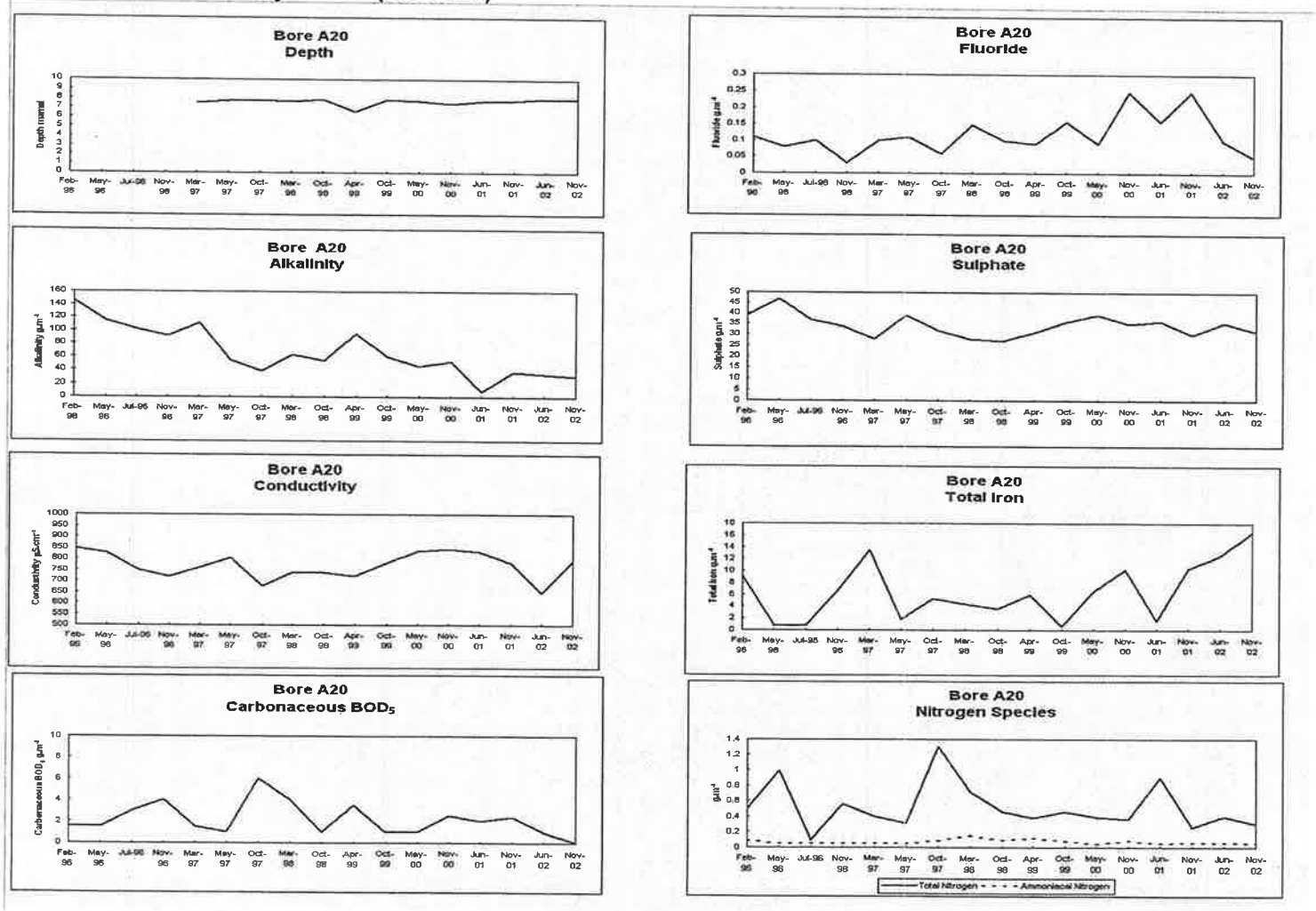


Figure A9.5 Groundwater Quality Trends (Bore A21)

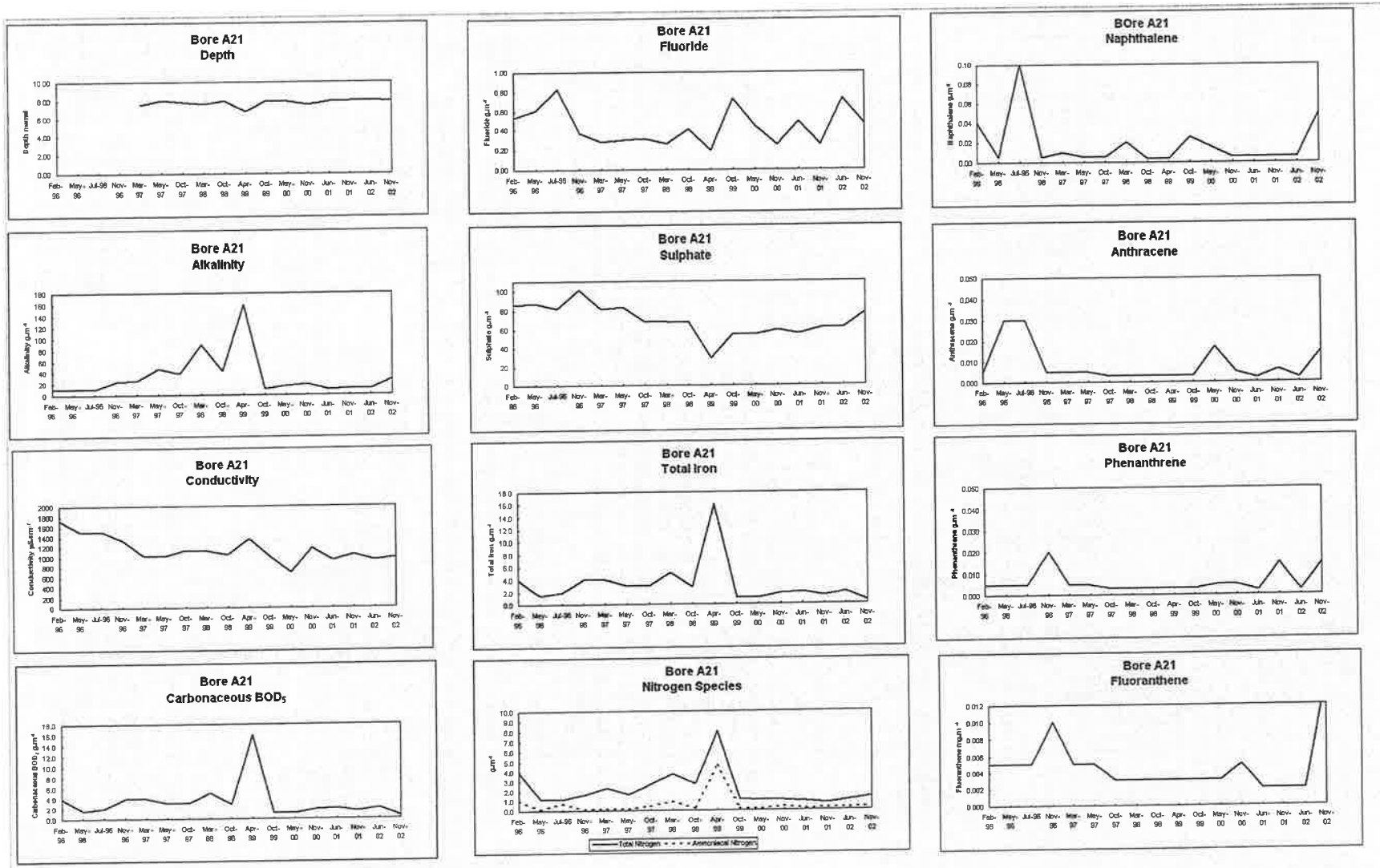


Figure A9.6 Groundwater Quality Trends (Bore A22)

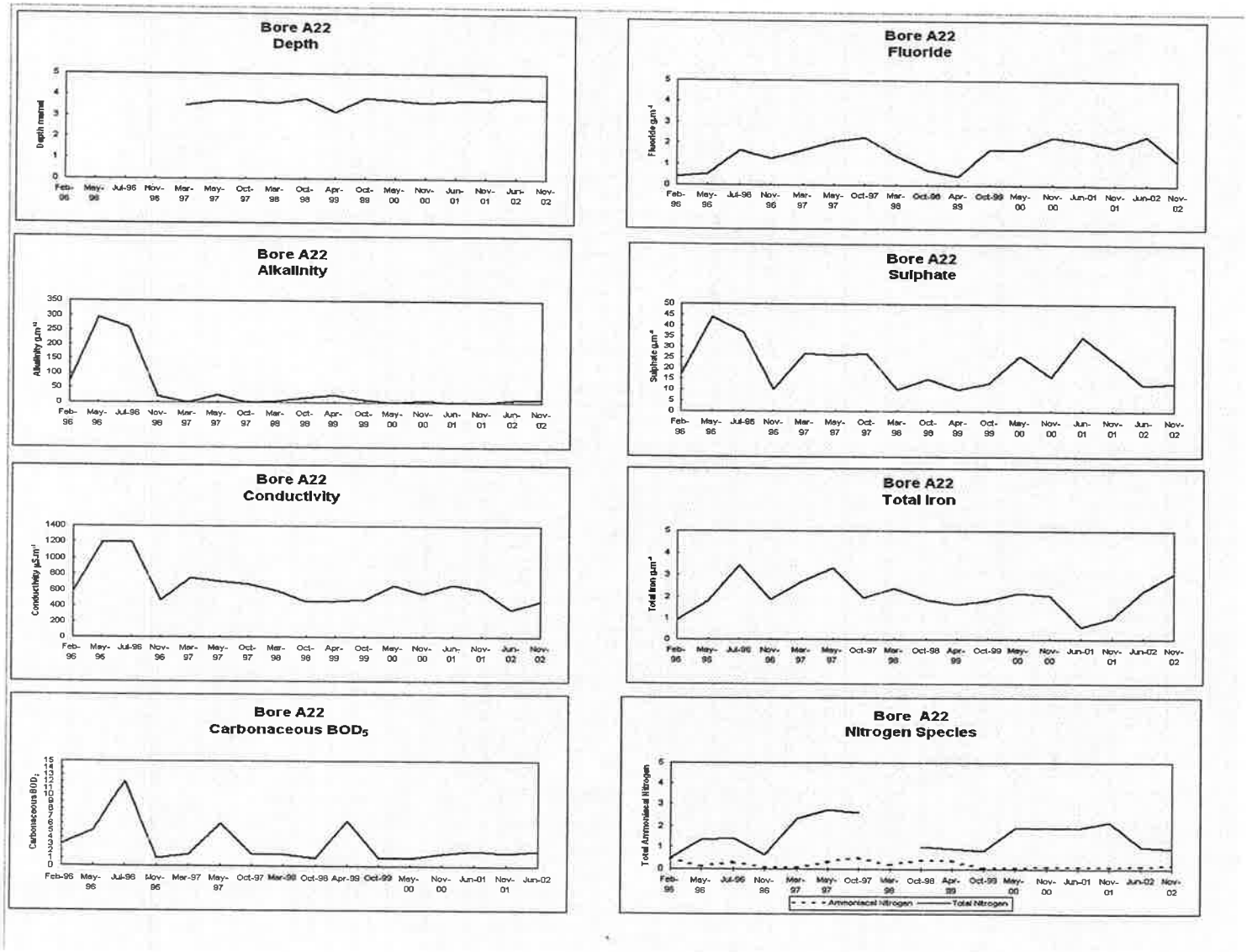


Figure A9.7 Groundwater Quality Trends (Bore A23)

