



New Zealand Aluminium Smelters Limited

Interdepartmental

Committee

Report

2000

**REPORT TO THE INTERDEPARTMENTAL COMMITTEE
ON ENVIRONMENTAL EFFECTS OF THE TIWAI ALUMINIUM SMELTER
FOR THE YEAR ENDING 31 DECEMBER 2000**

**MEETING AT TIWAI
28 MARCH 2000**

**THE INFORMATION CONTAINED IN THIS REPORT IS CONFIDENTIAL TO
THE MEMBERS OF THE INTERDEPARTMENTAL COMMITTEE**

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Summary

Main Stack

Main stack discharges to air were within permit standards and generally stable during 2000.

In January a high gaseous fluoride result of 0.30 kg/min coincided with a period of non-routine operation of the dry scrubber system.

Total particulate discharges were higher than normal in November and December (1.25 kg/min and 1.38 kg/min respectively) as a result of broken bags in the dry scrubbing system. These were replaced and tests carried out after repairs had been completed indicated the discharge had returned to normal.

Potline Roof Louvres

Potline roof louvre discharges were within permit standards during 2000 but continued to show a slight increase in gaseous fluoride, total particulate, particulate fluoride, and sulphur dioxide. Work has continued on the two yearly investigation to determine overall Potline roof louvre discharges and verification of the Line 2A sampling manifold.

Dispersion

Wind speeds were generally similar to 1999 with westerly winds again more frequent during 2000 compared with 1998. Rainfall for 2000 was about average with the summer drier than normal, spring wetter than normal, and autumn and winter rainfall about normal.

Vegetation

Ambient air gaseous and particulate fluoride concentrations during 2000 were lower than those reported for 1999, but similar to previous years.

The fluoride concentrations of ungrazed grass and pinus radiata needles close to the smelter were higher during 2000 than during 1999. Fluoride concentrations off Comalco land were similar to the fluoride concentrations reported for 1999.

The fluoride concentrations of grazed grass for all monitoring farms and cattle urine and cattle bone on GMF4 were within permit standards during 2000 and similar to previous years.

Liquid Discharges

Discharges from drains and of treated effluent and their effects on the environment were within permit standards and similar to previous years.

The faecal coliform concentration in groundwater down stream of the treated sewage disposal area decreased significantly during 2000 compared with 1999.

Landfill

Monitoring of groundwater near the NZAS landfill during 2000 generally indicated similar results to 1999. Bores located downstream of the landfill face had increased concentrations of nitrogen species and fluoride indicating the proximity of the bore to the MRP fines storage area. This increase is unlikely to significantly effect the receiving seawater in Foveaux Strait.

Introduction

This report outlines NZAS' commitment to maintaining and where possible improving the smelter's environmental performance.

This report includes some of the annual reports forwarded to the Southland Regional Council (SRC) each year with additional sections including discharges to air, dispersion conditions, liquid discharges etc. included to cover NZAS' discharges to, and effects on, the environment.

Operations at NZAS remained stable throughout 2000 with continued improvements associated with the issue of air burn of anodes in the reduction cells. Initiatives to improve the smelter's efficiency continued throughout the year.

The data is provided in summaries, maps and where appropriate as graphs. Analysis of trends and other comments are also included where appropriate.

Discharges into Air

Introduction

Discharges into air from the smelter and wharf are covered by Air Discharge Permit Number 93566. The permit conditions were revised following NZAS' application to change or cancel some conditions, which was approved by the Southland Regional Council on 5 August 1998.

This Chapter covers:

- Main Stack Discharges,
Including annual survey of Polycyclic Aromatic Hydrocarbon analysis of Carbon Bake Furnace ducts.
- Potline roof louvre discharges,
- Fluoride discharges into air,
- Baghouse discharges,
- Main Stack plume opacity, and
- Sulphur contents of raw materials and fuels used in the aluminium smelting process.

Main Stack Discharges

Monitoring results

The following table shows the average main stack monitoring results for 2000. The averages are equivalent to the 12 month running average for the period ending December 2000.

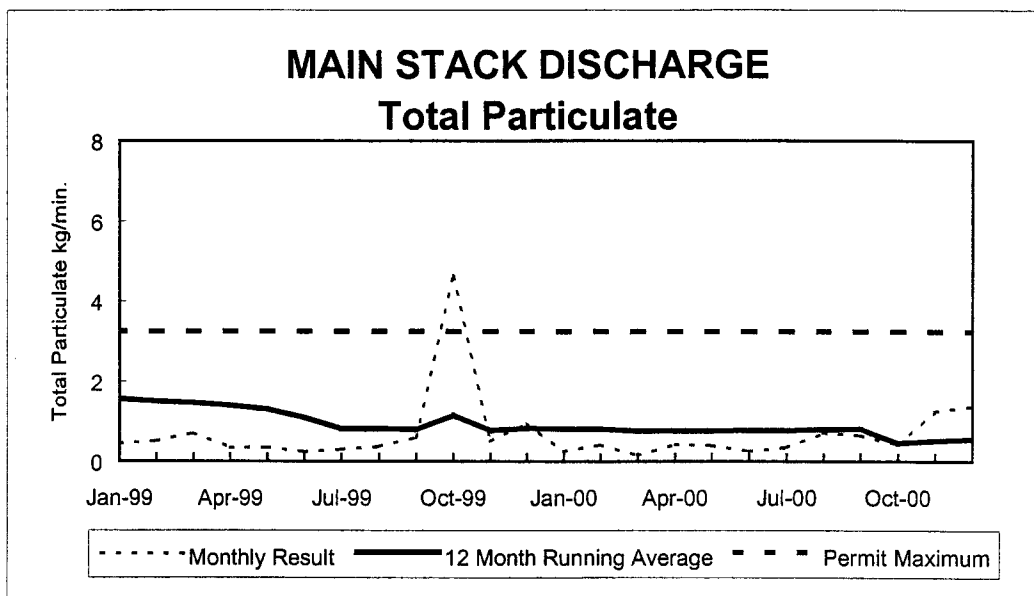
Parameter	Units	Running 12 month average		
		Standard	2000 Result Annual	Maximum for any month
Gas flow rate	Sm ³ /min	-	60,600	-
Total particulate	kg/min	3.25	0.71	0.81
Gaseous fluoride	kg/min	0.65	0.14	0.15
Particulate fluoride	kg/min	1.94	0.03	0.04
Sulphur dioxide	kg/min	-	13.1	13.3
Total condensable hydrocarbons	kg/min	-	0.11	-
Polycyclic aromatic hydrocarbons	kg/min	-	0.01	-

Main Stack Discharges, Continued

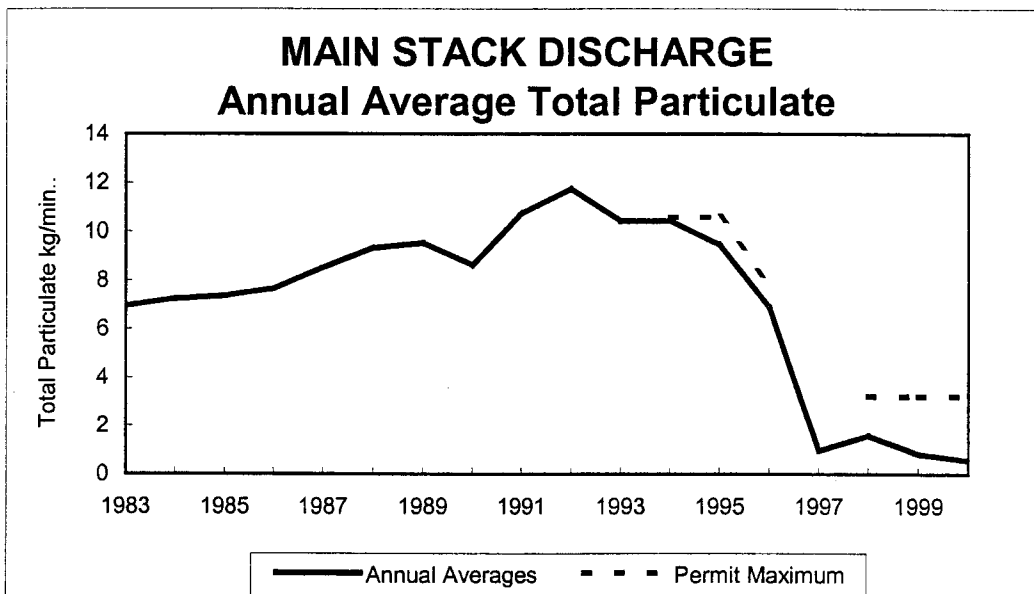
Total particulate

Standard: 12 month running average not to exceed 3.25 kg/min.

The following graph show both the average monthly and 12 monthly running average main stack total particulate discharge during 1999 and 2000.



The following graph shows the annual average main stack total particulate discharge.

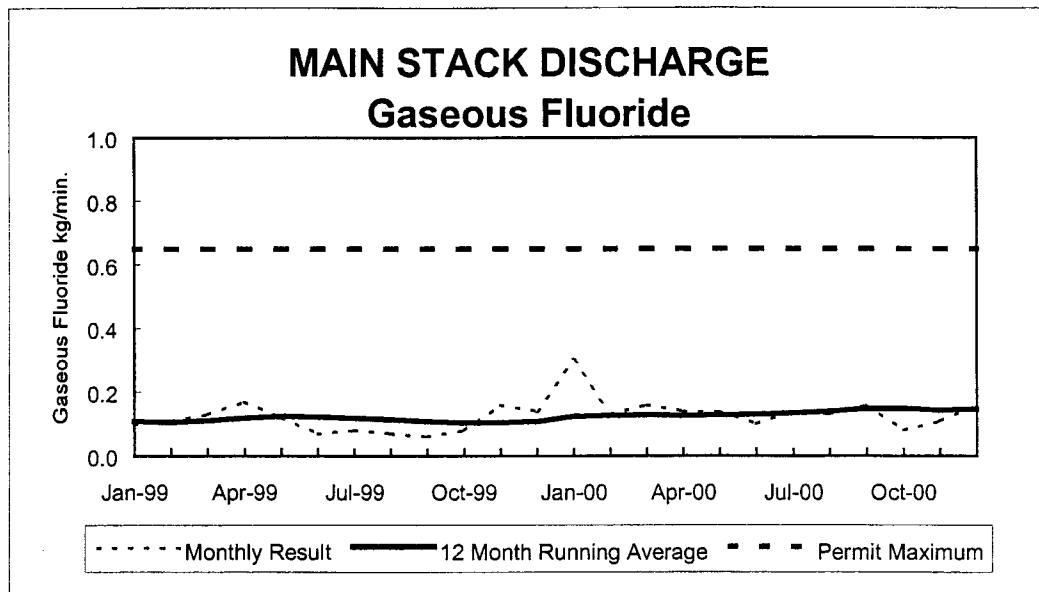


Main Stack Discharges, Continued

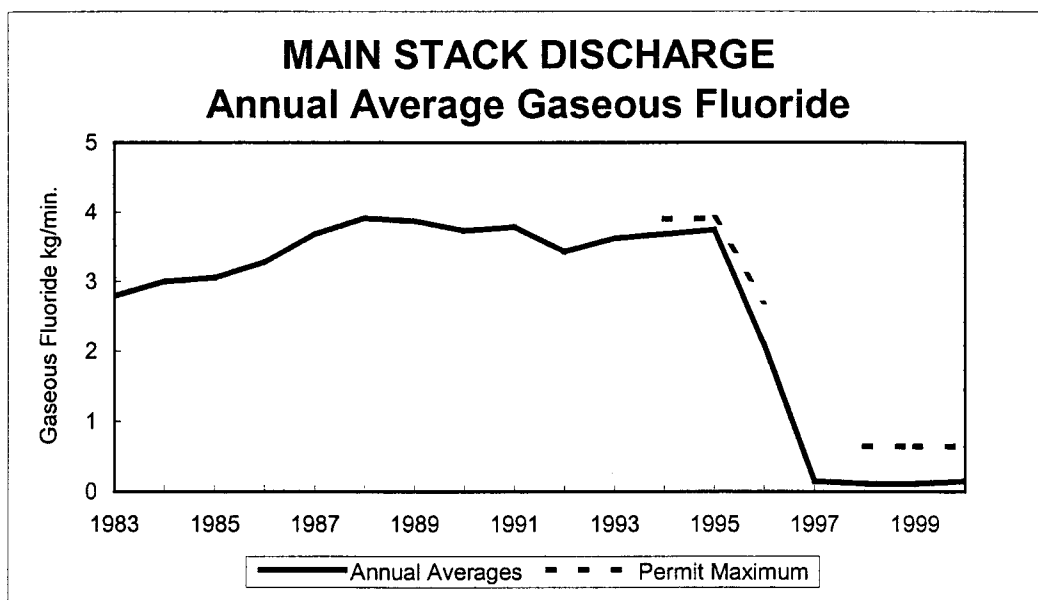
Gaseous fluoride

Standard: 12 month running average not to exceed 0.65 kg/min.

The following graph show both the average monthly and 12 monthly running average main stack gaseous fluoride discharge during 1999 and 2000.



The following graph shows the annual average main stack gaseous fluoride discharge.