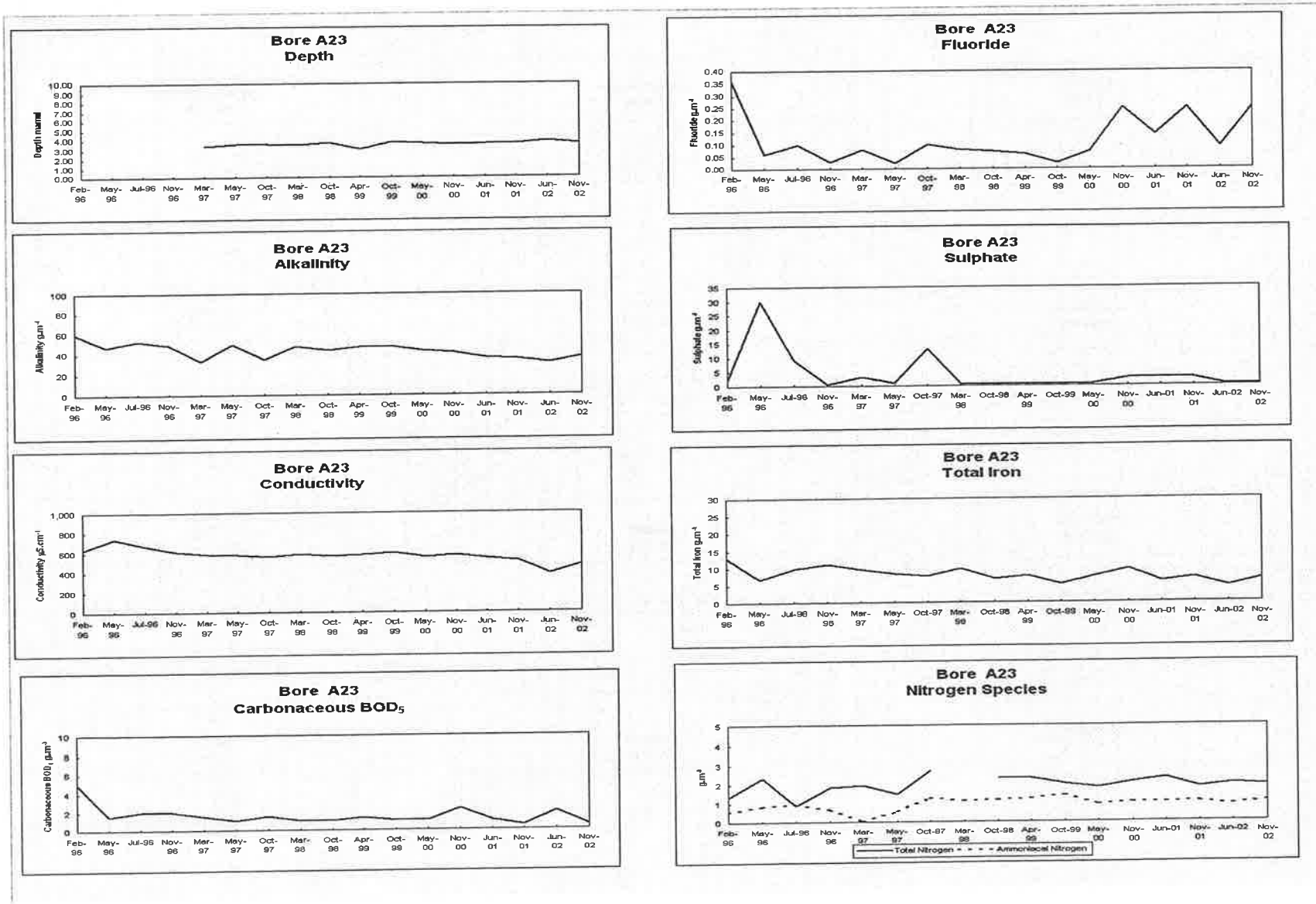
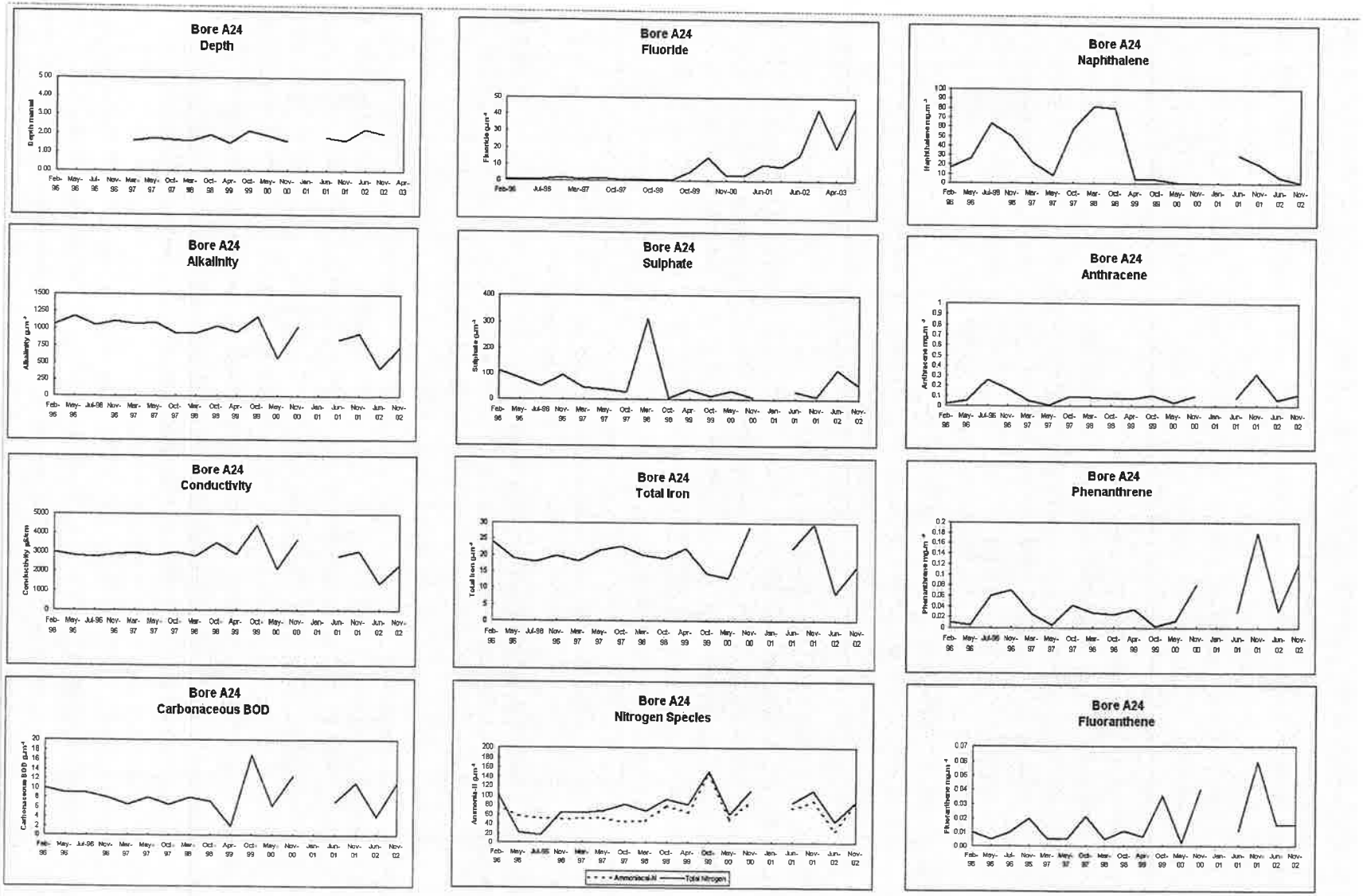


Figure A9.8 Groundwater Quality Trends (Bore A24)



Appendix 10: Baseline and Leaching data

Table A10.1 Haysom's Dross Cell and Eastern Carbon Fines Baseline Water Quality Data

Constituent	T1C 9500 30/8/96	T1A 9502 30/8/96	T2B 9504 30/8/96	T3C 9506 30/8/96
PH (pH units)	7.6	7.7	7.4	6.8
Electrical Conductivity (mS/m)	38.2	45.0	52.5	35.3
Soluble Alkalinity ($g.m^{-3}$ as $CaCO_3$)	149	120	133	51.2
Acidity ($g.m^{-3}$ as $CaCO_3$)	<1	<1	<1	<1
Bicarbonate ($g.m^{-3}$)	462	425	499	524
Soluble Calcium ($g.m^{-3}$)	58.9	53.5	63.8	4.38
Soluble Magnesium ($g.m^{-3}$)	5,09	5.12	6.70	2.14
Soluble Sodium ($g.m^{-3}$)	15.9	28.5	38.0	69.6
Soluble Potassium ($g.m^{-3}$)	2.3	2.3	2.4	1.3
Nitrate-N + Nitrite-N ($g.m^{-3}$)	1.22	1.35	0.058	0.036
Nitrate-N ($g.m^{-3}$)	1.16	1.34	0.049	0.029
Nitite-N ($g.m^{-3}$)	0.064	0.005	0.009	0.007
Dissolved Reactive Phosphorous ($g.m^{-3}$)	0.004	0.006	0.006	0.02
Chloride ($g.m^{-3}$)	20	52	54	42
Fluoride ($g.m^{-3}$)	0.14	0.08	0.12	1.28
Soluble Sulphate ($g.m^{-3}$)	40	29	49	46
Boron ($g.m^{-3}$)	0.05	<0.05	<0.05	0.17
Total Cyanide ($g.m^{-3}$)	<0.007	<0.007	<0.007	<0.007
Soluble Aluminium ($g.m^{-3}$)	0.115	0.084	0.047	0.223
Soluble Arsenic ($g.m^{-3}$)	0.002	0002	0.002	<0.001
Soluble Nickel ($g.m^{-3}$)	0.011	0.004	0.007	0.003
Soluble Lead ($g.m^{-3}$)	0.0005	0.0003	0.0002	0.0003

Table A10.2 Haysom's Dross Leaching Data - Column Leaching Comparison

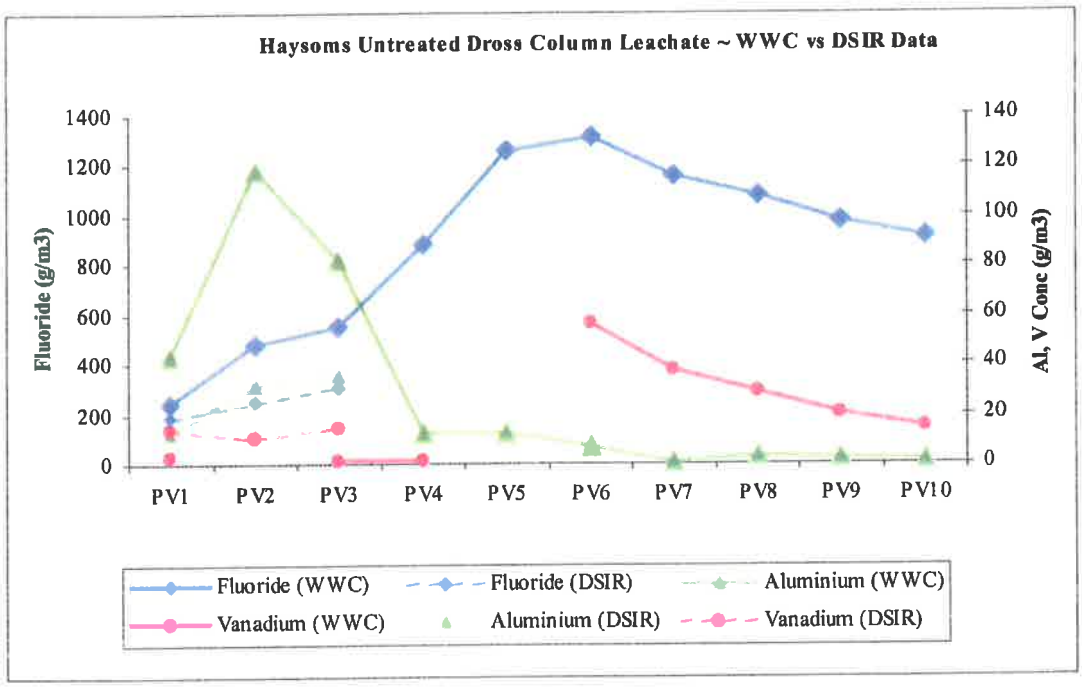
HAYSOM'S DROSS LEACHING DATA

Column Leaching Data Comparison

	Parameter					
Pore Volume	**Fluoride**		**Aluminium**		**Vanadium**	
Data Source	**(WWC, 2000)**	**(DSIR, 1992)[1]**	**(WWC, 2000)**	**(DSIR, 1992)[1]**	**(WWC, 2000)**	**(DSIR, 1992)[1]**
PV1	241	192	43.05	12.3	3.075	13.86
PV2	479	252	118	31.5		11.01
PV3	553	303	82.1	35.7	1.8	15.3
PV4	882		12.5		1.56	
PV5	1260		12.2			
PV6	1310		7		56.7	
PV7	1160		0.5		38.1	
PV8	1080		2.9		29.1	
PV9	974		2.3		20.4	
PV10	909		1.3		14.6	
	884.8		28.185		20.666875	
Value Assumed for Model Input	450		80		14.5	

Note: [1] DSIR (1992) data is combined mean weight of screen waste (60%) and baghouse dust (30%).

Figure A10.3 Haysom's Untreated Dross Column Leachate



From URS (2003), Tiwai Landfill and Haysom's Dross Cell Report.

Appendix 11: Receiving Environment Concentrations

Table A11.1 Predicted South Coast Receiving Environment Concentrations

Constituent	Maximum Predicted Groundwater Discharge Concentration ($g.m^{-3}$) NO ATTENUATION	Maximum Predicted Groundwater Discharge Concentration ($g.m^{-3}$) WITH CHEMICAL ATTENUATION	Groundwater Discharge After Minimum Likely Dilution ($g.m^{-3}$) 1000 times	Background Concentration in Seawater ($g.m^{-3}$)	Receiving Water Criteria (ANZECC 2000) ($g.m^{-3}$)
Aluminium	2.5	0.07	0.00007	0.002	ID (0.0005)
Fluoride	160	32	0.032	1.3	NGV
Ammoniacal Nitrogen	3	NM	0.003	0.015	0.91^{1} $(0.5)^{2}$
Vanadium	1.5	1.5	0.0015	0.0025	0.1^{1} $(0.05)^{2}$

ID - Insufficient Data, low reliability indicative interim working level provided in brackets.
[1] 95% Level of Protection
[2] 99% Level of protection

Table A11.2 Predicted Bluff Harbour Receiving Environment Concentrations

Constituent	Maximum Predicted Groundwater Discharge Concentration ($g.m^{-3}$) NO ATTENUATION	Maximum Predicted Groundwater Discharge Concentration ($g.m^{-3}$) WITH ATTENUATION	Groundwater Discharge After Minimum Likely Dilution ($g.m^{-3}$) 100 times	Background Concentration in Seawater ($g.m^{-3}$)	Receiving Water Criteria (ANZECC 2000) ($g.m^{-3}$)
Aluminium	2.5	0.084	0.00084	0.002	ID (0.0005)
Fluoride	2.5	2.5	0.025	1.3	NGV
Ammoniacal Nitrogen	3	NM	0.03	0.015	0.91^{1} $(0.5)^{2}$

ID - Insufficient Data, low reliability indicative interim working level provided in brackets.
[1] 95% Level of Protection
[2] 99% Level of protection

From the values presented in Table A11.2, it can be seen that the discharges from the proposed and existing activities at the Tiwai Landfill which are:-

- within the relevant ANZECC marine trigger levels for the 95% level of protection and the more conservative 99% level of protection; and,
- where guideline criteria are not available, concentrations are comparable to or below the background concentrations in seawater after reasonable mixing.

Appendix 12:Monitoring of Bores

Table A12.1 Analysis Methodology and Frequency of Groundwater Monitoring

Frequency	Analytes	Method
Six monthly – all bores	pH	APHA 4500-H^+ B
	Conductivity	APHA 2510 B
	Alkalinity	APHA 2320 B
	Fluoride	APHA 4500-F C
	Sulphate	$BaCl_2$ turbidimetric equiv. to APHA 4500-SO_4 E
	Total Nitrogen	Calculation using TKN and Nitrate-N and Nitrite-N
	Ammonia-N	APHA 4500-Norg G
	Carbonaceous BOD_5	APHA 5210 B
	Total Fe	APHA 3125B ICP-MS
Six monthly – bores A21, A24, A6	PAH – anthracene, naphthalene, phenanthrene, fluoranthene	US EPA CLP (SIM modified)
Annually *	TPH	APHA 5520-F
Biennially – all bores	Total Kjeldahl Nitrogen	APHA 4500-Norg
	Nitrate-N	APHA 4110 B
	Nitrite-N	EPA 600/4-79-020 353.2
	Potassium	APHA 3500-K B
	Weak Acid Dissociable Cyanide	APHA-CN I
	Boron, Manganese, Nickel, Vanadium	US EPA 200.8
	Temperature	Calibrated Thermometer

* It is proposed to change the annual analysis of TPH to a biennial analysis.

Appendix 13: Landfill Management Plan

NEW ZEALAND ALUMINIUM SMELTERS LIMITED

LANDFILL MANAGEMENT PLAN

SEPTEMBER 2003

Preface

Introduction

This document is the current New Zealand Aluminium Smelters Limited, (NZAS) Landfill Management Plan. This Landfill Management Plan is a dynamic document. It will be reviewed and updated as new landfill management practices are accepted and applied.

NZAS Landfill Management Plan – Table of Contents

Introduction

Overview

Introduction

This section outlines the background to waste management at New Zealand Aluminium Smelters Limited (NZAS). It also provides a method of comparing the contents of the NZAS Landfill Management Plan with the requirements of the Regional Solid Waste Management Plan.

The NZAS Landfill Management Plan is a dynamic document. It will be reviewed and updated as new management practices are accepted and applied.

In this section

This section contains the following topics:

Approvals

The Resource Management Act	The Resource Management Act 1991(RMA), requires approvals to be obtained for discharges including: • any contaminant onto or into land in circumstances which may result in that contaminant (or any other contaminant emanating as a result of natural processes from that contaminant) entering water, and • contaminant from any industrial or trade premises onto or into land.
Definition of contaminant	The wastes that are landfilled are included in the definition of "contaminant" in the Resource Management Act.
Authorising activities	Accountability under (RMA) for authorising the discharge associated with landfilling in Southland lies with the Southland Regional Council, which operates under the brand name of Environment Southland.
Discharge Permits	Discharges onto or into land at the NZAS Landfill are covered by Discharge Permit Number 94460, which was granted by the Southland Regional Council on 30 October 1995. The permit expires on 26 April 2006 and is included as Appendix 1.
Application for Replacement Discharge Permit	An application for a replacement of Discharge Permit 94460 to allow the NZAS landfill to operate for a further 20 years, plus to allow for the landfilling of the Haysom's Dross Waste Powder is due to be submitted.
Renewal of Discharge Permit	To continue operation of the NZAS landfill, NZAS must apply for a new discharge permit by 26 October 2005, ie no later than 6 months before the expiry date of the existing discharge permit. This will be done through the replacement application and amendments will need to be made to this document to allow for new expiry dates.

Continued on next page

Approvals, Continued

Land Use Approval	The Invercargill City District Plan authorises the land use aspects of the disposal of waste at the NZAS landfill by Rule 4.33. The disposal of waste is also authorised by Land Use Consent (reference Property T3/3) for Aluminium Smelting and related and/or ancillary activities granted on 19 December 1994.
Asbestos disposal approval	The Land Use approvals (above) provide the approval required by the Health and Safety in Employment (Asbestos Regulations 1998, section 13(3)(a)).

Regional Solid Waste Management Plan

Effect of Rule 4.5.2 (d)	The effect of the Regional Solid Waste Management Plan, Rule 4.5.2 (d) is to require a refuse disposal facility management plan to be prepared. This rule specifies what must be included in the refuse disposal facility management plan.
Management Plan headings	Appendix C of the Regional Solid Waste Management Plan provides a list of typical headings that could be used in a management plan for a refuse disposal facility site. The headings cover more topics than those which must be included under Rule 4.5.2.
NZAS Landfill management plan content	This NZAS Landfill management plan has been prepared to provide a level of detail based on Appendix C of the Regional Solid Waste Management Plan. The following table gives the location in the NZAS Landfill Management Plan of the details which must be included in accordance with Rule 4.5.2 (d).

Continued on next page

Regional Solid Waste Management Plan, Continued

Data which must be included

The following table shows where the data which must be included is located in the NZAS Landfill Management Plan.

Data	Location
(i) Any provision to be made for the reusing and recycling of material.	Continuous Improvement Program, pages 7 and 8. Waste Segregation and Current Disposal Methods, pages 9 to 14.
(ii) The type of fencing proposed for the refuse disposal facility site.	Access, page 31. Perimeter fencing, page 38. Litter, page 46.
(iii) Methodology proposed for the management of stormwater within the refuse disposal facility site.	Water control, page 40. Landfill revegetation program, pages 44 and 45.
(iv) An Operator's manual for the site	Landfill Operation, pages 36 to 47. Landfill Operation Current Best Practice, Appendix 2.
(v) Type of work to be carried out to prepare the site for use as a refuse disposal facility site.	Water control, page 40. Site preparation, page 48.

Continued on next page

Data which must be included, cont.

Data	Location
(vi) The methodology proposed by the consent holder to monitor the groundwater at the refuse disposal facility site.	Monitoring, page 48.

Continuous Improvement and Waste Minimisation

NZAS objectives

NZAS has objectives of minimising the amount of waste generated from the smelting operations, and providing environmentally acceptable and effective management of residual waste. The methodologies for achieving these objectives are currently provided for in the:

- Continuous Improvement Programme.
- Waste Disposal and Management CBP.

Continuous Improvement Programme objectives

The NZAS Continuous Improvement Programme has five basic objectives given below:

- Improved safety and occupational health.
- Improved environmental performance.
- Staff development.
- Improved product quality.
- Improved processes, which includes use of materials.

Current management policy

It is NZAS policy to recover the highest possible value from all materials used in the smelter operation and to deal with materials in an environmentally appropriate manner.

This policy is pursued by dealing with process byproducts in the following ways:

- Reducing the amount of material introduced and used in each process,
- Minimising the amount of byproducts from processes and reusing byproducts wherever possible,
- Ensuring that when byproducts are produced they are in a form which maximises the possibility of recycling,
- Recycling externally byproducts that cannot be reused.

Continued on next page

Continuous Improvement and Waste Minimisation, Continued

Current waste management policy, cont.	• Producing by-products in such a way that, where appropriate, the return to NZAS is maximised, • Recovering as much material and / or energy from the byproducts as possible, and • Providing environmentally acceptable and effective residual management once the amounts of byproducts have been reduced by the above stages.
Reuse and recycle	Reuse means the return of the waste to the NZAS operation. Recycling means the use of NZAS waste as a raw material for other peoples processes.
Policy updates and access	The Waste Disposal and Management Current Best Practice is updated as necessary and can be accessed on NZAS Site Intranet under Plant Services.

Waste Segregation and Current Disposal Methods

Segregation at source

Where ever possible NZAS will segregate waste at source.

Waste segregation improves the potential for:

- Reuse
- Recycle, and
- Alternative disposal methods.

Waste categories

The current waste from the NZAS operations can be categorised as:

- Reused at NZAS,
- Disposed or recycled off-site,
- Stored for future processing, and
- Disposed of at the landfill.

Future changes in reuse, recycling and disposal options may change the type of waste in each category. Provision at the landfill may be required for COMTOR (SCL processing) product, refractory and other construction or demolition materials if other uses are not established.

Reuse at NZAS

These wastes are usually managed by the generating MRU and are unlikely to be included in the landfill operation.

Continued on next page

Waste Segregation and Current Disposal Methods, Continued

Waste currently disposed or recycled off-site

The table below shows the NZAS wastes that are currently disposed or recycled off-site.

Waste Type	Collected In	Disposed	Future Plans
Cardboard	Recycling Cages	Off-site Recycling	No Change
Ferrous Metals	Skips and Bins	Scrap Dealer	No Change
Food Waste	Wheelie Bins	Off – Site Disposal	No Change
Liquids containing oils	Drums and special receivers	Refined Off - Site	100% on-site waste oil through Hydroline
Medical Wastes	Segregated at Medical Centre	Kew Hospital	No Change
Non – Ferrous Metals	Skips and Bins	Scrap Dealer	No Change
Non – Process Aluminium	Skips and Bins	Scrap Dealer	No Change
Oils	Drums and special receivers	Off – Site Disposal	No Change

Continued on next page

Waste Segregation and Current Disposal Methods, Continued

Waste currently disposed or recycled off-site, cont.

Waste Type	Collected In	Disposed	Future Plans
Packaging	Wheelie Bins	Off-Site Disposal/ Recycling.	Packaging covenant with suppliers.
Paper	Wheelie Bins and Recycling Boxes	Off – Site Recycling	No Change
PCB's	Original equipment or designated containers	Dedicated Storage prior to Off – Site Disposal	No Change
Plastics	Wheelie Bins	Off – Site Disposal	No Change
Printer Cartridges	Containers and boxes	Off – Site Recycling	No Change
Refractory Bricks	Skips and Trucks	Off – Site Recycling and Reuse	No Change
Wood	Skips and Bins	Recycled (mostly pallets) (Only a small % of clean material is landfilled)	Possible options for chipping some wood.

Continued on next page

Waste Segregation and Current Disposal Methods, Continued

Waste currently stored for future processing

The table below shows the NZAS wastes that are currently stored for future processing.

Waste Type	Collected In	Disposed	Future Plans
Chemicals	Vessels and Containers	Designated Storage facilities	Depends on Disposal options available
Electrostatic Precipitator Tars	No longer collected	Designated Storage facility	Reuse/ Recycle options being evaluated
MRP fines (Dross)	No longer collected	Stored in Designated Area at Landfill	Reuse options being evaluated
Spent Cathode Lining	Direct Transport to Storage	Covered Stock Pile and Designated Buildings	Reuse options being evaluated

Continued on next page

Waste Segregation and Current Disposal Methods, Continued

Waste that currently can be disposed at the NZAS Landfill

The table below shows the NZAS wastes that currently can be disposed at the NZAS Landfill.