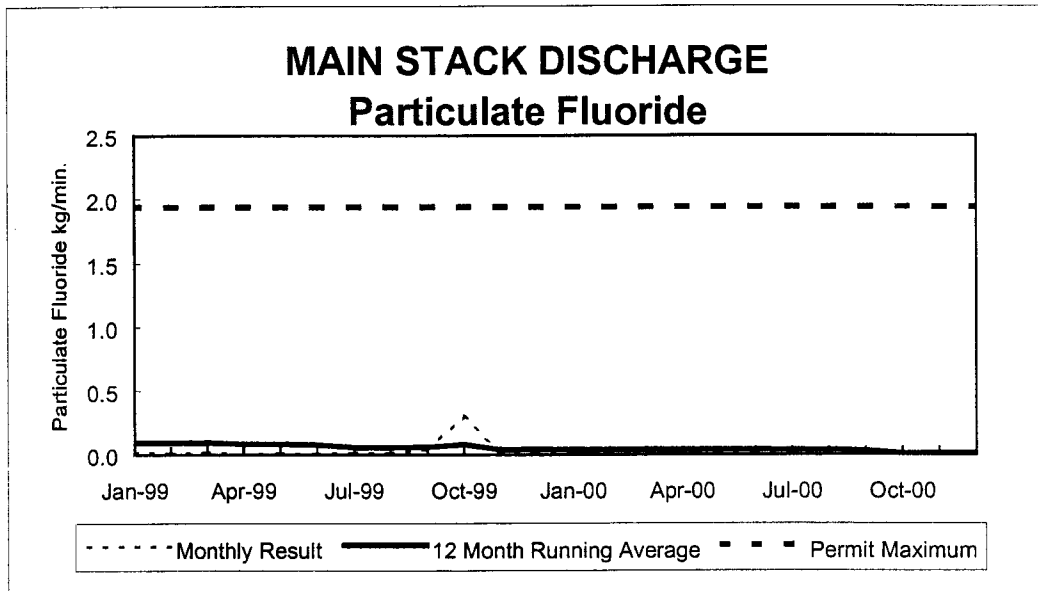


Main Stack Discharges, Continued

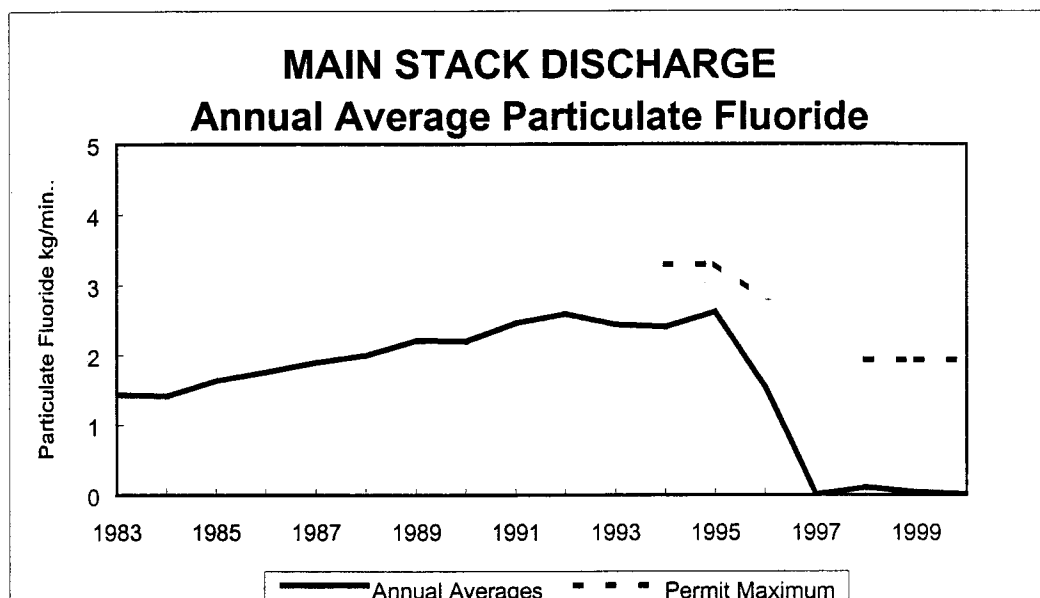
Particulate fluoride

Standard: 12 month running average not to exceed 1.94 kg/min.

The following graph shows both the average monthly and 12 monthly running average main stack particulate fluoride discharge during 1999 and 2000.



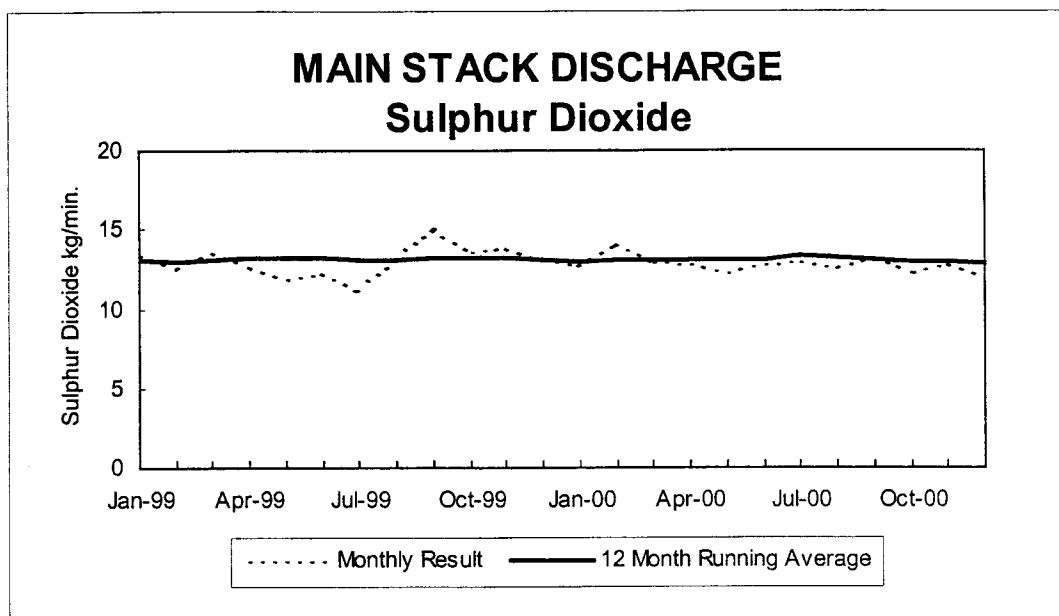
The following graph shows the annual average main stack particulate fluoride discharge.



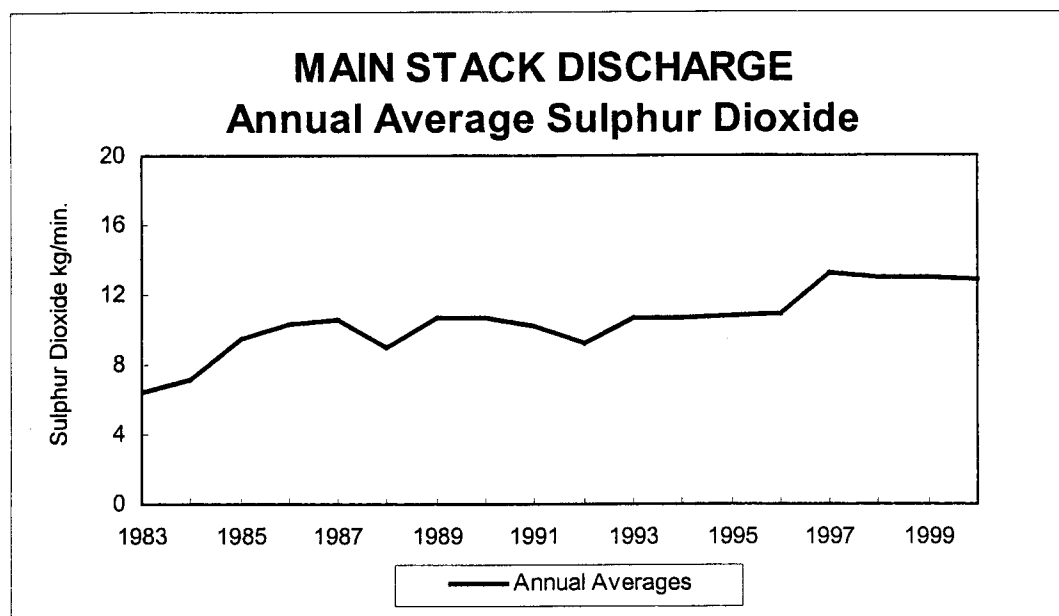
Main Stack Discharges, Continued

Sulphur Dioxide

The following graph shows both the average monthly and 12 monthly running average main stack sulphur dioxide discharge during 1999 and 2000.



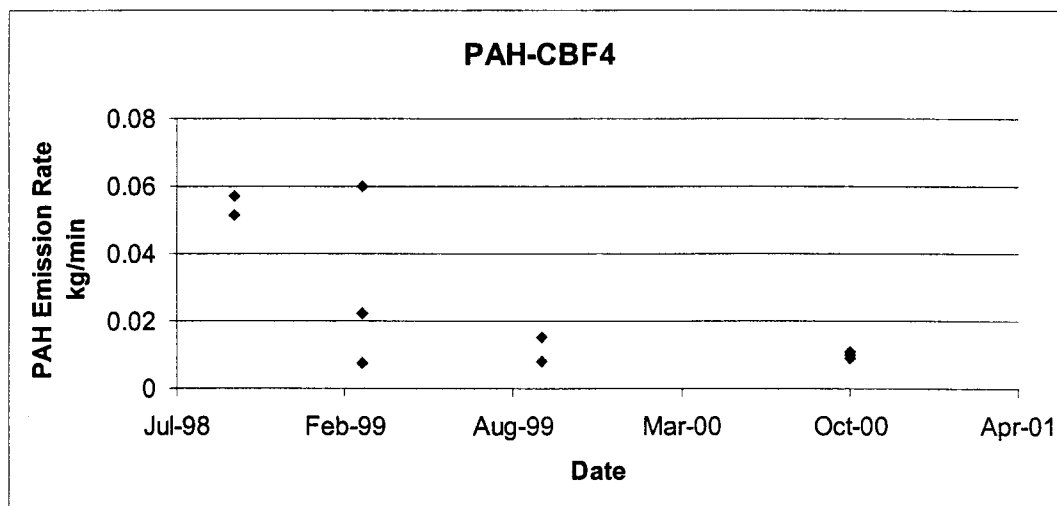
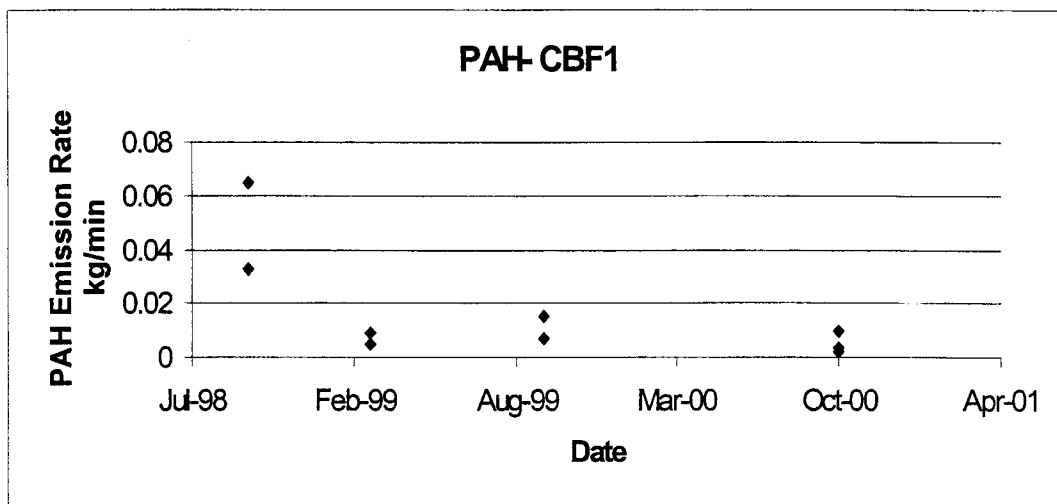
The following graph shows the annual average main stack sulphur dioxide discharge.



Main Stack Discharges, Continued

Polycyclic Aromatic Hydrocarbon analysis of Carbon Bake Furnace ducts.

The annual analysis of the Carbon Bake Furnace ducts, CBF1 and CBF4 was carried out during October 2000.



Polycyclic Aromatic Hydrocarbon emissions for 2000 were similar to 1999, and continued to decrease from those observed during 1998.

Main Stack Discharges, Continued

Comments

Discharges of total particulate, gaseous fluoride and particulate fluoride from the main stack were within the permit standards throughout 2000.

The high gaseous result of 0.30 kg/min for January coincided with a period of non-routine operation of the main stack dry scrubber system. One reactor was operated for a period of nine hours without alumina feed, in preparation for filter maintenance.

During November and December the main stack discharge rate for total particulate was 1.25 and 1.38 kg/min. On investigation it was found that the increased discharges were the result of broken bags in the dry scrubber system and these have now been replaced. A test after the repairs had been completed, showed a total particulate discharge rate of 0.27kg/min, which is within normal operating range.

The main stack sulphur dioxide discharges for 2000 were similar to those reported in 1999 (12 month averages 13.1 kg/min and 13.0 kg/min respectively). Polycyclic Aromatic Hydrocarbon (PAH) emissions continued to decrease from the relatively high levels detected in 1998. Analysis of the Carbon Bake Furnaces (1 and 4) Duct indicate a similar decrease in PAH emissions.

Potline Roof Louvre Discharges

Monitoring results

The table below shows the Potline roof louvre monitoring results for 2000. The permit standards are for 12 month running averages.

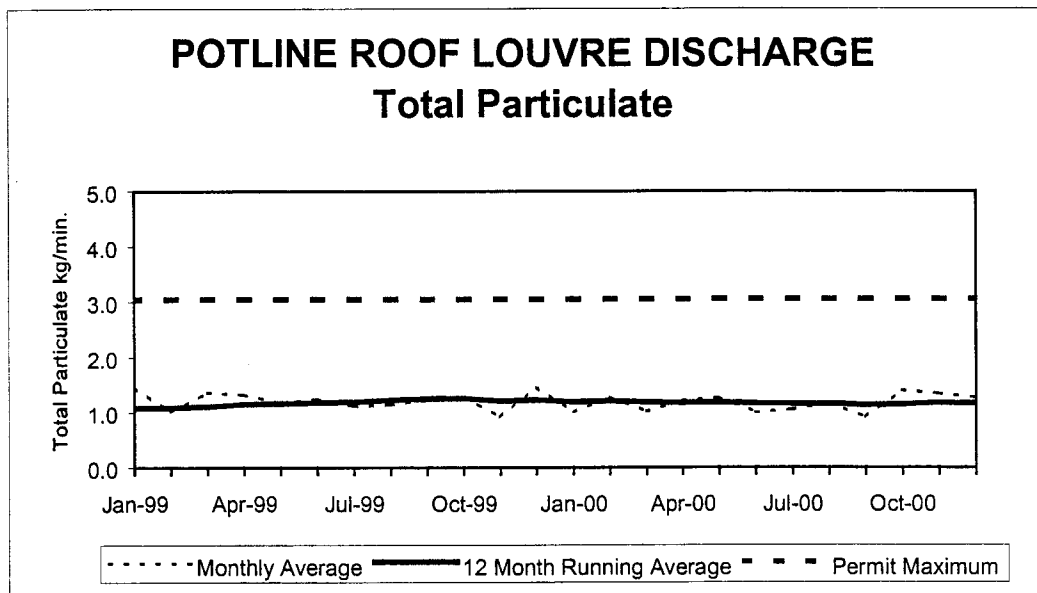
Parameter	Units	Running 12 month average		
		Standard	2000 Result Annual	Maximum for any month
Total particulate	kg/min	3.05	1.16	1.21
Gaseous fluoride	kg/min	0.38	0.13	0.13
Particulate fluoride	kg/min	0.38	0.19	0.20
Sulphur dioxide	kg/min	-	0.29	0.30

Potline Roof Louvre Discharges, Continued

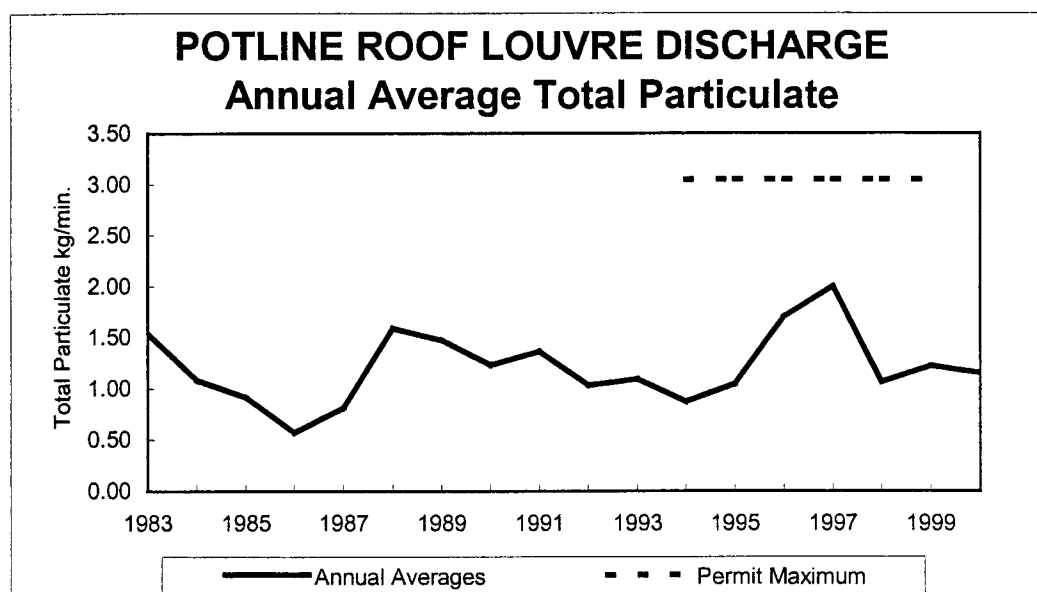
Total particulate

Standard: 12 month running average not to exceed 3.05 kg/min.

The following graph shows both the average monthly and 12 month running average Potline roof louvre total particulate discharge during 1999 and 2000.



The following graph shows the annual average Potline roof louvre total particulate discharge.

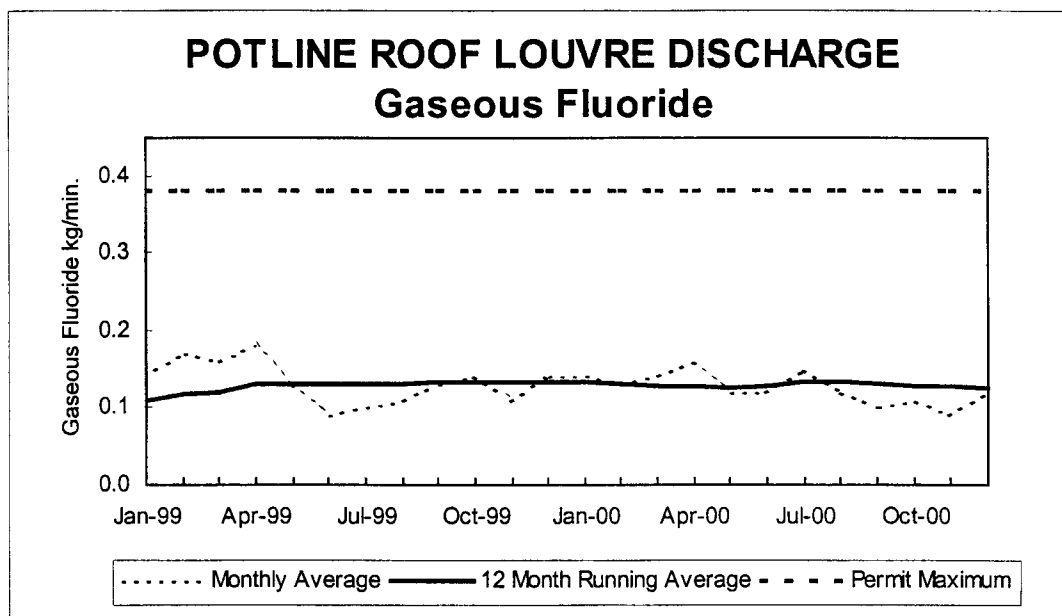


Potline Roof Louvre Discharges, Continued

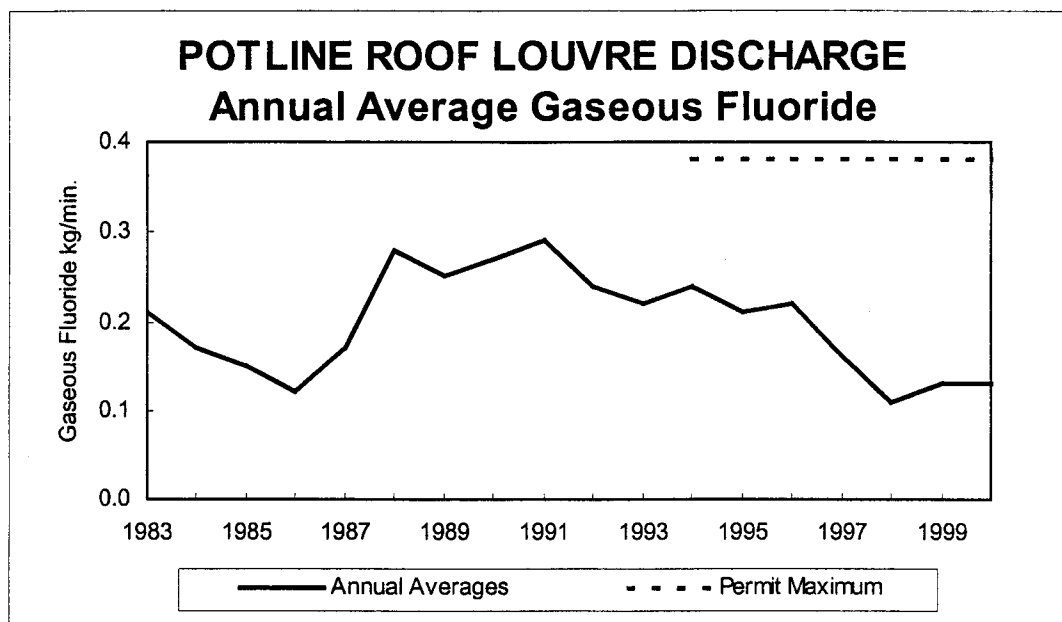
Gaseous fluoride

Standard: 12 month running average not to exceed 0.38 kg/min.

The following graph shows both the average monthly and 12 month running average Potline roof louvre gaseous fluoride discharge during 1999 and 2000.



The following graph shows the annual average Potline roof louvre gaseous fluoride discharge.

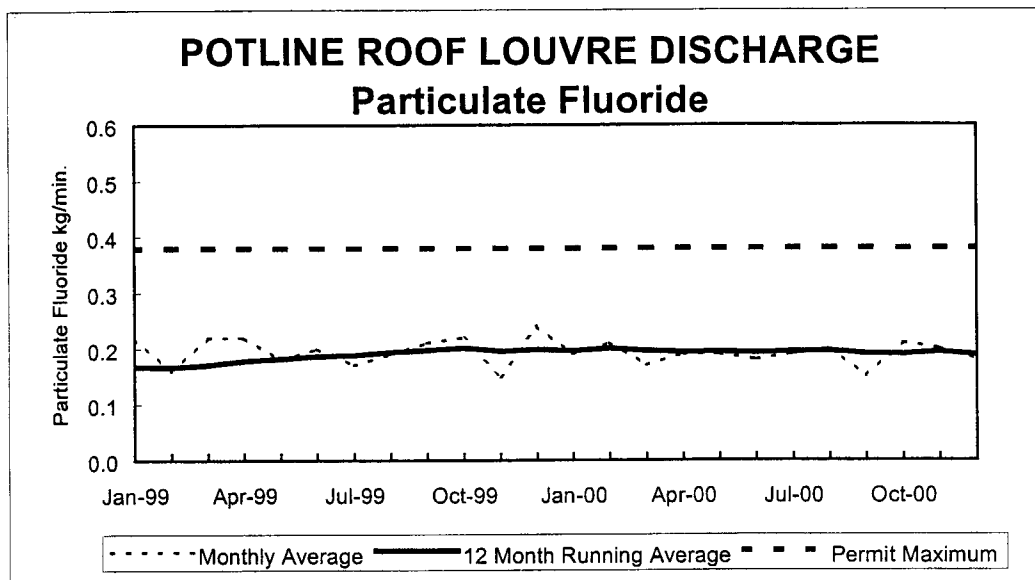


Potline Roof Louvre Discharges, Continued

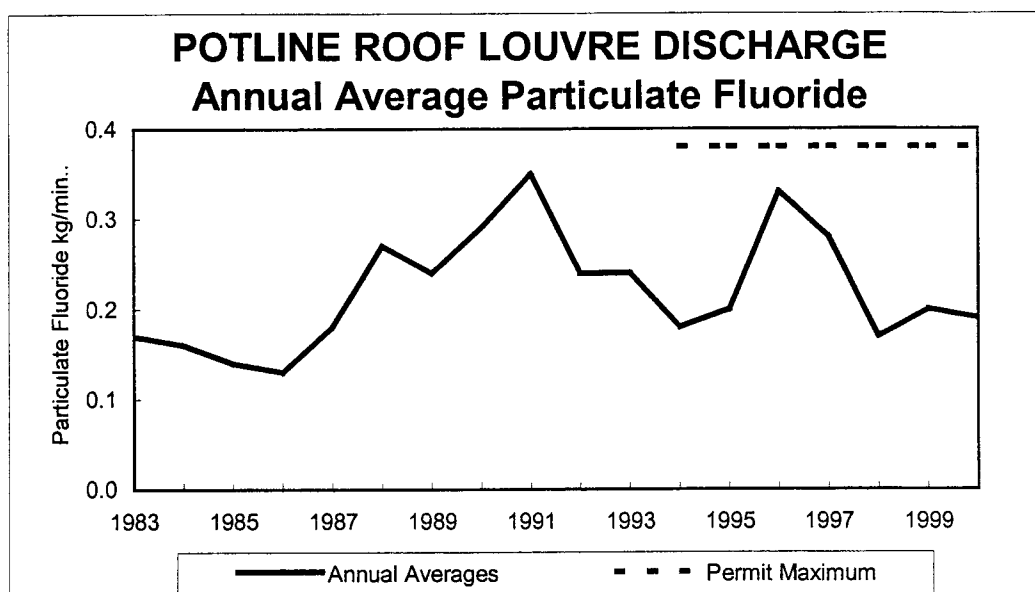
Particulate fluoride

Standard: 12 month running average not to exceed 0.38 kg/min.