Waste Type	Collected In	Disposed	Future Plans
Asbestos	Segregated in labelled Bags	Buried in Designated Area	No Change Amount Reducing, almost Nil.
Building Waste	Bags and Skips	Landfill Face	Builder to remove from site
Carbon Dusts	Skips	Defined Area	Possible Alternative
Concrete	Skips	Landfill Face or Defined Cleanfill Area	No Change
Dust Collector Bags	Skips	Landfill Face	No Change
Glass	Skips	Landfill Face	No Change
Man made mineral fibre (MMMF)	Segregated in marked Bags	Buried in Defined Area	No Change Amount Reducing, almost Nil

Continued on next page

Waste Segregation and Current Disposal Methods, Continued

Waste that currently can be disposed at the NZAS Landfill, cont.

Waste Type	Collected In	Disposed	Future Plans
Non-Classifiable Materials (includes small amounts of currently disposed or recycled off -site but does not include PCB's and medical wastes)	Skips	Landfill Face	Improved Segregation
Oils from small spill clean-ups	Bins and Drums	Bioremediation Area	No Change
Refractory Bricks	Skips	Landfill Face or Defined Area (option if no off-site removal available)	No Change
Rubber	Skips	Landfill Face (some is recycled)	No Change
Tree and Garden Waste	Skips	Landfill Face	No Change
Water based Liquids, ie Pit Cleaning's	Sump Cleaner	Exposed Landfill Area (dependant on the source, some removed from site)	Some possibly blended with CBF Fuels

The NZAS Landfill Site

Overview

Introduction This section gives details of the current status of the landfill site. It outlines its history, upgrading and staging, projected life and geotechnical features,

In this section This section contains the following topics:

History

Origins	The NZAS landfill has been in existence since the smelter commenced operations in 1972. Although no formal records have been located it is believed the landfill was started during the initial construction of the smelter in 1970.
Construction Material	It is known that construction materials were deposited in the landfill early in the 1970's, in the mid 1970's and in the early 1980's. This coincided with the major construction and upgrades at NZAS.
NZAS Materials	The materials deposited into the landfill in the past from the NZAS operations have included: • Refractory Bricks, • Aluminium Dross and MRP Fines, • Carbon Dusts, • Petroleum Coke and Metallurgical Coke which contains Pitch and Iron, • Cryolite (the main fluoride component of the landfill contents), • Aluminium, • Steel Strapping in significant quantities, • Asbestos, • Paint Tins, • Timber, • Mineral Fibres, • Plastic materials, • Waste Oil and Grease (now recovered and removed), and • Copper Wire.
Operating History	Access to the NZAS landfill has always been restricted to NZAS and Contractors working on the NZAS Site. Prior to the mid 1980's the landfill management consisted of regular covering of completed areas.

Continued on next page

History, Continued

Notable Events Notable events in the history are:

Year	Event
1984	Health Department approval as an asbestos disposal site.
1986 – 87	Health Department approval as an asbestos disposal site.
1990 - 92	Recovery of aluminium dross and MRP fines stored up to this time for off-site processing.
1991 – 92	Oil recovery from waste oil pond.
1992	Removal of bottom sediments and soil from waste oil pond and start of bioremediation.
1992	Start of landfill surface profiling.
1993	Start of revegetation programme.
1994	Closure of burning pit, on 31 December. Small pit formed in case burning for border control required.
1995	Application for discharge permit for landfill approved.
1995	Oil pond bioremediation completed.
1996	Removal of ESP tar.

Continued on next page

2002	Significant reduction in the quantities of Dross Waste Product going to the landfill.
2003	Application for Discharge Consent to make provisions for the landfilling of the Haysom's DWP in an extension of the existing landfill.

Material Recovery	In the past, work to improve the landfill profile has exposed materials that were considered to be recyclable. Wherever possible these materials have been recovered.

Landfill Development

Initial Upgrading

Since 1991 upgrading work at the NZAS Landfill has included:

- More effective management practices,
- Cleaning up and re-contouring,
- Upgrading signage, particularly around separate waste cells,
- Removing and remediating the waste oils storage area,
- Increasing the protection of the celled areas against the spreading of waste by wind,
- The clearer separation of wastes, and
- Revegetating the majority of the site.

Staging

General wastes have been placed within the landfill in stages. Each stage represents an area of the landfill that is filled, levelled, contoured and revegetated. The following table outlines the staged use of the landfill and correspond to the landfill map shown in Figure 1.

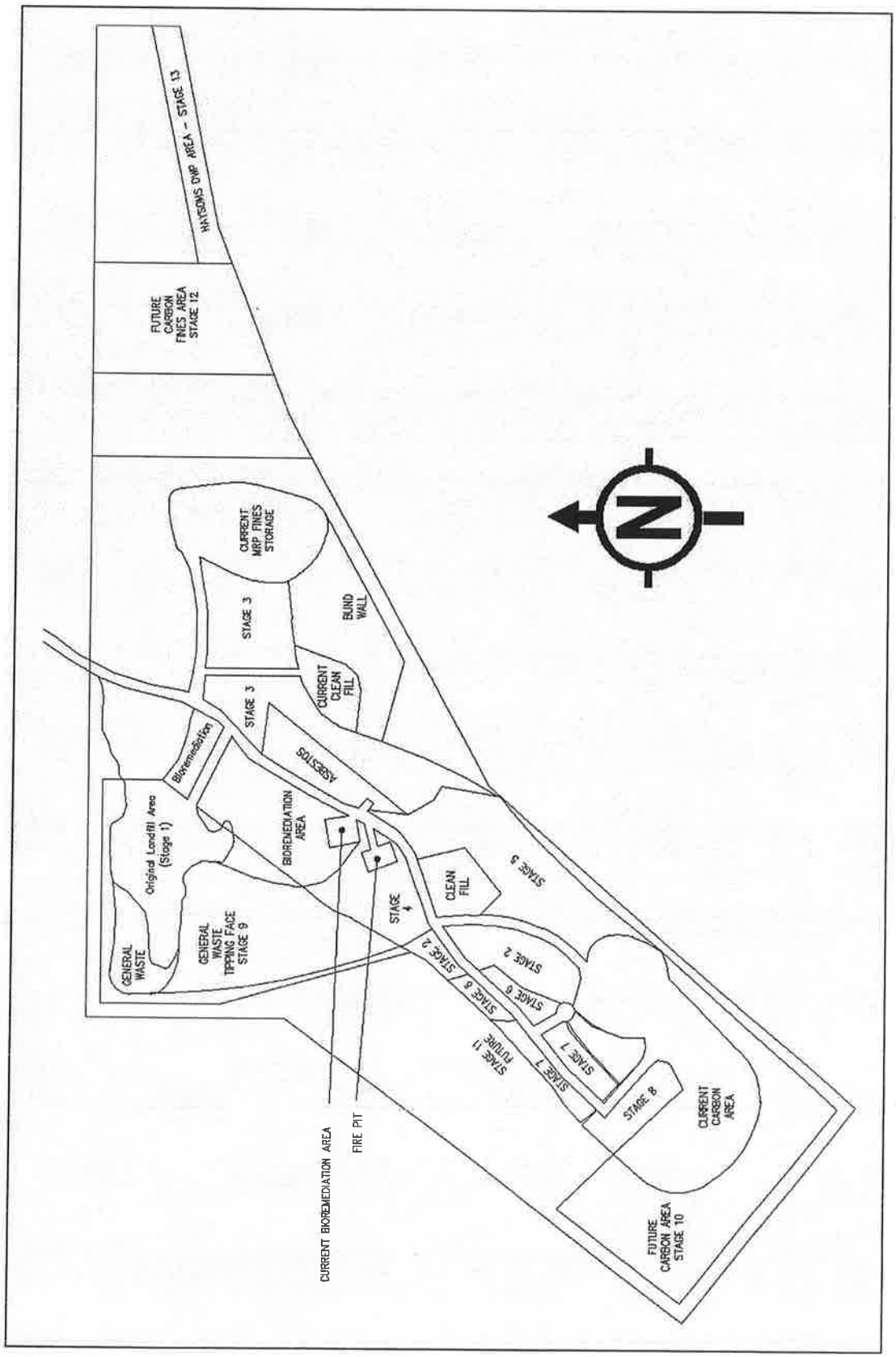
Stage	Area	Area Status
1	Original Landfill Northwest End	
2	Southwest and Southeast of Main Road	Closed 11/91
3	Northeast of End	Closed 4/92
4	West of Main Road	Closed 10/92
5	East of Main Road	Closed 3/93
6	Southwest and Southeast of Main Road	Closed 7/93

Continued on next page

7	Southwest and Southeast of Main Road	Closed 9/93
8	Southern End	Closed 3/2001
9	North West End	Current Non-classified
10	South West of Main Road	Current Carbon Area
11	Southern End	Closed, to be left in manuka
12	Eastern End	Proposed Future Carbon Area
13	Eastern End	Proposed Haysom's DWP Area

Landfill Development, Continued

Figure 1 **Map of Landfill**



Upgrading during staging

During staging, the Plant Services Output Team have regularly improved the completed landfilled areas. These areas have been incorporated into the staged development by:

- Removing large amounts of waste metals (in the form of industrial steel, machinery and ducting) from the landfill site for recycling,
- Excavating and boxing pitch tar prior to relocation,
- Recovering waste oils for recycling and remediating the residual oil slugs,
- Excavating general waste and removing it to the active landfill face.

This work is generally completed and is unlikely to be repeated, because NZAS now manages the landfill to eliminate the need to recover waste. This is achieved using:

- Segregation of materials prior to entering the landfill, and
- Designated Areas.

Projected Life

Approximately 20 years life	Including the requirements of the Assessment of Environmental Effects (AEE) 2003, the manuka area to the west of the existing landfill would not be filled. Using this regime the general or non-classified waste area has a projected life of approximately 20 years. The carbon disposal site has a projected life of approximately 7 years. These projected life calculations are based on the predicted maximum rate of waste disposal. Future improvements in waste stream and disposal efficiencies, which lessen the volume of waste materials disposed of at the landfill, would extend its projected life.
Closure plan and after care methodology	The landfill is included in the Closure Plan for all the NZAS operations. The NZAS Closure Plan is reviewed and updated at regular intervals. The current Closure Plan provisions for the landfill are to cover, shape and revegtate the area.

Geotechnical Investigation

Woodward Clyde investigation

The geotechnical aspects of the landfill site were investigated by Woodward-Clyde (NZ) Ltd (1994). This investigation included the drilling of wells, logging the strata in the wells, and a walkover survey. Details of the methods used and the well locations are included in the Woodward - Clyde report.

URS investigation

Further to the Woodward Clyde (NZ) Ltd (1994) report, URS (2003) have prepared an assessment of environmental effects for the groundwater with regard to the Tiwai Landfill and Haysom's Dross Cell. This investigation involved modelling of existing data to gain an assessment of effects of discharge to groundwater and the further receiving environment.

Geology

The geology in the landfill area is shown in Figures 2 and 3. Two distinct geological materials occur below the landfill site. These are:

- Unconsolidated materials comprised of gravel and sands with some silts and peat's, and
- Underlying bedrock which is hard, dense, tight, poorly (partially) fractured and fine grained.

Hydraulic conductivity measured

Hydraulic conductivity is a measure of permeability and is defined as the rate at which water will move through one square meter of aquifer under a gradient of one horizontal to one vertical.

Rising and falling head tests were performed in the wells at the landfill to determine the hydraulic conductivity.

The data for the unconsolidated material indicates that hydraulic conductivities on the eastern side of the landfill at 2.5×10^{-5} ms^{-1} are slightly greater than those on the western side at 5.5×10^{-6} ms^{-1}.

This variation in permeability would be consistent with greater reworking of sediments on the ocean beach side.

The underlying bedrock hydraulic conductivity is substantially less than that of the unconsolidated materials. This bedrock forms the local hydrological basement for the landfill site.