The following graph shows both the average monthly and 12 month running Potline roof louvre particulate fluoride discharge during 1999 and 2000.



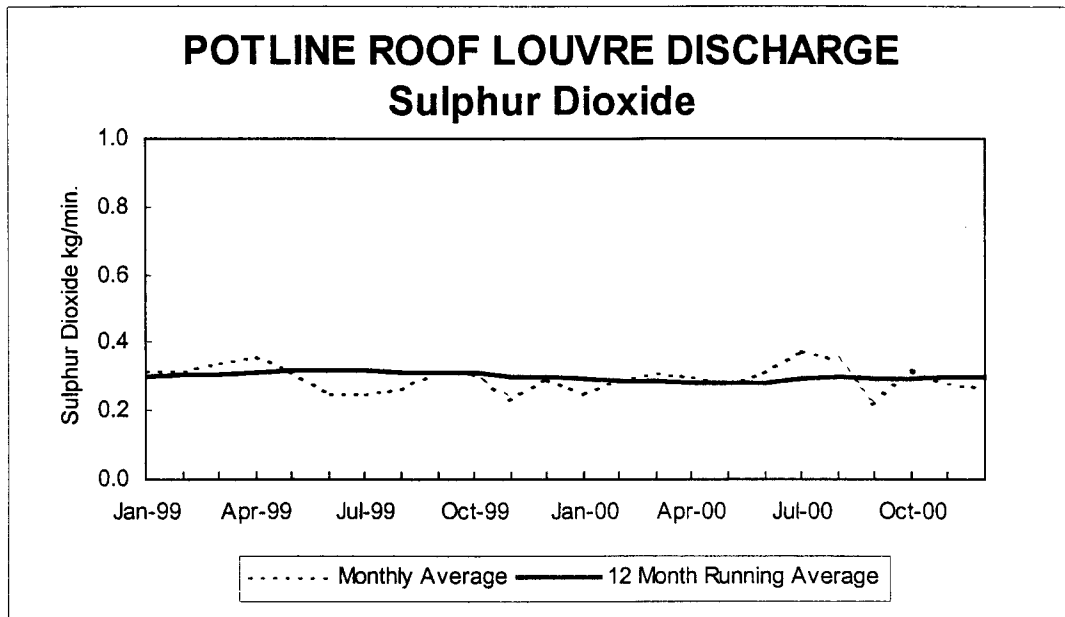
The following graph shows the annual average data for Potline roof louvre particulate fluoride discharge.



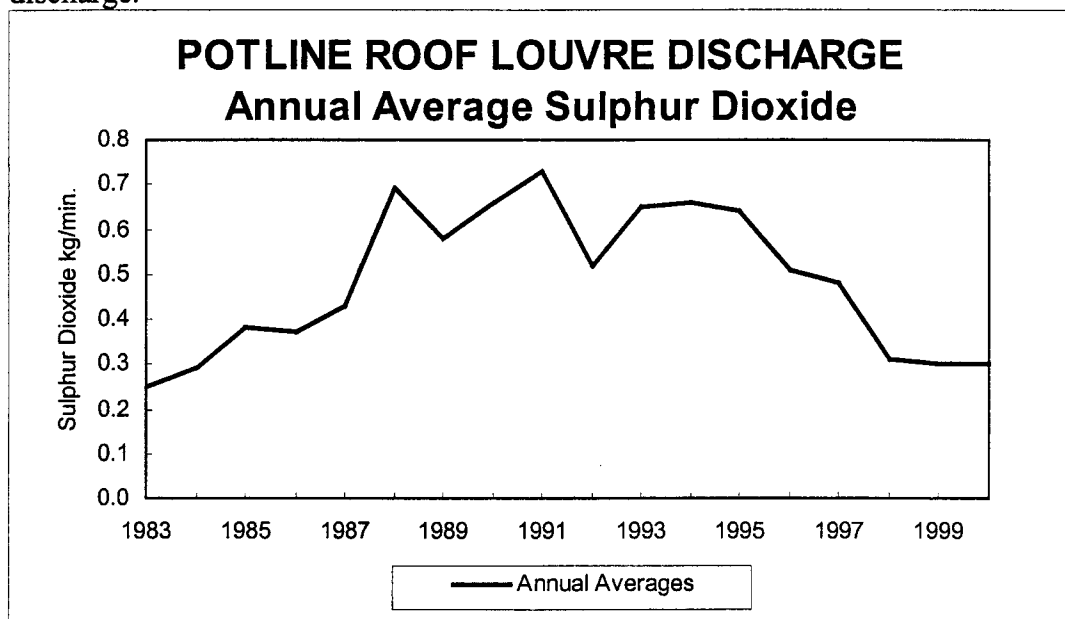
Potline Roof Louvre Discharges, Continued

Sulphur dioxide

The following graph shows both the average monthly and 12 month running Potline roof louvre sulphur dioxide discharge during 1999 and 2000.



The following graph shows the annual average Potline roof louvre sulphur dioxide discharge.



Potline Roof Louvre Discharges, Continued

Comments

The discharge of total particulate, particulate fluoride and gaseous fluoride from the Potline roof louvres was within permit standards.

The two yearly measurement of Potline roof louvre gas flow and verification of the Line 2A sampling manifold, due 1999/2000 is still incomplete due to technical difficulties with the measurement method. The anticipated completion date is mid-2001.

The measurements indicate that there has been a concentration increase in gaseous fluoride, total particulate, particulate fluoride, and sulphur dioxide. Of particular significance is an increase of up to 20 % in gaseous fluoride concentration (based on unchanged flowrates).

Work continues on verifying the average flow through the Potline roof louvres, and studying effects associated with the change to side louvre height (1999) and operational changes to increase metal production.

Prior to 1999, Potline side louvre heights were orientated lower than the original building design specifications. In 1999 the side louvres were raised above the specifications to provide a healthier working environment for staff working in Potlines. This alteration to side louvre height appears to have affected the dispersion characteristics of Reduction gases through the roof and side louvres.

In association with the plant upgrade in 1996/1997, all Reduction cell hood covers were replaced. This coincided with a decrease in Potline roof louvre emissions. Normal physical deterioration of the covers may effect their efficiency in containing cell fumes. This change in cover efficiency would have contributed to the increase in fluoride concentrations we are now observing.

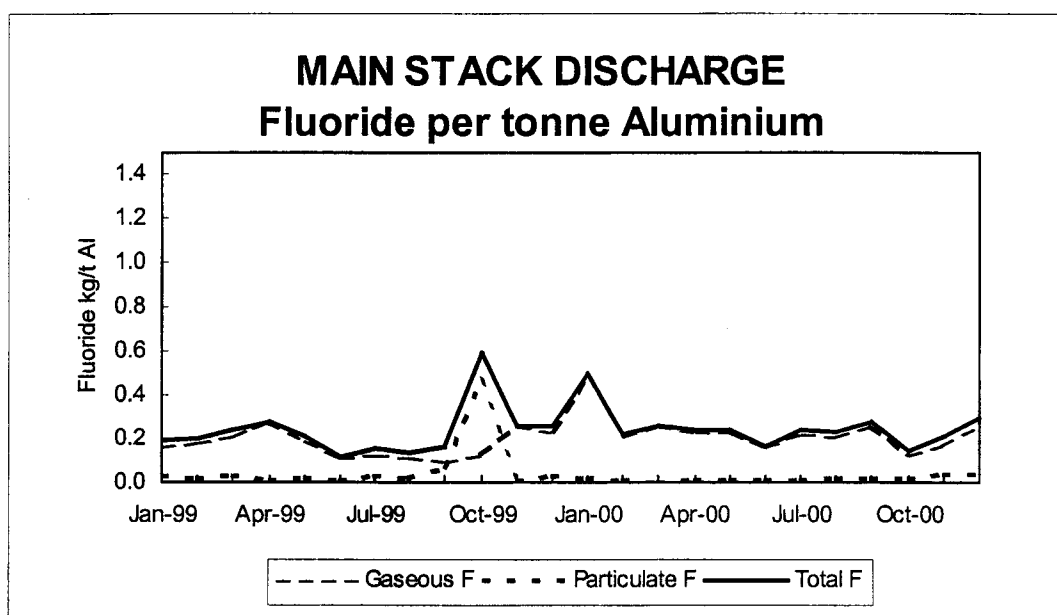
Fluoride Discharges

Performance data

The table below shows the fluoride discharges expressed as a ratio of hot aluminium metal production during 2000.

Parameter	Units	2000 Result Annual	Maximum for any month
Main Stack			
• Gaseous fluoride	kg/t Al	0.23	0.48
• Particulate fluoride	kg/t Al	0.02	0.04
• Total fluoride	kg/t Al	0.25	0.49
Reduction Line Roof Louvres			
• Gaseous fluoride	kg/t Al	0.20	0.26
• Particulate fluoride	kg/t Al	0.30	0.34
• Total fluoride	kg/t Al	0.50	0.56
Plant			
• Gaseous fluoride	kg/t Al	0.43	0.70
• Particulate fluoride	kg/t Al	0.32	0.35
• Total fluoride	kg/t Al	0.75	1.02

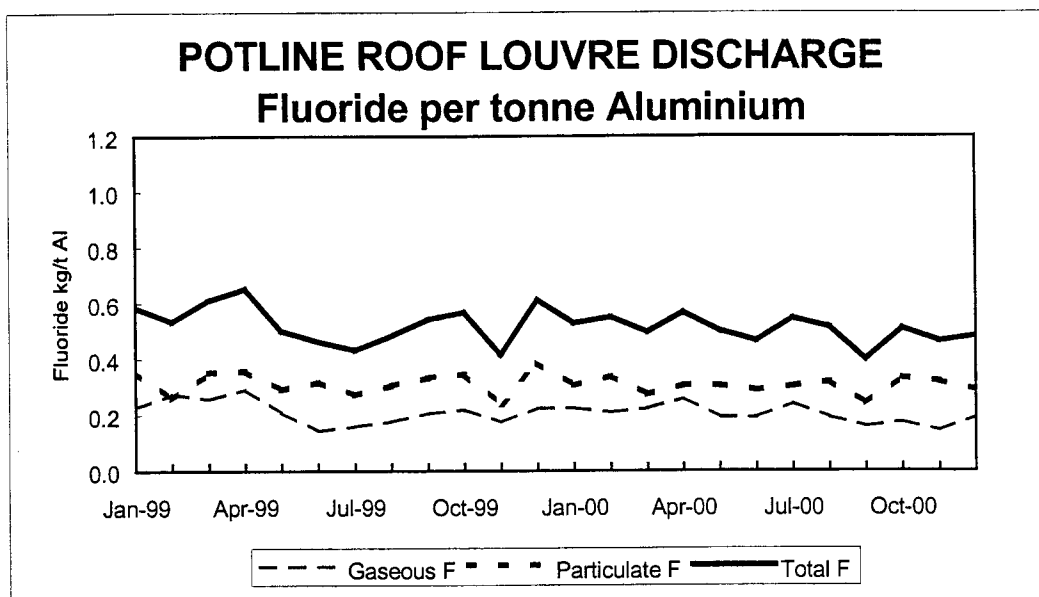
The following graph shows the monthly main stack fluoride per tonne aluminium discharge during 1999 and 2000.



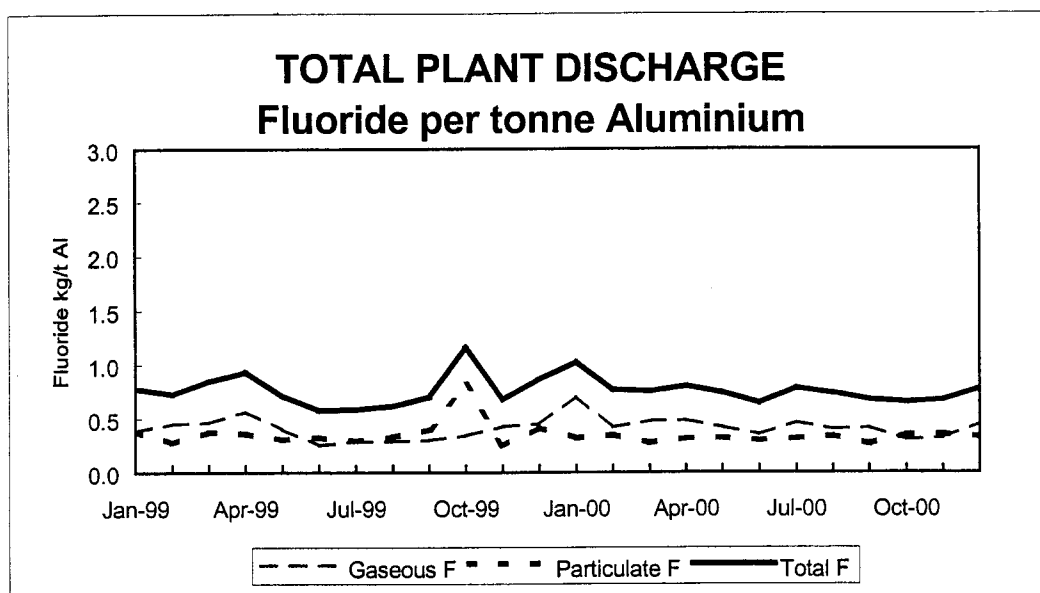
Fluoride Discharges, Continued

Performance data, Continued

The following graph shows the average monthly Potline roof louvre fluoride per tonne aluminium discharge during 1999 and 2000.