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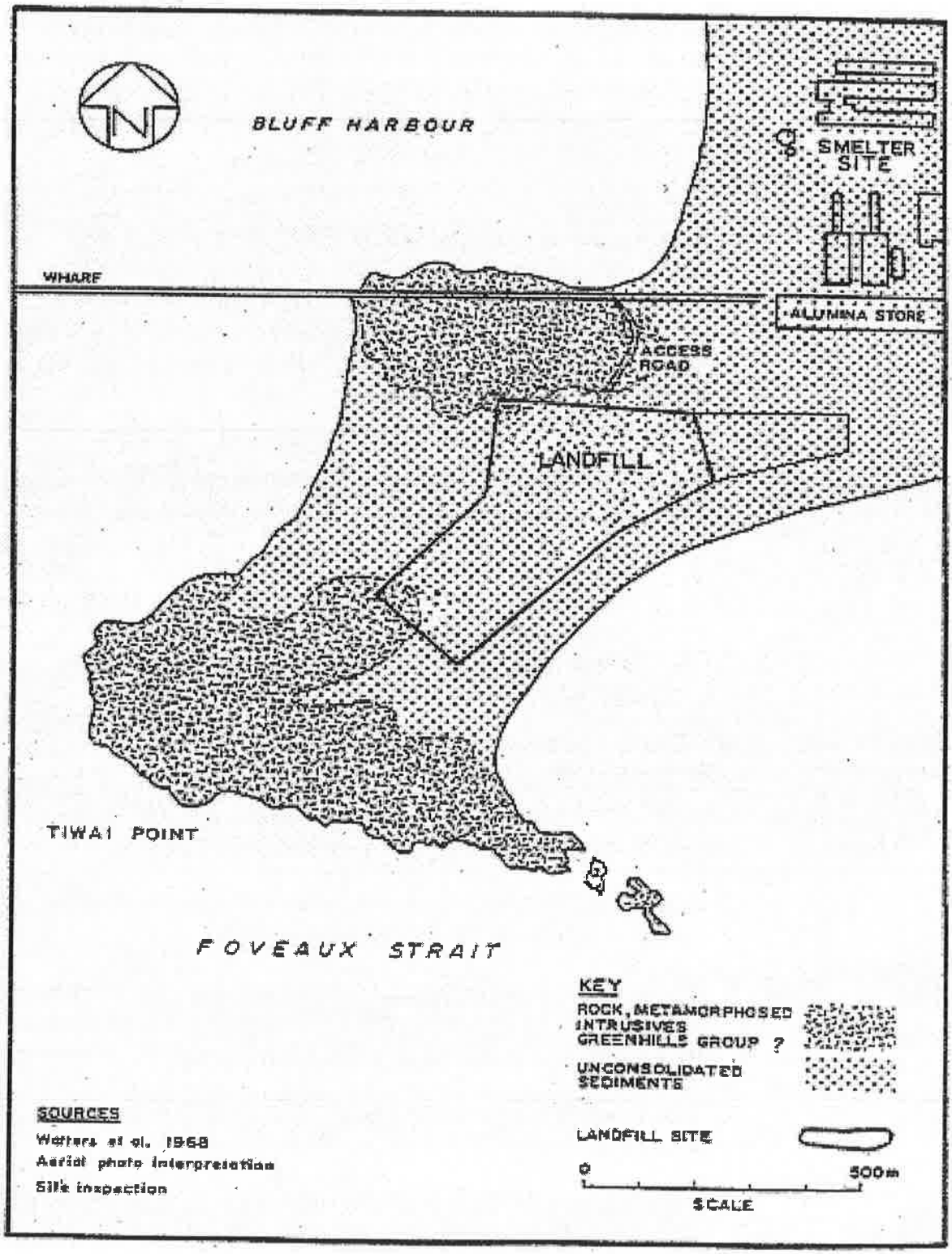
Geotechnical Investigation

Figure 2 **Site Geology**



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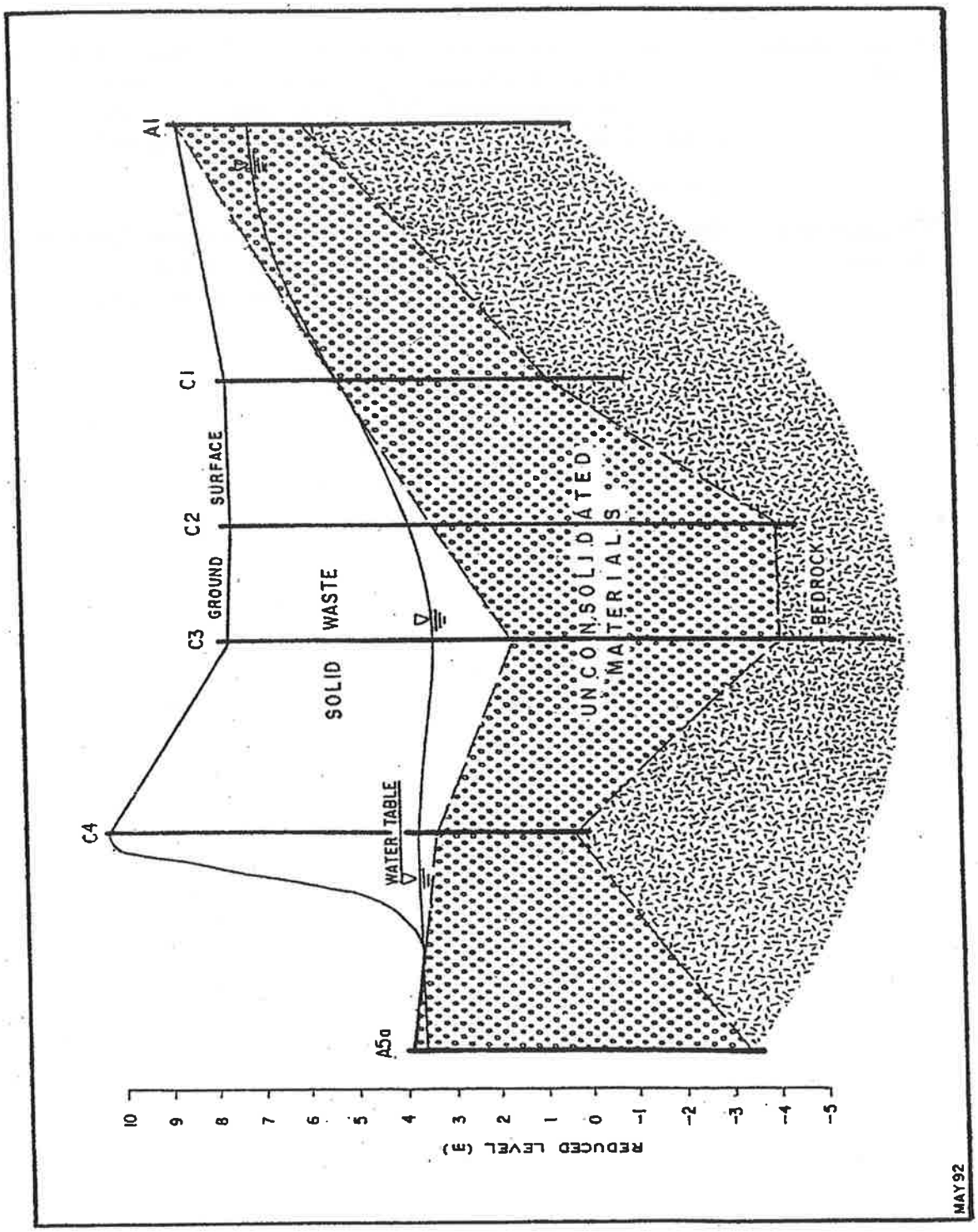
Geotechnical Investigation, Continued

Figure 3 **Schematic Hydrogeological Section**



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Geotechnical Investigation, Continued

Potentiometric Surface	The potentiometric surface of groundwater is the imaginary surface to which water will rise under its full head from a groundwater aquifer. The potentiometric surface of the groundwater under and around the landfill site is given for August 2003 in Figure 4.
Groundwater Recharge	The cross section shown in Figure 3 shows that elevated portions of the water table underlie the landfill and the ground to the north. Some groundwater recharge from the elevated ground is indicated in Figure 4. Most of the recharge to the groundwater system beneath the landfill results from the percolation of incident rainfall. It has been calculated that up to 60% of the rainfall onto the landfill site percolates to the underlying groundwater system.

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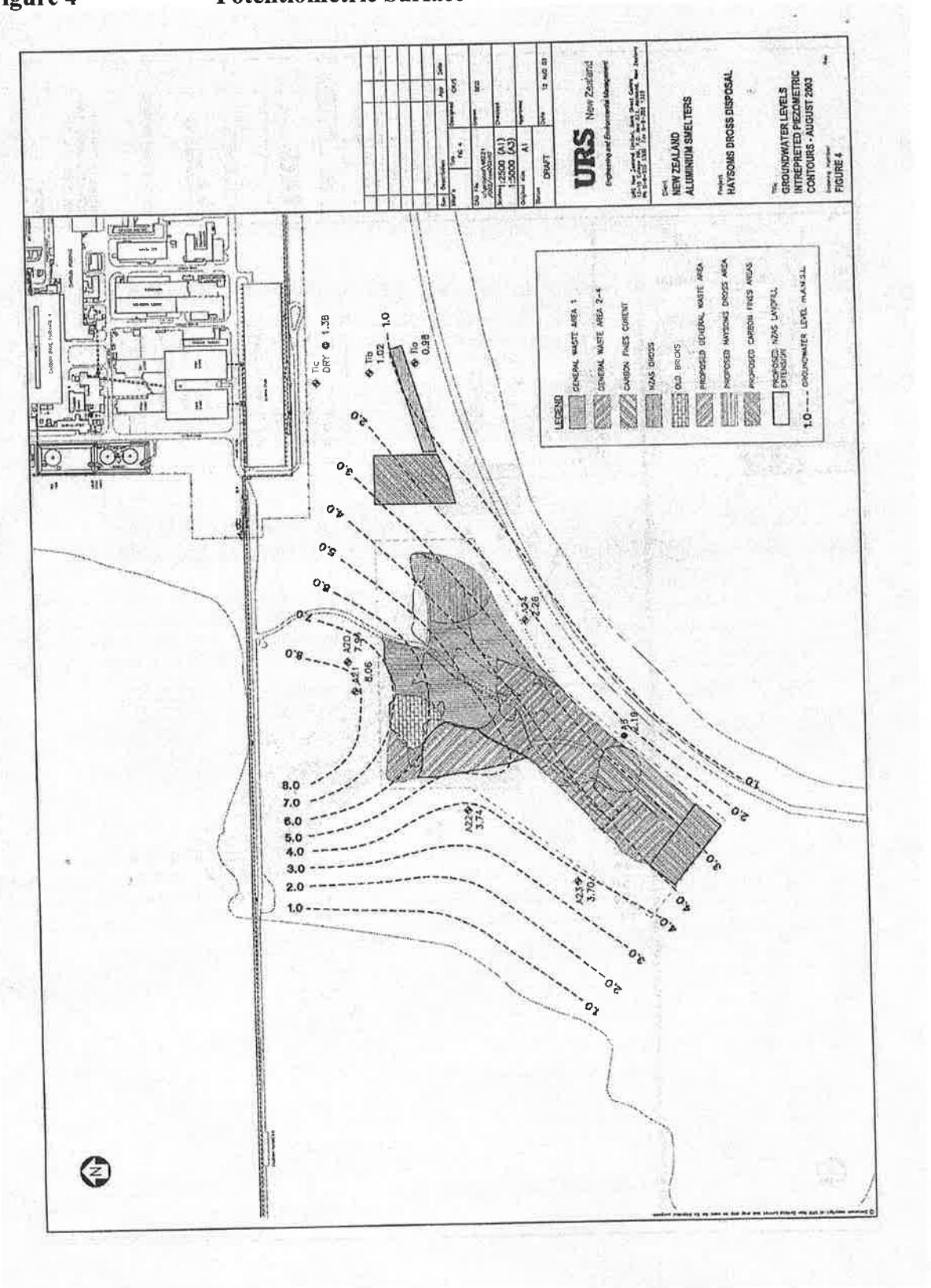
Geotechnical Investigation, Continued

Figure 4 **Potentiometric Surface**



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Groundwater Flow Rate

The potentriometric contours in Figure 4 show that the groundwater from beneath the landfill flows down gradient to both the eastern and western coastlines. Ground water discharges to both the ocean and harbour beaches.

The groundwater flow has been estimated at:

- About 140m^3 day^{-1} (94% of the recharge) flows to the ocean beach to the east, and
- About 9m^3 day^{-1} flows to the harbour beach to the west.

The reason for this difference is the greater distance, lesser gradient and lower permeability to the west.

Groundwater Flow Times

Velocity calculations indicate that the average times for groundwater from beneath the landfill to reach the coasts are:

- 1.1 to 2.2 years to the east (ocean), and
- 20 to 40 years to the west (harbour).

Management

Overview

Introduction This section outlines the management of the NZAS landfill, under the current organisational structure. It includes access, hours of operation, management structure, staff requirements and training.

In this section This section contains the following topics:

Access

General Access	The landfill is located at the western end of Tiwai Peninsula and can only be accessed by road from the NZAS site. The NZAS site is bordered by a 2 metre high security fence. Access onto the NZAS site is controlled by security officers. The current practice is to open the landfill to contractors, and other NZAS staff authorised by Plant Services to deposit waste under the supervision of the Plant Services Output Team.
Vehicle Access	Vehicle access to the NZAS landfill is provided off the Wharf Road at the western end of the plant. • Vehicle access is restricted to on-site approved vehicles only. • Signage is placed at the entrance to the NZAS landfill stating the NZAS Landfill Hours of Operation.
Access during Day Shift Hours	During Day Shift Hours access to the landfill shall be restricted to: • Plant Services Output Team staff, • Contractors authorised to deposit waste by the Plant Services Output Team, and • Other NZAS staff depositing waste under Plant Services Output Team supervision.
Access outside Day Shift Hours	Access outside Day Shift Hours shall be restricted to vehicles authorised by the Plant Services Output Team.
Hours of Operation	Smelter operating needs may require the hours of operation to be changed. Any changes to the hours of operation require the approval of the Superintendent, Plant Services. Signage is placed at the entrance to the NZAS landfill stating the NZAS Landfill Hours of Operation.

Management Structure

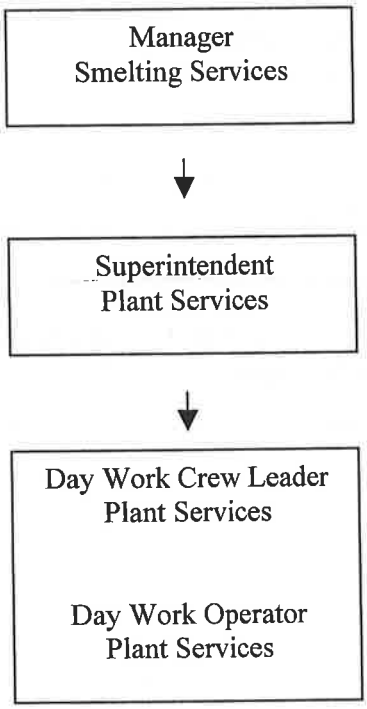
Accountability

Under the current NZAS organisational structure, the Superintendent Plant Services, is accountable for the landfill operations.

The Technical Development MRU staff are accountable for providing technical advice and specialist services.

Structure

The current management structure for landfill operations is:



Staff

Landfill Operator	The current routine landfill operations require Plant Services staff to carry out routine operations of the landfill during Day Light Hours to maintain the landfill in accordance with the Landfill Management Plan.
Additional Staff	Improvement activities, eg profiling and revegetation, usually require additional staff. These staff may be from the Plant Services Output Team, Contractors or other NZAS MRU's Task assignment for the additional staff is the accountability of the Superintendent, Plant Services.
Immunisation Program	Hepatitis A immunisation is mandatory for Plant Services staff working at the landfill and is arranged through the NZAS Medical Centre. Ensuring staff are immunised is the accountability of the Superintendent, Plant Services.

Staff Training

Training Accountability	The Superintendent, Plant Services is accountable for ensuring that all staff involved in landfill operations are trained. The Technical Development MRU shall assist with education and advise the Superintendent, Plant Services, of appropriate precautions.
Special Wastes	All staff managing the landfilled special wastes shall receive training in the characteristics of material, the safe method of use, the necessary personal protective equipment and emergency procedures. This includes all relevant Current Best Practices (Appendix 2).
Training	The Superintendent, Plant Services shall ensure that all staff involved in landfill operations are fully conversant with landfill procedures. The Superintendent, Plant Services, assisted by Technical Development MRU shall ensure staff are updated on current landfill issues. The Superintendent, Plant Services, decides the training content from the best available material and courses.

Improvements to Practices

Ongoing Reviews	The operation of the landfill is reviewed on an ongoing basis by the Superintendent, Plant Services, as information on improved landfill and waste management practices become available. Improved practices are implemented where practicable.

Landfill Operations

Overview

Introduction

This section outlines the operations of the NZAS landfill. It summarises the preparation of the site, access, water control, landfilling and compaction, waste segregation, the control of nuisances, the landfill revegetation program, inventory and monitoring.

In this section

This section contains the following topics:

General Requirements for Landfill Operation

Application of Operator's Guide	The practices outlined in this section apply to all NZAS staff at the landfill. They are adopted to; • Minimise the risk of harm to those handling waste materials, • Minimise any potential adverse effects on the environment resulting from the operation of the landfill, and • Ensure that all landfill activities are carried out within NZAS Waste Disposal and Management CBP.
Current Best Practices	NZAS staff accountable for disposing of or managing waste at the landfill site must conversant with all Landfill Current Best Practices. The Current Best Practices are regularly updated and the latest Current Best Practices (29 August 2003 –**Draft**) for Landfill Operation is attached as Appendix 2.

Site Preparation

Signs	Signs at the beginning of the landfill road shall inform users of the hours of operation. Within the landfill there are signs to: • Direct vehicles to the active landfill face, • Show designated areas were specific wastes are to be deposited, and • Warn against excavation in the Asbestos burial Area.
Topography	The landfill has raised the ground level to 7.1 – 10.5m above sea level and has an evened out surface.
Screens	The relatively remote location of the NZAS landfill means that the screens are not required to isolate the landfill from other activities. Improvements to the visual aspects from the elevated parts of Bluff is provided by: • Restricting the working face, • Profiling, and • Revegetation.
Perimeter Fencing	The location of the landfill, at the western end of Tiwai Peninsula, means that access can only be gained through security controlled NZAS main gate. There is no need for a separate perimeter fencing or security gate at the landfill.

Continued on next page

Site Preparation, Continued

Site Preparation	Preparation for future areas for landfilling will include: • Removing and/or levelling vegetation, • Levelling the ground surface if necessary, Removing if practical, uncompacted surface pea gravel, soil and sand up to a depth which is practical to maintain a compacted surface (normally about 500mm).
General Face - Bunding of Cell Walls	The current General Cell Tipping Face is at the North West end of the Landfill. This will be worked in small cell blocks with a bunded wall on the western boundary working back from Stage 9 towards closed cells 4, 2, and 6. A maximum working face of between 10 and 15 metres in width will be maintained at all times. The purpose of working small cell blocks is to minimise the visual impact from Bluff and to protect waste from the prevailing winds. Cells will be prepared using waste material for bund walls with outer walls being covered with about 300mm of soil, sand or pea gravel and revegetated.
Carbon Face - Cells	The current Carbon Face is at the South end of the Landfill. This area for Carbon is expected to take around 7 years to fill. It is proposed that the Carbon face will then move to the landfill extension area, between the Haysom's DWP and the existing landfill. Cell blocks are kept level to minimise the visual impact from Bluff.

Water Control

Stormwater Catchment Area	The catchment area for the stormwater is the landfill site. Stormwater from other catchment areas on Tiwai Peninsula do not flow through the landfill site.
Storm Water Control	All surfaces within the landfill shall be contoured to divert water away from the fill sites. Rainfall will either infiltrate into the landfill or flow overland and infiltrate the land surrounding the landfill. No stormwater channels are formed without Technical Development MRU approval.
Ponding Prevention	Surface water collects in excavations within the site boundaries during extended rainfall periods but is quickly absorbed. Excessive ponding is avoided by continuing to grade surfaces whenever landfill areas are closed, either at an intermediate or final stage
Reducing Leachate	Leachate production is reduced by covering waste at both intermediate and final stages of closure and by the landfill revegetation programme.
Periods of High Rainfall	Extra control and remedial work shall be undertaken during periods of high intensity rainfall to minimise adverse effects. This work may include: • Avoiding washouts, and • Maintaining the segregation of wastes by rebuilding bunds where necessary.

Landfilling and Compaction

Compaction	The materials landfilled at the NZAS Landfill require minimal compaction. To date there is no evidence of subsidence in the areas covered. This includes both roads and revegetated areas. The active landfill face is compacted by the vehicles that transport the waste material. Compaction at the active face is further aided by: • The thinning of waste material over the face, and • Maintaining, wherever possible, a sloping active face.
Size of Active Landfill Face	The active landfill face is kept between 10 and 15 metres in width to minimise the area of exposed waste.
Waste at the Landfill Face	All depositing of waste at the landfill face is concentrated in the active area.
Access to the Face	General access to the landfill face shall be authorised by Plant Services Output Team staff. The active face is reached by a vehicle track, positioned to allow only one vehicle at a time to deposit waste. Statutory access shall be allowed for Ministry of Forestry and Ministry of Agriculture and Fisheries officers for border control purposes. Every effort shall be made to assist the officers during these visits.

Waste Segregation

Landfill Categories	For landfilling purposes, wastes are segregated into the following categories: • Unacceptable waste • Waste requiring segregated disposal or storage, and • General waste.
Unacceptable Waste	Unacceptable wastes are wastes which are considered unsuitable for landfilling at NZAS. Current waste in this category are: • Spent Cathode Lining • Wastes included in tables on pages 10 and 11.
Waste Requiring Segregated Disposal or Storage	The landfill is divided into defined areas for the segregation of wastes where required. This facilitates, where appropriate, the future recovery of waste materials for disposal, recycling or reuse. Currently the defined areas in the landfill area for segregation of wastes are: • Packaged Asbestos, • Man Made Mineral Fibres (MMMF), • Carbon Dust, • Metals Reclamation Plant (MRP) fines, and • Clean Fill.
General Waste	Waste materials entering the landfill site that do not require segregated disposal or storage, are currently classified for landfilling purposes as general waste. These general wastes are disposed at the active landfill face.

Hydrocarbon Bioremediation

Current Bioremediation	A small area of about 600m^2 in the south east corner of the closed bioremediation area has been defined as a bioremediation area for oil contaminated materials. This will be managed using design criteria specified by the Technical Development MRU.
Closed Bioremediation Area	An area of 9880m^2 at the north west part was used for the bioremediation of oil contaminated soil from mitigation work at the landfill. Bioremediation has reduced the oil content of the soil to acceptable levels and the bioremediation area was closed and successfully sown with grass.

Landfill Revegetation Program

Overview

NZAS has carried out an extensive revegetation program at the landfill site since late 1991. This has involved, where necessary, surface covering followed by the planting of approximately 26,000 native trees and shrubs. To date an area of approximately 4.7 ha has been revegetated.

Revegetation Goals

NZAS aims to revegetate the completed landfill areas with native plants, with an emphasis on the selection and planting of trees and shrubs typical of Tiwai Peninsula. The benefits of the revegetation program include:

- Returning the closed areas back to their original state as closely as is possible,
- Stabilising the final cover, and
- Reducing the visual impact of the landfill.

Covering

The Plant Services Output Team cover completed landfill areas with up to 300mm of pea gravel, sourced from site excavation.

Planting

Advice and assistance with the revegetation of the closed areas is currently sourced from the Department of Conservation, Invercargill.

This includes:

- Advice on the plants best suited to the Tiwai Peninsula environment,
- Sourcing the native material, and
- Overseeing the planting program.

Continued on next page

Landfill Revegetation Program, Continued

Future Revegetation	The revegetation program will continue as areas of the landfill become closed and available for restoration. All completed landfill areas will be returned as closely as possible to their original state and the planting program maintained.

Control of Nuisances

Litter	The spread of litter in the landfill is minimised by proper landfill face placement and waste containment. Fencing will be installed if required. The Day Work Operator is accountable, on a daily basis, for picking up any loose litter in the landfill.
Dust	The spread of dust is minimised by the construction of bunds around designated areas containing dust waste. The carbon dust area, near the landfill face, should be compacted as necessary.
Open Pit Burning not Permitted	Open burning is not permitted at the landfill (Air Discharge Permit No. 93566, Condition F6). There is an exemption for border control requirements and this is carried out under the instruction of the officers from statutory bodies.
Pests	NZAS shall continue to co-operate with Environment Southland in the reduction of pests in the landfill. Contractors are currently employed by the Technical Development MRU to control pest weeds and pest animals upon request. The results of these are reported to the Plant Services Output Team.
Birds	The landfill area has not been a host to significant numbers of scavenging birds in the past. Future management emphasis to minimise the scavenging birds in the future includes: • Litter control, • The size of the active landfill face, and • Minimising of exposed earthworks and shallow pools and puddles.
Unauthorised People	NZAS access controls prevent unauthorised people from entering the landfill area. Scavenging at the landfill is not considered an issue.

Emergencies

Required Actions

The following actions are required in the event of an accident or an uncontrolled fire in the landfill area.

- Contact Security immediately by either using the radio telephone or dialling 888 on the nearest NZAS phone,
- Remain available to advise and assist Emergency Services, and
- Report the incident as soon as possible to Plant Services Superintendent and Crew Leader.

Monitoring

Waste Amount and Types

Data on the amount and types of materials being landfilled are obtained by detailed surveys during periods chosen to represent typical conditions.

These must be undertaken at least two yearly to comply with the Landfill Discharge Permit.

This current method has been chosen because:

- It is practical, and
- It is capable of providing the required level of data.