The following graph shows the average total plant fluoride per tonne aluminium during 1999 and 2000.



Comments

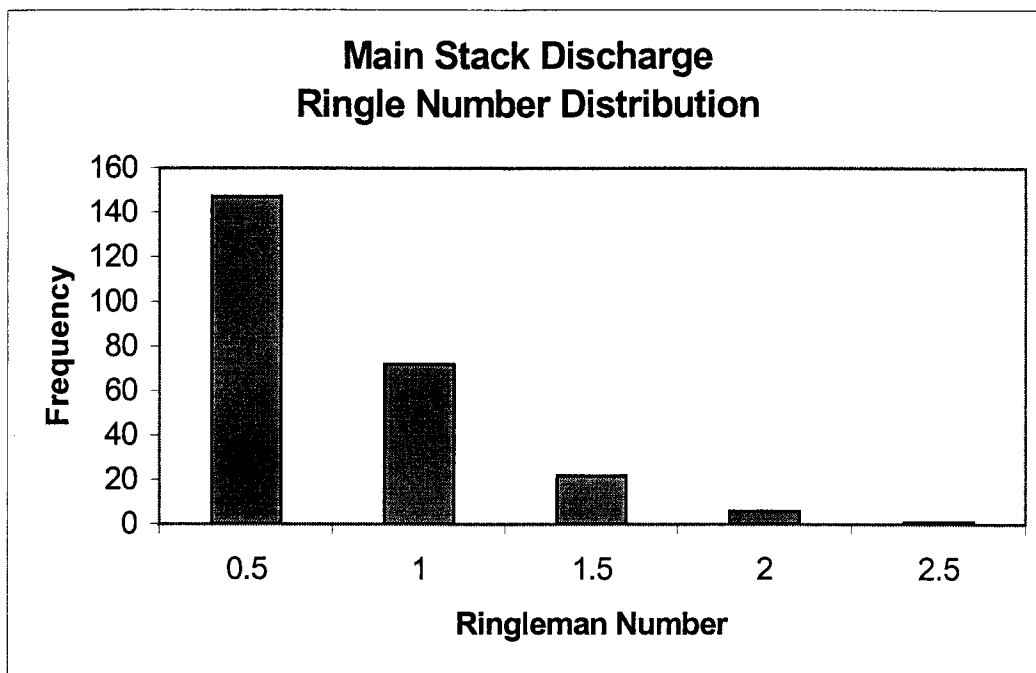
The fluoride discharge rate from the plant was generally stable during 2000.

Baghouse Discharges

The Regular inspection of the baghouse discharges continued during 2000. These inspections were in addition to the on-going operational surveillance of this equipment. Monthly inspections across all dust collector equipment reported emissions (using the six-point observation scale) to be between 0 and 1, a score of 1 being "barely discernable emissions".

Main Stack Plume Opacity

Main Stack plume opacity is determined by visual observations using the standard Ringleman chart. The following graph summarises the observations recorded during 2000.



The visual observations indicate that the main stack plume was similar to 1999.

Sulphur Content of Raw Materials and Fuels

The following table shows the maximum, minimum, and average sulphur content of raw materials and fuels delivered to the smelter during 2000.

Material	Units	Permit Maximum	2000 Annual Average	2000 maximum	2000 minimum
PetroleumCoke	%	3.0	2.69	2.88	2.61
Pitch	%	1.0	0.44	0.46	0.43
HeavyFuel Oil	%	3.5	2.16	2.39	1.84

Comments

All shipments of raw materials and fuels during the 2000 met permit standards for sulphur contents.

The average sulphur content of the petroleum coke and pitch during 2000 was lower than that reported for 1999. The average sulphur content of heavy fuel oil during 2000 was similar to that reported for 1999.

Dispersion Conditions

Introduction

This chapter covers the monitoring of meteorological conditions at the Tiwai Point meteorological station. These conditions effect the dispersion of discharges into air from the smelter. The data includes

- the distribution of wind strength,
- the distribution of wind direction, and
- rainfall.

Meteorological Conditions

The mean wind frequency diagram on the following page shows that the 2000 wind pattern was dominated by westerly and north westerly winds.

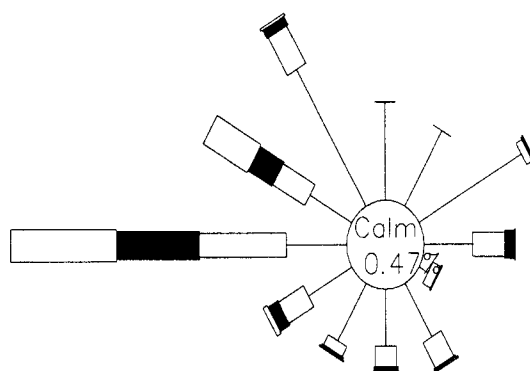
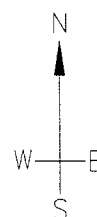
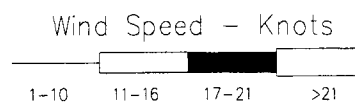
The following table shows the predominant winds and total rainfall recorded for each month during 2000.

Month	Predominant Wind Direction	Rainfall (mm)
January	West, south and south east	91
February	West and north west	76
March	West and north west	68
April	West and north west	66
May	West, north and north east	151
June	West, north west, north east and south	110
July	West, north west and east	70
August	West, north west and east	58
September	West, north west and east	77
October	West, north west	132
November	West, south west and south east	77
December	West and north west	98

Meteorological Conditions, Continued

NEW ZEALAND ALUMINIUM SMELTERS LIMITED – TIWAI POINT
WORKPLACE AND ENVIRONMENTAL MONITORING OUTPUT TEAM
MEAN WIND FREQUENCY (%) OF SURFACE WIND DIRECTIONS
PERIOD: SUMMARY 2000

Scale:



% Time at	
1-10 Knots	56.3
11-16 Knots	20.5
17-21 Knots	10.9
>21 Knots	11.9
Calm	0.47

Ambient Air

Introduction

This chapter covers the monitoring for gaseous and particulate fluorides in ambient air at six monitoring sites. Also covered are the changes to the one month sampling period at most sites.

Permit Standards

The standards for ambient air gaseous fluoride covered by the air discharge permit are:

- 24 hour average $2.0 \mu\text{g}/\text{m}^3$
- 7 day average $1.0 \mu\text{g}/\text{m}^3$
- One month average $0.5 \mu\text{g}/\text{m}^3$

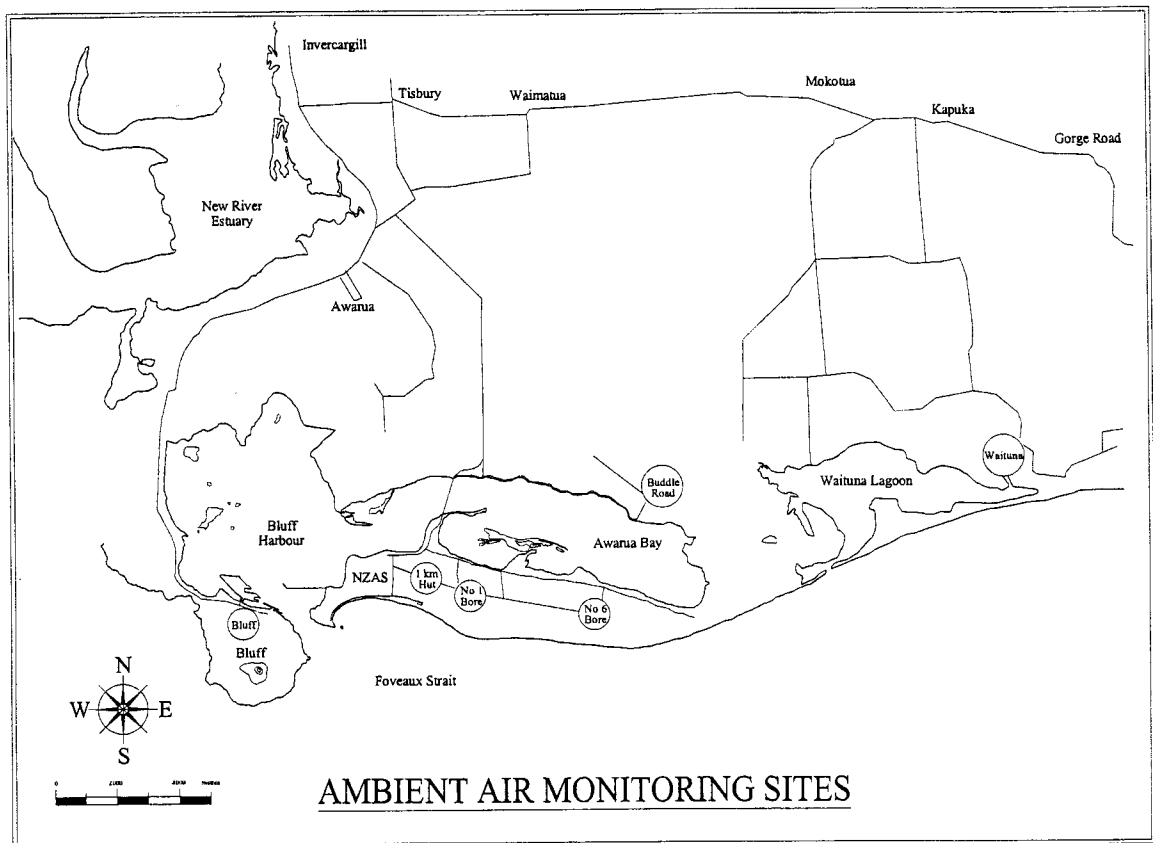
The 24-hour average is not to be exceeded on more than eight days in any twelve consecutive months.

The standards apply to measurements on land off Tiwai Peninsula and on Tiwai Peninsula east of Comalco New Zealand Ltd's freehold land.

The analytical method used is referenced to ASTM 3580.1991 and has a detection limit of $0.1 \mu\text{g}/\text{m}^3$.

Site Locations

The locations of the monitoring sites are shown in following map.



Ambient Air at 1 Kilometre Hut

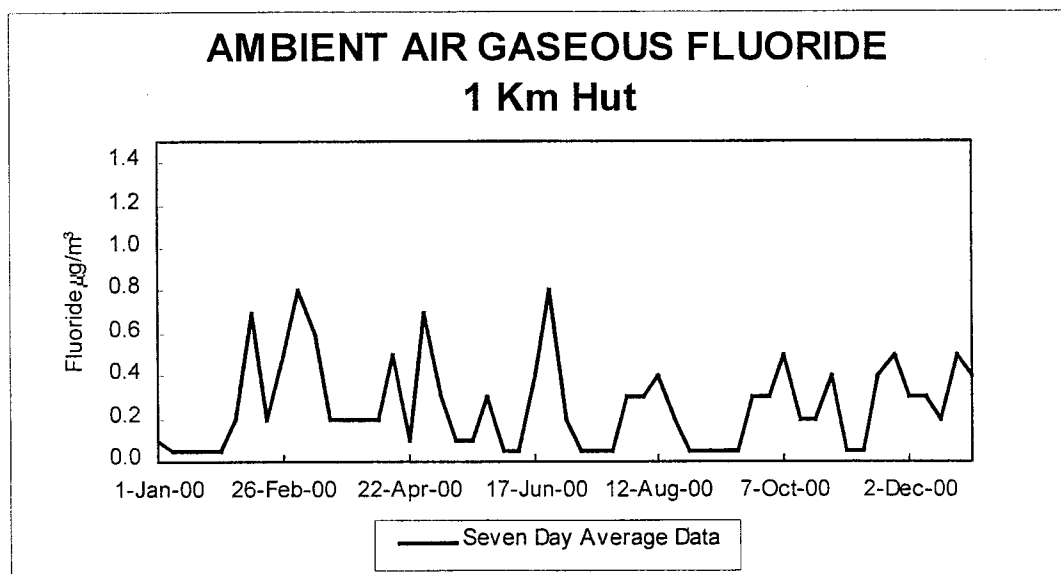
Monitoring results

The following table summarises the monitoring results during 1999 and 2000. The sampling frequency for ambient air fluoride at this site is seven days.

Parameter	Units	Standard	1999	2000
Gaseous fluoride concentration				
• Max 7 day average	$\mu\text{g}/\text{m}^3$	-	1.3	0.8
• Max monthly average	$\mu\text{g}/\text{m}^3$	-	0.5	0.4
• Annual Average	$\mu\text{g}/\text{m}^3$	-	0.3	0.25
Particulate fluoride concentration				
• Max 7 day average	$\mu\text{g}/\text{m}^3$	-	0.4	0.3
• Max monthly average	$\mu\text{g}/\text{m}^3$	-	0.2	0.1
• Annual Average	$\mu\text{g}/\text{m}^3$	-	<0.1	<0.1

Gaseous fluoride

The following graph shows the seven day average gaseous fluoride results for this site.

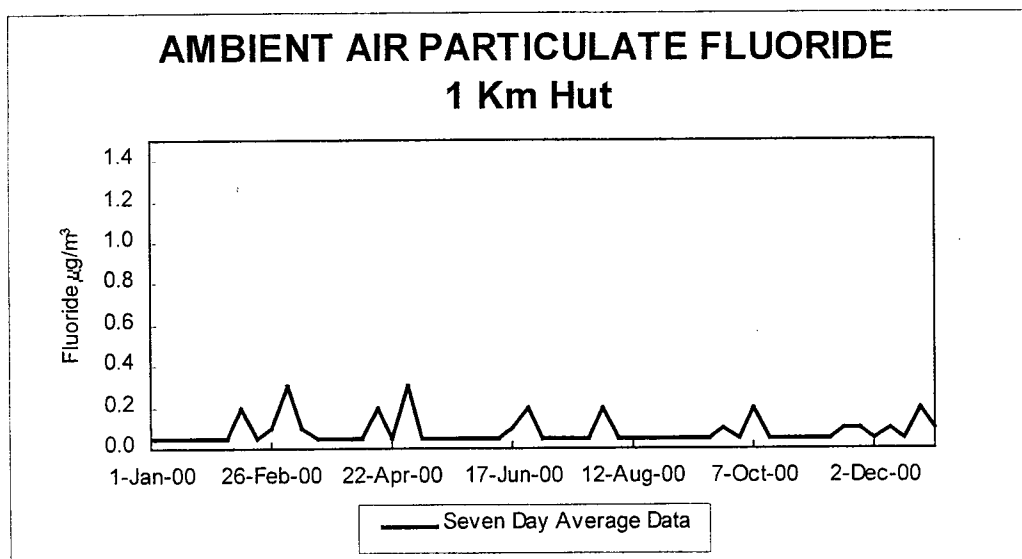


Note: Concentrations less than $0.1 \mu\text{g}/\text{m}^3$ are plotted as $0.05 \mu\text{g}/\text{m}^3$

Ambient Air at 1 Kilometre Hut, Continued

Particulate Fluoride

The following graph shows the seven day average particulate fluoride results for this site.



Note: Concentrations less than $0.1 \mu\text{g}/\text{m}^3$ are plotted as $0.05 \mu\text{g}/\text{m}^3$

Comments

All results for this site are below the permit standards that apply to areas located at greater distances from the smelter.

Ambient Air at Other Sites on Tiwai Peninsula

Monitoring results

The following table summarises the monitoring results during 1999 and 2000 for the two other sites located on Tiwai Peninsula.

Site	Parameter	Units	Standard	1999	2000
No.1 Bore	Gaseous fluoride concentration				
	• Max 7 day average	$\mu\text{g}/\text{m}^3$	1.0	0.2	< 0.1
	• Max monthly average	$\mu\text{g}/\text{m}^3$	0.5	0.1	< 0.1
	• Annual average	$\mu\text{g}/\text{m}^3$	-	< 0.1	< 0.1
	Particulate fluoride concentration				
	• Max 7 day average	$\mu\text{g}/\text{m}^3$	-	0.2	< 0.1
No.6 Bore	• Max monthly average	$\mu\text{g}/\text{m}^3$	-	< 0.1	< 0.1
	• Annual average	$\mu\text{g}/\text{m}^3$	-	< 0.1	< 0.1
	Gaseous fluoride concentration				
	• Max 7 day average	$\mu\text{g}/\text{m}^3$	1.0	< 0.1	< 0.1
	• Max monthly average	$\mu\text{g}/\text{m}^3$	0.5	< 0.1	< 0.1
	• Annual average	$\mu\text{g}/\text{m}^3$	-	< 0.1	< 0.1
	Particulate fluoride concentration				
	• Max 7 day average	$\mu\text{g}/\text{m}^3$	-	< 0.1	< 0.1
	• Max monthly average	$\mu\text{g}/\text{m}^3$	-	< 0.1	< 0.1
	• Annual average	$\mu\text{g}/\text{m}^3$	-	< 0.1	< 0.1

Comments

Gaseous and particulate fluoride concentrations were close to or below the detection limit of the Australian standard method at these sites and were within the permit standards throughout 2000.

Ambient Air at Sites off Tiwai Peninsula

Monitoring results

The following table summarises the monitoring results during 1999 and 2000 for the three ambient air monitoring sites located off Tiwai Peninsula.

Site	Parameter	Units	Standard	1999	2000
Buddle Road	Gaseous fluoride concentration				
	• Max 7 day average	$\mu\text{g}/\text{m}^3$	1.0	< 0.1	< 0.1
	• Max monthly average	$\mu\text{g}/\text{m}^3$	0.5	< 0.1	< 0.1
	• Annual average	$\mu\text{g}/\text{m}^3$	-	< 0.1	< 0.1
	Particulate fluoride concentration				
	• Max 7 day average	$\mu\text{g}/\text{m}^3$	-	< 0.1	< 0.1
Waituna	• Max monthly average	$\mu\text{g}/\text{m}^3$	-	< 0.1	< 0.1
	• Annual average	$\mu\text{g}/\text{m}^3$	-	< 0.1	< 0.1
	Gaseous fluoride concentration				
	• Max 7 day average	$\mu\text{g}/\text{m}^3$	1.0	< 0.1	< 0.1
	• Max monthly average	$\mu\text{g}/\text{m}^3$	0.5	< 0.1	< 0.1
	• Annual average	$\mu\text{g}/\text{m}^3$	-	< 0.1	< 0.1
Bluff	Particulate fluoride concentration				
	• Max 7 day average	$\mu\text{g}/\text{m}^3$	-	< 0.1	< 0.1
	• Max monthly average	$\mu\text{g}/\text{m}^3$	-	< 0.1	< 0.1
	• Annual average	$\mu\text{g}/\text{m}^3$	-	< 0.1	< 0.1
	Gaseous fluoride concentration				
	• Max 7 day average	$\mu\text{g}/\text{m}^3$	1.0	< 0.1	< 0.1
	• Max monthly average	$\mu\text{g}/\text{m}^3$	0.5	< 0.1	< 0.1
	• Annual average	$\mu\text{g}/\text{m}^3$	-	< 0.1	< 0.1
	Particulate fluoride concentration				
	• Max 7 day average	$\mu\text{g}/\text{m}^3$	-	0.2	< 0.1
	• Max monthly average	$\mu\text{g}/\text{m}^3$	-	< 0.1	< 0.1
	• Annual average	$\mu\text{g}/\text{m}^3$	-	< 0.1	< 0.1

Ambient Air at Sites off Tiwai Peninsula, Continued

Comments

All permit standards were met at the three sites off Tiwai Peninsula throughout 2000.

All gaseous and particulate fluoride concentrations were at or below the detection limit of the Australian standard method at these sites during 2000.

Atmospheric Deposition

Introduction

This chapter covers the monitoring of atmospheric deposition at seven monitoring sites.

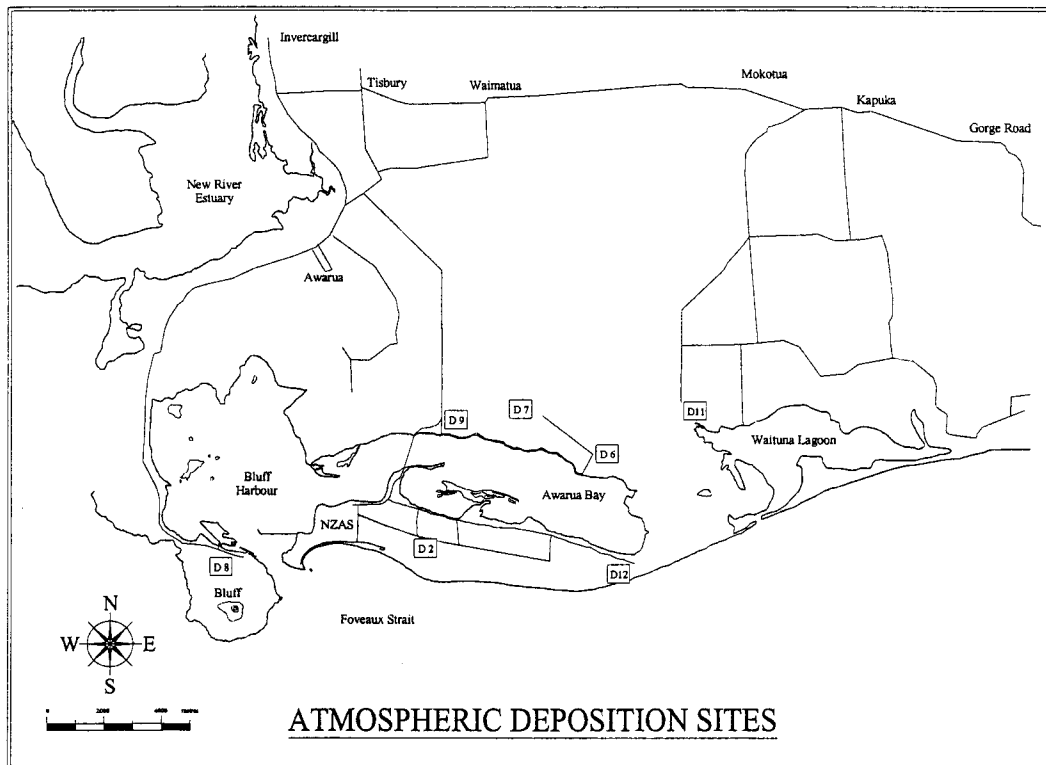
Permit Guidelines

The guidelines for atmospheric deposition apply to sites off Tiwai Peninsula and are shown in the table below.

Parameter	Unit	Guideline
Fluoride:	g.m^{-3}	0.9
Reactive Aluminium		
• Aesthetic highest desirable	g.m^{-3}	0.05
• Aesthetic excessive	g.m^{-3}	0.20

Site Locations

The locations of the monitoring sites are shown in the following map.



Atmospheric Deposition Monitoring Results

Fluoride Deposition

The fluoride atmospheric deposition during 2000 is summarised in the following table.

Site	Units	2000 average	Maximum for any month	Minimum for any month
D2. No.1 Bore ¹	g/m ³	0.29	0.55	0.09
D12 TEF2 ¹	g/m ³	0.05	0.09	<0.05
D6 Buddle Road	g/m ³	0.07	0.16	<0.05
D7 Gibson's Farm	g/m ³	0.05	0.12	<0.05
D8 Bluff	g/m ³	0.05	0.19	<0.05
D9 Awarua Bay Road	g/m ³	<0.05	0.08	<0.05
D11 Marshall Road	g/m ³	<0.05	0.08	<0.05

Note 1: Site located on Tiwai Peninsula and excluded from permit guideline.

Reactive Aluminium Deposition

The reactive aluminium atmospheric deposition during 2000 is summarised in the following table.

Site	Units	2000 average	Maximum for any month	Minimum for any month
D2. No.1 Bore ¹	g/m ³	0.08	0.20	<0.03
D12 TEF2 ¹	g/m ³	<0.03	<0.03	<0.03
D6 Buddle Road	g/m ³	<0.03	<0.03	<0.03
D7 Gibson's Farm	g/m ³	<0.03	0.04	<0.03
D8 Bluff	g/m ³	<0.03	<0.03	<0.03
D9 Awarua Bay Road	g/m ³	<0.03	0.03	<0.03
D11 Marshall Road	g/m ³	<0.03	<0.03	<0.03

Note 1: Site located on Tiwai Peninsula and excluded from permit guideline.

Atmospheric Deposition Monitoring Results, Continued

Comments

All permit guidelines were met during 2000. Fluoride and reactive aluminium deposition during 2000 was generally within the normal range of results since the commissioning of the main stack dry scrubbing system in 1997.

The highest fluoride and reactive aluminium concentrations measured at most sites during 2000 were determined during March and November. This was most likely due to low rainfall, which resulted in low dilution of material deposited on the raingauge collection surface.

The maximum concentrations of fluoride and reactive aluminium were measured at No.1 Bore during March, and significant values during October to December were also observed.

The predominant wind and strength for this period were westerlies of less than 10 knots. Together with the low rainfall data, this explains the observed higher deposition of fluoride at this site close to, and 'down-wind' of the smelter.

Conversely, during periods of high rainfalls (October and December) and similar winds, the levels - while significant due to the increase in fallout associated with wet deposition- were lower than the maximum and are associated with a dilution effect on the deposit gauge.

Fluoride in Ungrazed Grasses

Introduction

This chapter covers the monitoring of fluoride in ungrazed grasses at 23 monitoring sites located at Bluff, Green Hills, Awarua Plains, Waituna Wetlands and Tiwai Peninsula.