The design and timing of these surveys is the accountability of the Superintendent, Plant Services. Currently the surveys are conducted over 1 month period every year to address the type and volume of material being deposited at the NZAS Landfill.

Changes in Material Types

The types of waste material being deposited at the NZAS Landfill are likely to be relatively constant as the only source is the smelter operations. However, changes in the smelter operations may result in small changes in the types of wastes. Data on the impact of such changes on the types of waste being landfilled can be obtained from:

- Data from the detailed surveys of amounts and types of materials being landfilled,
- Data from the allocation of skip trucks to transport the waste, and
- Knowledge of the smelters operation changes.

Groundwater

A good database exists on groundwater at the landfill site. The Technical Development MRU is accountable for the groundwater monitoring.

The current monitoring involves sampling 6 bores twice each year. One set of samples is collected in the summer and the other set is collected in the winter.

Continued on next page

Groundwater, continued

Three additional groundwater monitoring wells are proposed to assess the groundwater quality. These include:

- One well "downstream" of the Haysom's DWP cell (well T1A)
- One well "upstream" of the Haysom's DWP cell (well T1B), and
- One well downstream (south) of the proposed eastern carbon fines area (approximate location indicated and yet to be installed).

The locations of the three proposed monitoring wells are depicted in Figure 5.

It is proposed that an unnamed well to be located south of the proposed Eastern Carbon Fines area be included in the Schedule of monitoring six months prior to commissioning of the proposed Eastern Carbon Fines area.

Given the groundwater is not of high quality and predominately moves seaward to the south coast with substantial dilution at the seawater tidal interface, that the proposed monitoring program is sufficient in assessing impacts upon groundwater and the receiving environment.

The Schedule of Conditions associated with the existing Discharge Permit is comprehensive. It is proposed that a similar Schedule of Conditions (including amendments previously granted, the additional monitoring wells referred above and any minor amendments) constitute the replacement Discharge Permit.

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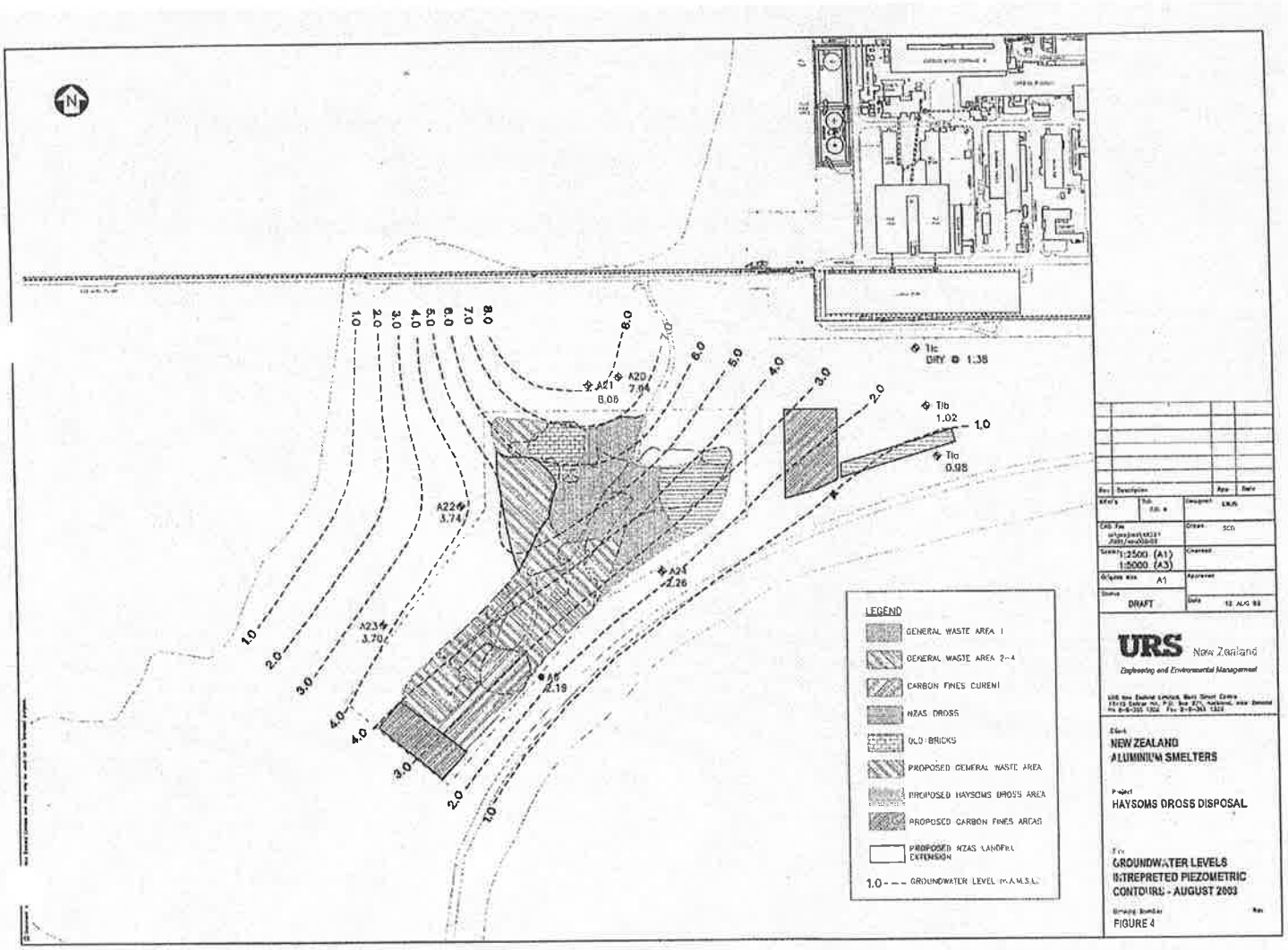
Figure 5: Monitoring Well Locations



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Monitoring, Continued

Reporting

The results of groundwater monitoring are supplied to Environment Southland within 20 working days of the end of the quarter the groundwater was sampled.

An annual report is also provided to Environment Southland by the 31 March each year. This Report includes:

- A summary of groundwater monitoring results for the previous calendar year.
- An outline of the proposed operation at the landfill for the next 12 months.
- An estimate of the amount and type of materials deposited at the landfill.

Appendices

Overview

Introduction This section outlines the Discharge Permits Relating to the Landfill, Approvals for Asbestos Disposal at the Landfill and Landfill Operation Current Best Practice.

In this section This section contains the following topics:

Appendix 1. Discharge Permits Relating to the Landfill (Consent Number 94460)

Application no. A1323

Consent no. 94460

SOUTHLAND REGIONAL COUNCIL

Private Bag 90116
Telephone (03) 215-6197
Fax No. (03) 215-8081

Cnr North Road and Price Street
Waikiwi
Invercargill

DISCHARGE PERMIT

Pursuant to Section 105(1) of the Resource Management Act 1991, a resource consent is hereby granted by the **Southland Regional Council**

to N Z A S Limited (called the "consent holder")

of Private Bag 90110, Invercargill

from 30 October 1995

PLEASE READ THIS CONSENT CAREFULLY AND ENSURE THAT ANY STAFF OR CONTRACTORS CARRYING OUT ACTIVITIES UNDER THIS CONSENT ON YOUR BEHALF ARE AWARE OF ALL THE CONDITIONS OF THE CONSENT.

DETAILS OF PERMIT

Purpose for which permit is granted: -		To discharge contaminants onto or into land including in circumstances where contaminants may enter water.
Location	- site locality :-	Tiwai Peninsula
	- map reference :-	E47:552:914
	- receiving environment :-	Land
	- catchment :-	Tiwai
Legal description of land at site :-		The south western end of Tiwai Peninsula, near Tiwai Point, as shown in application, Part CT 2A/78
Expiry date :-		26 April 2006

SCHEDULE OF CONDITIONS

1. The types of materials to be deposited shall generally be as described in the application and the operation of the landfill shall be in accordance with the Management Plan for the landfill, as amended from time to time.

2. The materials shall be deposited within the landfill boundaries as defined on the attached plan.

3. The consent holder shall estimate the amount and type of materials that have been deposited at the landfill at two yearly intervals, with the first two yearly interval ending on 31 December 1997.

4. Stormwater within the landfill site shall be managed so as to minimise the production of leachate. In particular, the consent holder shall:

   (i) divert clean stormwater away from the landfill site;
   (ii) within the landfill site, divert stormwater away from the tipping face;
   (iii) minimise the amount of uncovered areas and oversow areas that will not be worked for over 6 months; and
   (iv) contour the cover material to prevent ponding.

Application no. A1323 Consent no. 94460

5. The consent holder shall monitor groundwater as follows:

(i) in two bores north east (upstream) of the landfill site;
(ii) in two bores south east and two bores west (downstream) of the landfill site; and
(iii) by taking a representative sample from each bore and analysing for:

pH
total Kjeldahl nitrogen
total ammoniacal nitrogen
nitrate nitrogen
nitrite nitrogen
alkalinity
carbonaceous BOD_5
potassium
boron
fluoride
sulphate
temperature
conductivity
total iron
manganese
vanadium
nickel
total petroleum hydrocarbons
weak acid dissociable cyanide
naphthalene
anthracene
phenanthrene
fluoranthrene

(iv) the samples shall be taken once in each quarter for the first calendar year from the commencement of the consent with the frequency being assessed annually. The monitoring frequency may be changed to a minimum of once every two years with the approval of the Council's Director of Planning and Resource Management.

6. The parameters specified in condition 5(iii) shall be analysed in accordance with the most recent edition of APHA "Standards Methods for the Examination of Water and Wastewater" or by methods approved by the Council's Director of Planning and Resource Management.

7. The selection of the bore sites to be monitored in accordance with condition 5 of this permit is to be approved by the Council's Director of Planning and Resource Management.

8. (i) The results of analyses, carried out in accordance with condition 5 of this permit, shall be supplied to the Council no later than 20 working days from the end of each quarter, with the first quarter ending on 31 March 1996.

(ii) Any monitoring results obtained in accordance with Condition 5 of this permit which indicate a significant change from previous results shall be supplied to the Council within 10 working days of the consent holder receiving the results.

(iii) The methods of analyses are to be specified with the results.

9. The consent holder shall provide the Southland Regional Council with a report, annually by 31 March each year, which shall include:

- a summary of monitoring results over the previous twelve months and an interpretation of the results;
- an outline of the proposed operation at the landfill for the next twelve months;
- at two yearly intervals, the estimates required by condition 3 of this permit.

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10. Except where the Council's laboratory acts as the consent holder's agent, the Council may once every calendar year, audit the consent holder's monitoring methods and analyses by obtaining split samples of two of the groundwater samples taken in accordance with condition 5 above. The cost of the audit is to be met by the consent holder.

11. The Council may, in accordance with the conditions of this permit, and in accordance with sections 128 and 129 of the Act, serve notice at 2, 5 and 8 years from the commencement of this consent of its intention to review the conditions of this consent for the purpose of dealing with any adverse effects on the environment which may arise from the exercise of this consent which were not anticipated when the consent was granted.