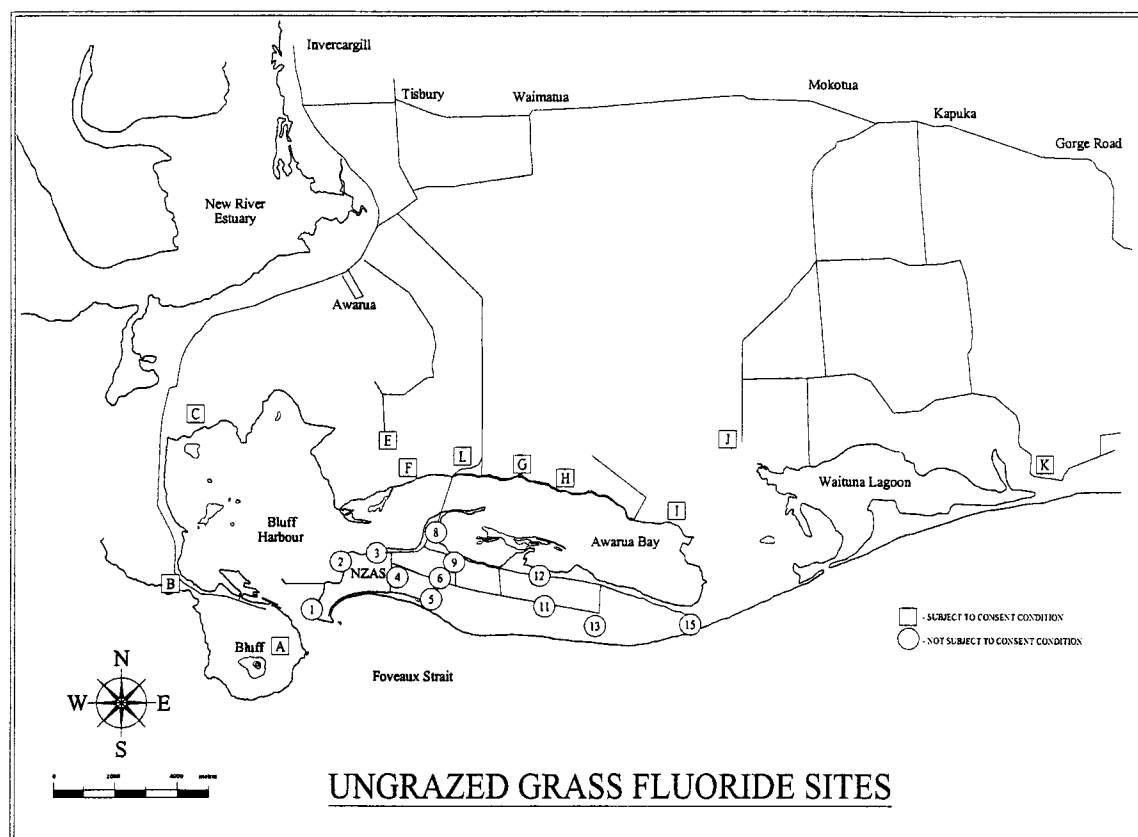
Permit Guidelines

The guidelines for fluoride in ungrazed grasses (on an unwashed, dry weight basis) on land off Tiwai Peninsula are detailed below. These guidelines came into effect in April 1994.

- Monthly sample shall not exceed 80 mg/kg more than once in any 12 consecutive months.
- Running average of any two consecutive months shall not exceed 60 mg/kg.
- Running average of any 12 consecutive months shall not exceed 40 mg/kg.

Site Locations

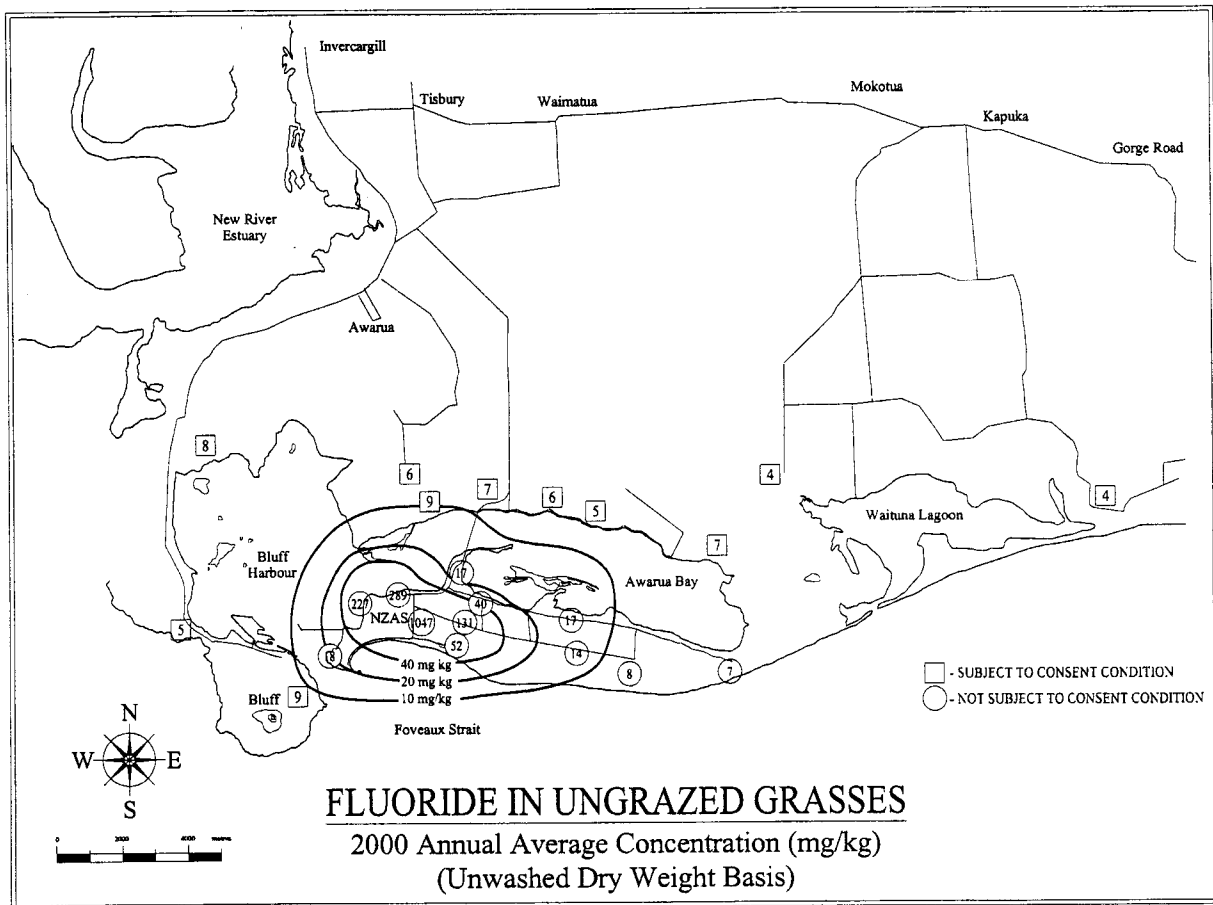
The ungrazed grass monitoring sites are shown on the following map.



Ungrazed Grass Monitoring Results

Annual average fluoride concentrations

The 2000 average ungrazed grass fluoride concentrations are shown in the following map.



Ungrazed Grass Monitoring Results, Continued

Monthly maximum concentration

The following table shows the maximum monthly fluoride concentrations for sites off Tiwai Peninsula during 2000.

Sites off Tiwai Peninsula	Permit Guideline not to be exceeded more than once in any 12 consecutive months mgF/kg	Maximum Monthly Result During 2000 MgF/kg
Ungrazed Grass Site A	80	23
Ungrazed Grass Site B	80	17
Ungrazed Grass Site C	80	20
Ungrazed Grass Site E	80	13
Ungrazed Grass Site F	80	13
Ungrazed Grass Site G	80	12
Ungrazed Grass Site H	80	8
Ungrazed Grass Site I	80	12
Ungrazed Grass Site J	80	8
Ungrazed Grass Site K	80	6
Ungrazed Grass Site L	80	15

The monthly fluoride concentration in ungrazed grass was within the permit guideline for all sites during 2000.

Ungrazed Grass Monitoring Results, Continued

Two month average concentration

The following table shows the maximum two month running average fluoride concentrations for sites off Tiwai Peninsula during 2000.

Sites off Tiwai Peninsula	Permit Guideline	Maximum Two Month Running Average During 2000
	mgF/kg	mgF/kg
Ungrazed Grass Site A	60	15
Ungrazed Grass Site B	60	11
Ungrazed Grass Site C	60	13
Ungrazed Grass Site E	60	9
Ungrazed Grass Site F	60	12
Ungrazed Grass Site G	60	9
Ungrazed Grass Site H	60	8
Ungrazed Grass Site I	60	12
Ungrazed Grass Site J	60	7
Ungrazed Grass Site K	60	6
Ungrazed Grass Site L	60	11

The two month running average fluoride concentration in ungrazed grass was within the permit guideline for all sites during 2000.

Fluoride in Ungrazed Grasses, Continued

Running 12 month average concentration

The following table shows the maximum 12 month running average fluoride concentrations for sites off Tiwai Peninsula.

Sites off Tiwai Peninsula	Permit Guideline mgF/kg	Maximum 12 Month Running Average During 2000 mgF/kg
Ungrazed Grass Site A	40	10
Ungrazed Grass Site B	40	6
Ungrazed Grass Site C	40	8
Ungrazed Grass Site E	40	6
Ungrazed Grass Site F	40	13
Ungrazed Grass Site G	40	7
Ungrazed Grass Site H	40	5
Ungrazed Grass Site I	40	7
Ungrazed Grass Site J	40	4
Ungrazed Grass Site K	40	4
Ungrazed Grass Site L	40	7

The 12 month running average fluoride concentration in ungrazed grass was within the permit guideline for all sites during 2000.

Fluoride in Ungrazed Grasses, Continued

Comments

The annual average fluoride concentration in ungrazed grass at sites 1, 2, 3, and 4 increased during 2000. Sites 1, 2, 3, and 4 are close to the smelter and are influenced by discharges from the Potline roof louvres. This observed variation is consistent with historical data and is correlated to variation in production methods.

The increased fluoride concentrations of sites 1, 2, 3 and 4 are attributed to an increasing trend observed in Potline roof louvre discharges.

The fluoride concentrations at sites further from the smelter were similar to the concentrations reported for 1999.

The maximum monthly concentrations recorded at sites A, B, and C (23, 17 and 20 mg F/kg, respectfully) were observed during the month of May. As reported in the Resource Consent report for Quarter Two, 2000, resampling of these sites two weeks later continued to show elevated levels at A and B. Sites C and E had returned to normal range. Other vegetation sites within the vicinity (GMF1 and GMF2) were within normal ranges.

Light to moderate northerly and westerly windflow for the seven days prior to sampling the vegetation sites cannot associate the smelter with these elevated levels. No other cause for the elevated fluoride levels could be found.

Fluoride in *Pinus radiata*

Introduction

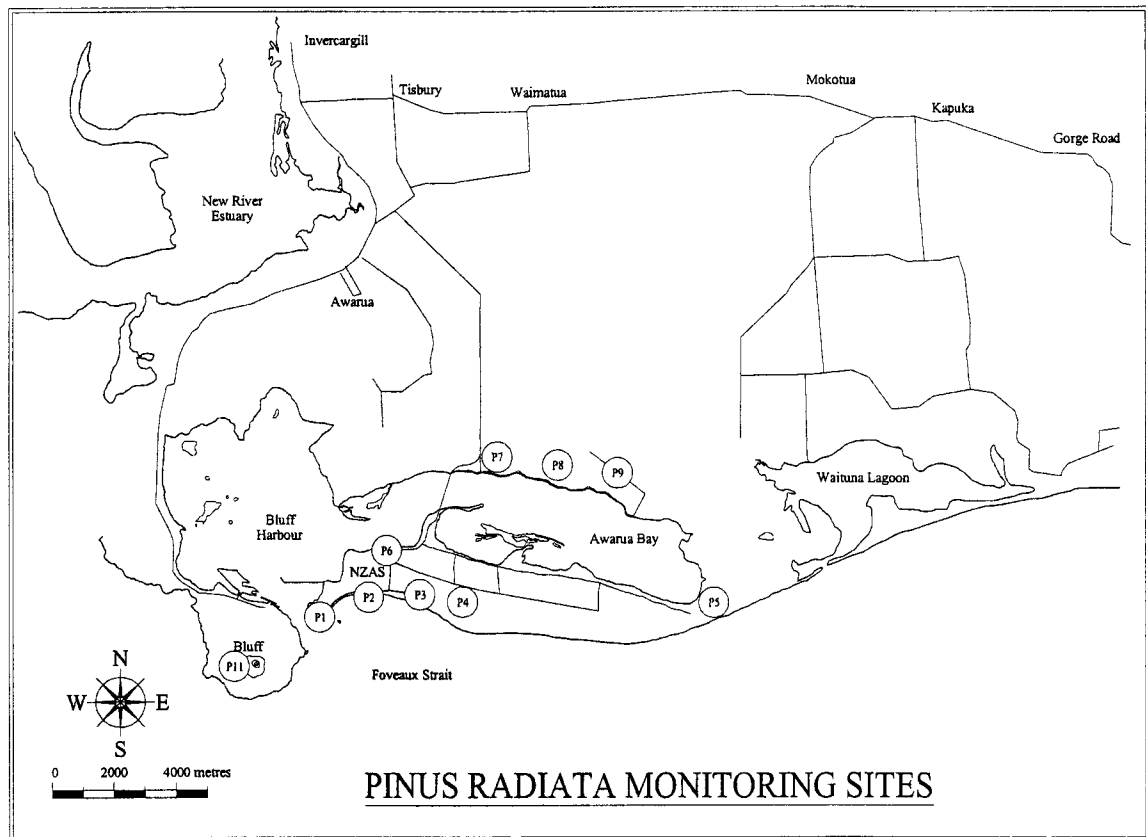
This chapter covers the monitoring of fluoride in *Pinus radiata* at 10 monitoring sites located at Bluff, Awarua Plains, Waituna and Tiwai Peninsula.