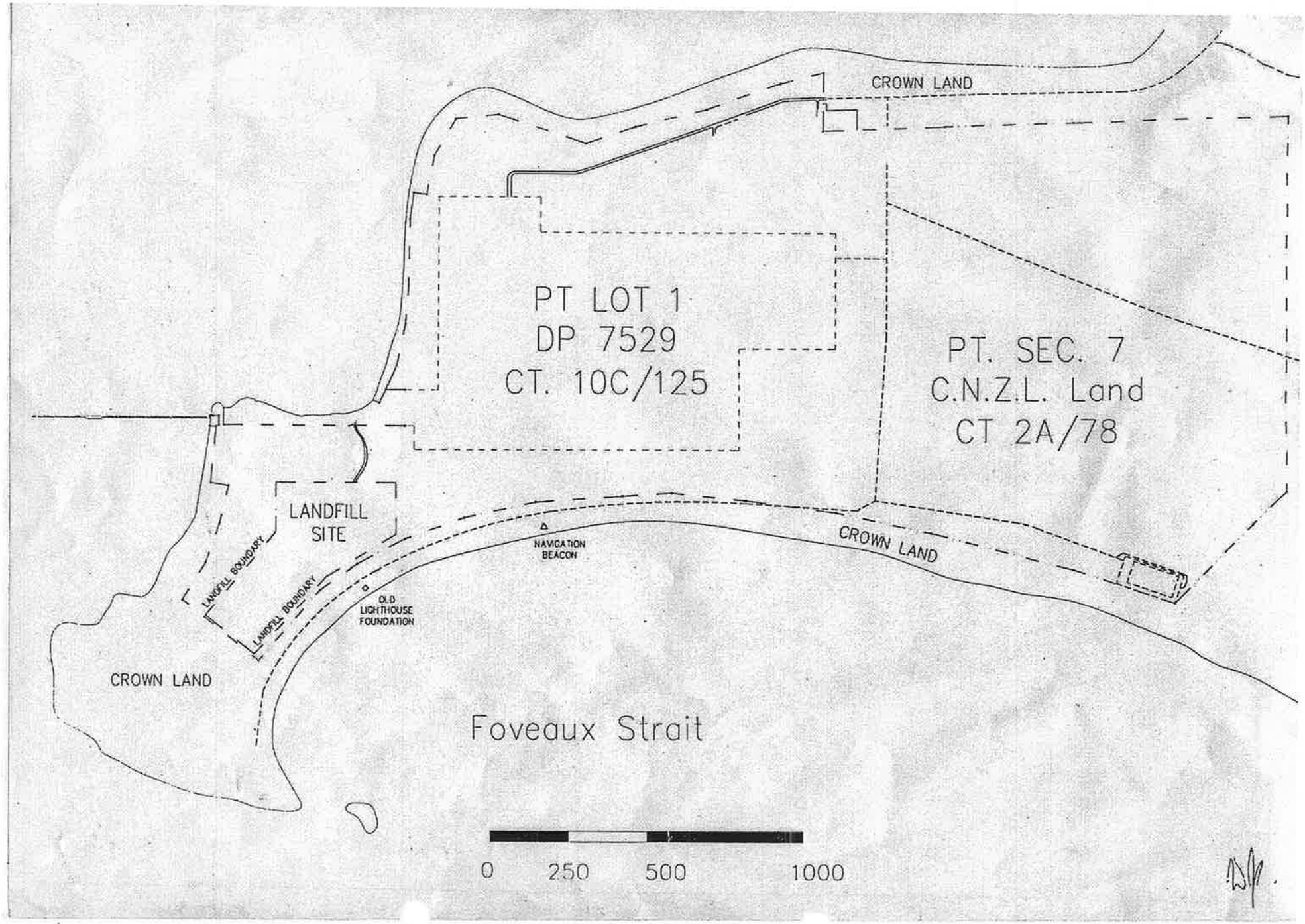
12. The consent holder may, in accordance with section 127 of the Act, apply to the Council at 2 yearly intervals, with notice to be given within 2 months of the anniversary from the commencement of this consent, for a review of the consent conditions for the purpose of a change or cancellation of any condition of this consent.

13. (i) The consent holder shall pay the Southland Regional Council an administration charge of $100 plus GST (or other figure set by Special Order under the Act) in advance, payable on the first day of July each year.

(ii) The consent holder will also be monitored in accordance with the Council's Special Order for consent monitoring on an annual basis, the cost of which is fixed in that Order and payable by the consent holder.

For: **THE SOUTHLAND REGIONAL COUNCIL** on 30 October 1995

W J Tuckey
DIRECTOR OF PLANNING AND RESOURCE MANAGEMENT


CROWN LAND
PT LOT 1
DP 7529
CT. 10C/125
PT. SEC. 7
C.N.Z.L. Land
CT 2A/78
LANDFILL
SITE
LANDFILL BOUNDARY
LANDFILL BOUNDARY
NAVIGATION
BEACON
OLD
LIGHTHOUSE
FOUNDATION
CROWN LAND
CROWN LAND
Foveaux Strait
0
250
500
1000

Appendix 2. Landfill Operation Current Best Practice

PS9.1 Landfill Operation

Context

NZAS has objectives of minimizing the amount of waste generated from smelting operations, and providing environmentally acceptable and effective management of residual waste. The methodologies for achieving these objectives are the Continuous Improvement Program, Waste Disposal and Management CBP and the Landfill Management Plan.

All waste deposited at the NZAS Landfill requires the approval of the Plant Services Output Team and is deposited in the designated areas under their direct supervision in designated cells or areas.

Purpose

To ensure all Plant Services Operators or Contractors who are required to undertake tasks at the NZAS Landfill Site are familiar with the procedures.

Resources

Personnel	One or more operators may be required depending on the tasks. Contractors carry out planting of native trees.
Equipment	Loader. Skip Truck Tip Truck Dozer Tractor

Safety Equipment

NZAS Safety Clothing
Safety Glasses
Safety Footwear
Hearing Protection
Riggers Gloves
Respirator
Disposable Overalls.
Vehicle seat belts must be worn.

Prerequisite Procedures

Personnel performing this task must be fully trained in the following task functions

Loader Operations

Heavy Truck Operations

Dozer Operations

Tractor (Lawn Mowing)

Prerequisite Conditions

The active Cell Tipping Face is to be kept between 10 and 15 meters in width to minimize the area of exposed waste.
Cell-Tipping areas must remain level at all times.
For operators working at the Landfill Hepatitis A immunization is mandatory.
Access to the Landfill requires authorization from the Plant Services Output Team.

Frequency

A fully trained operator undertakes the one task of clearing the waste materials in the Cell-Tipping areas on an as required basis.

Note: This procedure is coupled with the Landfill Management Plan. If it is updated, the copy in the Landfill Management Plan must be updated at the same time.

PS9.1 Landfill Operations

Main Steps	Actions	Issues
Access to landfill	• Access to the Landfill requires authorization from the Plant Services Output Team.	
Entry to landfill road	• Entry to the NZAS Landfill is off Wharf Road, west of the Alumina Store on the south west side of the site. • Care must be taken when entering the Landfill Road, as it is a one-way system.	Safety Give way to all vehicles entering the Landfill Adhere to the max speed limit of 30 km/hr.
Entry to the cell-tipping areas	• Assess the wind conditions. (Refer to the Reclaim anemometer on Plant Services Scada) • Enter the road to the appropriate Cell-Tipping Area.	Safety Assess may be restricted if wind speed exceeds 50 Beware of vehicles exiting the Cell-Tipping Storage Area.

PS9.1 Landfill Operations

Main Steps	Actions	Issues
Depositing waste materials	• Deposit waste materials in the appropriate Cell-Tipping Area, and between the signage indicating the tipping area. • Reverse the vehicle between the "Cell-Tipping Area" signs and deposit the waste material. **Signs at the beginning of the Carbon, MRP Asbestos, MMMF, General Waste and Bioremediation areas show where the specific waste is to be deposited.** **Special Conditions:** • **Respirators** are to be worn if alighting from vehicles when depositing waste material in the MRP and Carbon Cell-Tipping areas. • **MMMF & Asbestos Waste** is to be contained in plastic bags labeled and secured at the top before delivery to the Cell-Tipping Areas. **When handling Asbestos or MMMF Waste Respirator, Safety Glasses or Safety Goggles, Rigger Gloves and Disposable Overalls are to be worn.** **When exposed to Asbestos or MMMF waste through broken bags, loose materials blowing from the skip onto the operators then they MUST leave their Respirator on until their overalls and boots are removed, then disposing of the contaminated overalls in the appropriate manner and any clothing, PPE and boots cleaned.**	**Safety** Beware of vehicles exiting the Cell-Tipping Storage Areas. Vehicle doors and windows should remain closed. **Ensure that Cell-Tipping surfaces are secure.** **Ensure vehicles remain a safe distance from the edge of the Cell-Tipping Storage Areas.** **Process** Ensure waste materials are deposited in the appropriate Cell-Tipping areas.

PS9.1 Landfill Operations

Main Steps	Actions	Issues
Clearing cell-tipping areas	• Assess the wind conditions. (Refer to the Reclaim anemometer on Plant Services Scada) • A Loader is used to undertake the clearing of the Cell-Tipping Areas. • Select a low gear for this operation to maximise power and efficiency from the loader • Lower the bucket to push the material between the appropriate "Cell-Tipping Area Signs". • Keep the appropriate surface areas of the Cell-Tipping Areas level. • This may have to be repeated several times to clear waste materials in the Cell-Tipping Areas. • If the Cell-Tipping area is near a vertical drop ensure a lip of material is left on the tipping face edge to act as a stop for the vehicles tipping waste materials. **Note:** **The active Cell-Tipping Face is to be kept between 10 & 15 meters in width to minimize the area of exposed waste.** **Special Conditions:** • **Respirators** are to be worn if alighting from vehicles when depositing waste material in the MRP and Carbon Cell-Tipping areas. • **MMMF & Asbestos Waste** is to be contained in plastic bags labeled and secured at the top before delivery to the Cell-Tipping Areas. **When handling Asbestos or MMMF Waste Respirator, Safety Glasses or Safety Goggles, Rigger Gloves and Disposable Overalls are to be worn.** **When exposed to Asbestos or MMMF waste through broken bags, loose materials blowing from the skip onto the operators then they MUST leave their Respirator on until their overalls and boots are removed, then disposing of the contaminated overalls in the appropriate manner and any clothing, PPE and boots cleaned.**	**Safety** Access may be restricted if wind speed exceeds 50 km/hr Beware of vehicles exiting the Cell-Tipping Storage Areas. **Ensure that Cell-Tipping surfaces are secure.** **Ensure vehicles remain a safe distance from the Cell-Tipping Storage Area Sides.** **Process** Keep Cell-Tipping surfaces areas level at all times. **Environment** A bund wall is constructed of waste material covered with up to 300mm of pea gravel, sand or soil on the outer walls of the Cell-Tipping Areas to contain spillage. Each compleleted cell is covered in up to 300mm of pea gravel, sand or soil and re-vegetated.

PS9.1 Landfill Operations

Main Steps	Actions	Issues
Depositing oil contaminated waste	• Assess the wind conditions. (Refer to the Reclaim anemometer on Plant Services Scada) • Oil Contaminated waste is to be deposited in the bioremediation Cell-Tipping Area.	**Safety** Access may be restricted if wind speed exceeds 50 km/hr. Beware of vehicles exiting the Cell-Tipping Storage Areas.
Clearing bioremediation cell-tipping area.	• Assess the wind conditions. (Refer to the Reclaim anemometer on Plant Services Scada) • A Loader is used to undertake the working and clearing of the Bioremediation Area. • Select a low gear for the operation to maintain maximum power and efficiency from the loader. • Regular tillage within the top 300mm is required to enhance biological activity of the Oil Contaminated Waste. • Nutrients may need to be added to the cell when required. **Special Conditions:** • **Personal Protective Equipment** is to be worn when manual intervention is required to clear or sort oil contaminated waste in the bioremediation Cell-Tipping Area. • **Oil Contaminated Waste** is to be contained in the bioremediation Cell-Tipping Area at all times. • **Site Services MRU** will provide technical advice to support the management of the bioremediation Cell-Tipping Area.	**Safety** Access may be restricted if wind speed exceeds 50 km/hr. Beware of vehicles exiting the Cell-Tipping Storage Areas. **Process** **Carry out regular tillage within the top 300mm to enhance biological activity of the Oil Contaminated Waste.**

PS9.1 Landfill Operations

Main Steps	Actions	Issues
Burning of waste materials	**Open burning is not permitted at the NZAS Landfill. (Air Discharge Permit No 93566, Condition F6)** • There is an exemption for border control requirements and this is carried out under the instructions of the officers from the statutory bodies. • The Plant Services Superintendent must be notified before the above exemptions for border control requirements are exercised. • Notification is to be given to the Chief Fire Officer or the Officer in Charge of the Tiwai Industrial Fire Brigade if exemptions for border control requirements are to be exercised. • A Plant Services operator is to be in attendance if the exemptions for border control requirements are to be exercised.	Environment **Consideration to wind conditions and direction must be considered before lighting a fire** Safety **The Chief Fire Officer must give notification or the Officer in Charge of the Tiwai Industrial Fire Brigade before a fire can be lit in the burning pit.**
Covering of completed cells	• Assess the wind conditions. (Refer to the Reclaim anemometer on Plant Services Scada) • Trucks are used to deliver pea gravel to the completed cells. • A loader is then used to spread the pea gravel over the surface and sides of the completed cells or cells up to a depth of 300mm • Select a low gear for this operation to maintain maximum power and efficiency from the loader. **Special Conditions:** • **Completed Landfill Cells** are to be covered with up to 300mm of pea gravel, sourced from site excavation, compacted and revegetated. • **Respirators** May be required when covering completed Cell-Tipping	Safety Access may be restricted if wind speed exceeds 50 km/hr. Beware of vehicles exiting the Cell-Tipping Storage Areas. **Ensure that Cell-Tipping surfaces are secure.** **Ensure vehicles remain a safe distance from the edge of the Cell-Tipping Storage Area Sides.**
Revegetation of completed cells	• NZAS aim is to revegetate the completed Landfill Cells with native plants, with the emphasis on the selection and planting of trees and scrubs typical of Tiwai Peninsula. • Returning closed cells back to their original state or as closely as is possible • Stabilising the final covering. • Reducing the visual impact of the Landfill.	