Permit Guidelines

Pine needles between one and two years are sampled quarterly. The guideline for fluoride in washed *Pinus radiata* needles on land off Tiwai Peninsula is 75 mg/kg.

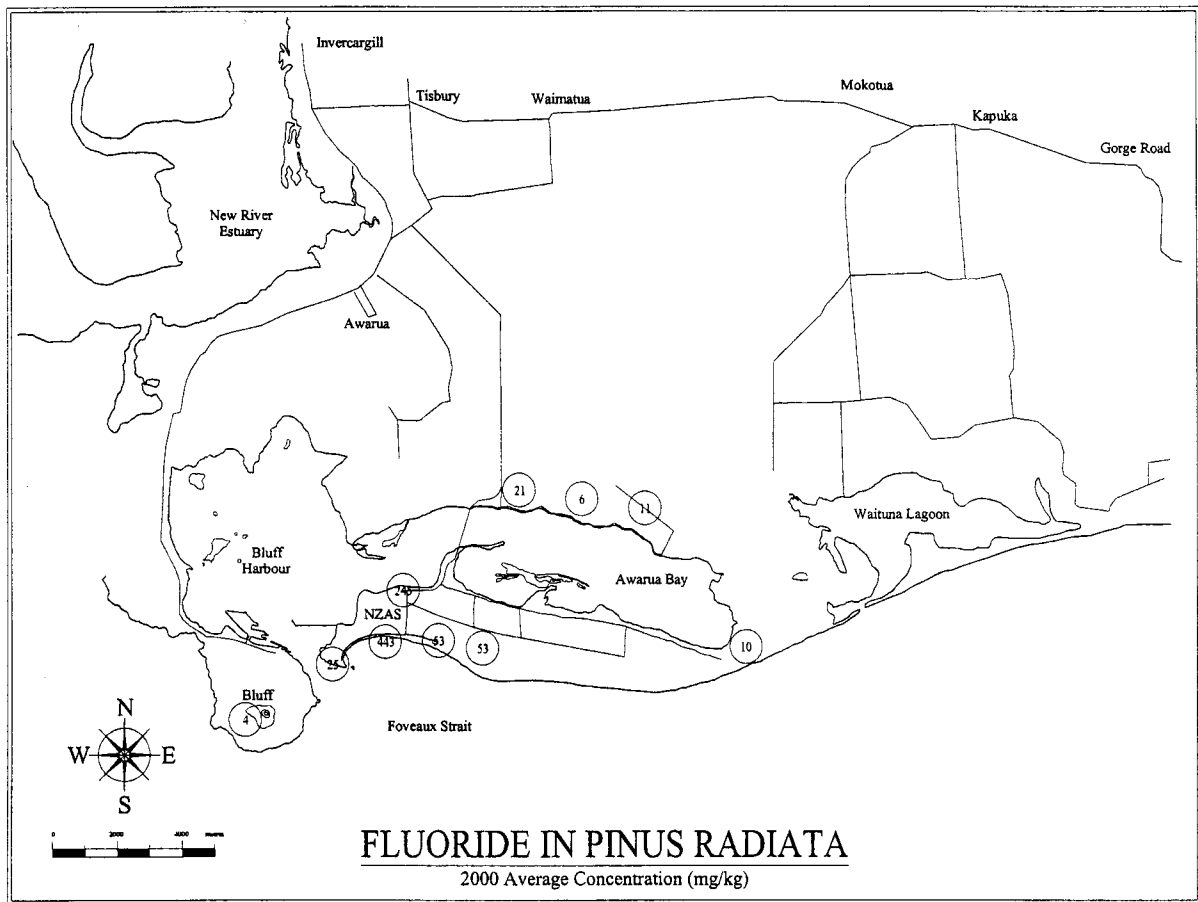
Site Locations

The locations of the monitoring sites are shown in the following map.



***Pinus radiata* Monitoring Results**

The 2000 annual average fluoride concentrations of pine needle samples collected from the monitoring sites are shown in the following map.



***Pinus radiata* Monitoring Results, Continued**

Comments

Fluoride concentrations in *Pinus radiata* needles were within the permit guideline during 2000.

Apart from site P2, which is close to the smelter, fluoride concentrations of pine needles were similar to the 1999 fluoride concentrations.

The average fluoride concentration measured at site P2 during 2000 was 443 mg/kg compared with 278 mg/kg in 1999. The average fluoride concentration measured at site P6 (also situated close to the smelter) during 2000 was 245 mg/kg compared with 220 mg/kg in 1999.

Historically, sites close to the smelter are influenced by discharges from the Potline roof louvres. There has been an increase in gaseous fluoride concentrations being emitted from the Potline roof louvres across the whole of Reduction (see section B. Discharges to Air).

The significant increase in fluoride concentrations at site P2 can be attributed to the high frequency of low wind speeds from the north, reducing the dispersion of discharges from the Potlines roof louvres, and the close proximity of the sampling site to the MRP fines dump at the NZAS landfill.

The sampling site P2 is directly downwind of the MRP fines dump at the landfill. Fluoride bearing dust associated with this material may be being carried by the prevailing weather and contributing to the observed increase in fluoride concentrations for *Pinus radiata* at this site.

The Health of Farm Livestock

Grazing Monitor Project

Summary

The maximum fluoride concentration for cattle urine sampled on GMF4 during 2000 exceeded permit guidelines. This sample was one out of a total of 14 and occurred in the first quarter of 2000. No reason could be attributed to the maximum value, and most likely represents the natural variation in a normal population.

The annual average for Fluoride concentration in cattle urine was below the permit standard. The fluoride concentration in grazed pasture and the annual average for fluoride concentration in cattle bone on GMF4 were within permit standards and guidelines.

The annual fluoride concentration in grazed pasture on all other grazing monitor farms were within permit standards and guidelines. Exceptions included monthly maximums determined for GMF1 and GMF2 during February and October, respectively. No causes could be attributed to the maximum values. With consideration for weather patterns experienced at the time, it was deemed unlikely that the elevated levels could have been due to smelter discharges.

Cattle bone fluoride concentrations on GMF4 were generally in the range of results determined on this farm over the past two years.

Decreased dental scores in cattle teeth formed on GMF4 since 1995 were consistent with those formed in earlier years. The stability reflects the decreased fluoride concentrations measured on this farm since the introduction of the dry scrubbing system at the smelter in 1996.

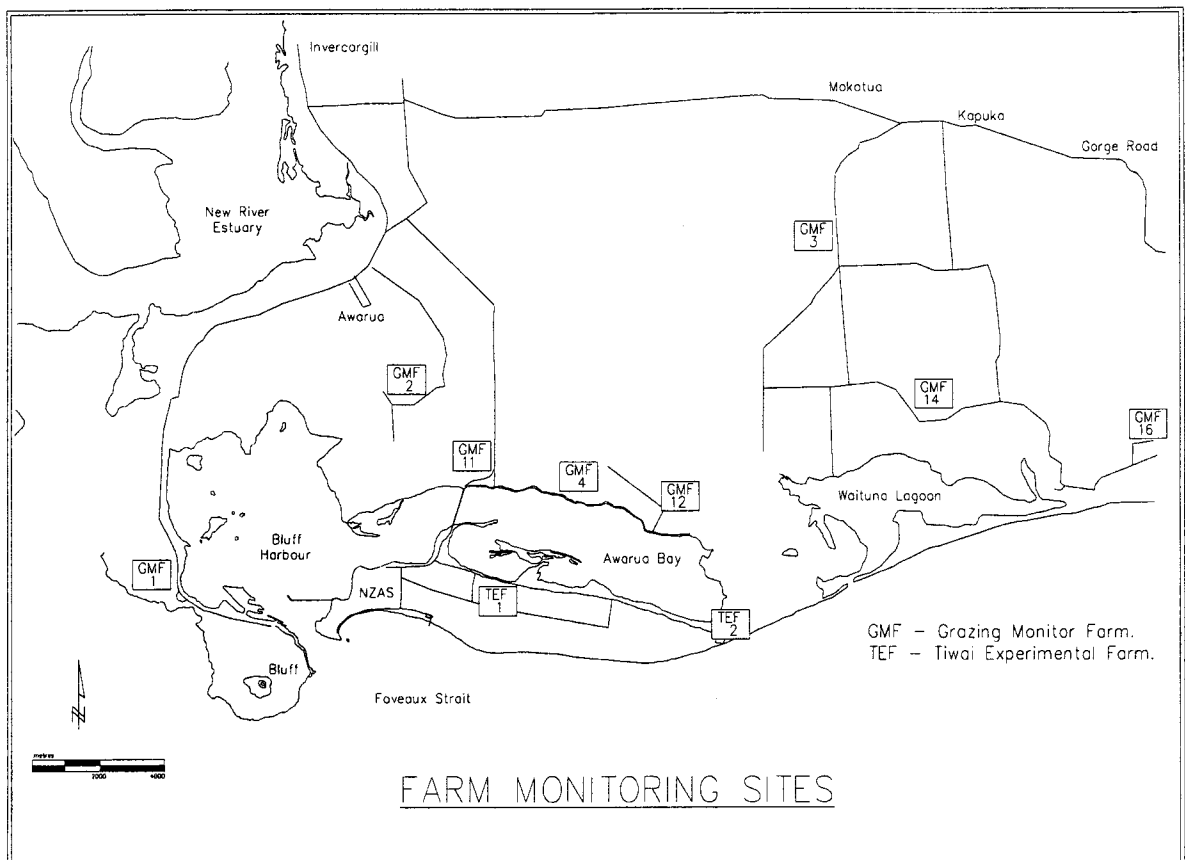
Introduction

Air Discharge and Coastal Permit Number 93566 requires NZAS to report on the health of farm livestock annually. The permit conditions were revised following NZAS' application to change or cancel some conditions which was approved by the Southland Regional Council on 5 August 1998.

The Grazing Monitor Project was established in 1969 prior to the smelter being commissioned. The project has continued since then with modifications as part of NZAS' Environmental Monitoring Program.

Site Locations

The following map shows the location of the farms included in the Grazing Monitor Project. Also included in the map are the locations of the two Tiwai Experimental Farms.



Monitoring the Health of Farm Livestock

The health of farm livestock is monitored by:

- measuring the fluoride concentration of cattle urine,
- measuring the fluoride concentration of cattle tailbone, and
- assessing the dental condition of cattle.

Urinary Fluoride

The urinary fluoride concentrations are corrected to a specific gravity of 1.030.

Bone Fluoride

The bone samples collected for measuring fluoride concentrations are from tail bone biopsies. The tailbone fluoride concentrations are converted to a metacarpal/metatarsal bone fluoride concentration using the method developed by J. Suttie.

Fluoride (F) in dry fat free metacarpal/metatarsal bone = F in ashed tailbone * 0.5.

Dental Condition

The tooth scoring system follows the method of J. Suttie. As most effects on teeth occur prior to eruption, when the teeth are forming, the tooth scores are given in relation to the year during which the tooth was formed. There is over 1 year between formation and eruption so the dental condition cannot be assessed until 1 to 2 years after any effects have occurred.

The inspection results from past years are combined to provide a table summarising the dental condition of the cattle permanent incisor teeth for the years when the teeth are forming.

Permit Standards

The Air Discharge and Coastal Permit contains a number of standards. A standard is defined in the permit as a limit which is not to be breached.

The standards for fluoride in grazed pasture (on an unwashed, dry weight basis) on land off Tiwai Peninsula are:

- monthly sample shall not exceed 80 mg/kg more than once in any 12 consecutive months,
- the average of any two consecutive months samples shall not exceed 60 mg/kg,
- running averages of monthly samples for a period of twelve months shall not exceed 40 mg/kg.

Permit Guidelines

The Air Discharge and Coastal Permit also contains a number of guidelines. A guideline is defined in the permit as a level which is set on best current knowledge, the exceeding of which requires further investigation or other action.

The guidelines for animal health monitoring are:

- urinary fluoride in dairy and beef cattle should not exceed 10 mg/L corrected to S.G. 1.030,
- bone fluoride concentrations as measured in metacarpal/metatarsal bones are:
 - ◆ 1605 mg/kg for two year olds,
 - ◆ 2379 mg/kg for four year olds, and
 - ◆ 2794 mg/kg for six year olds.

Grazing Monitor Farm No.1

The following information is contained in this section:

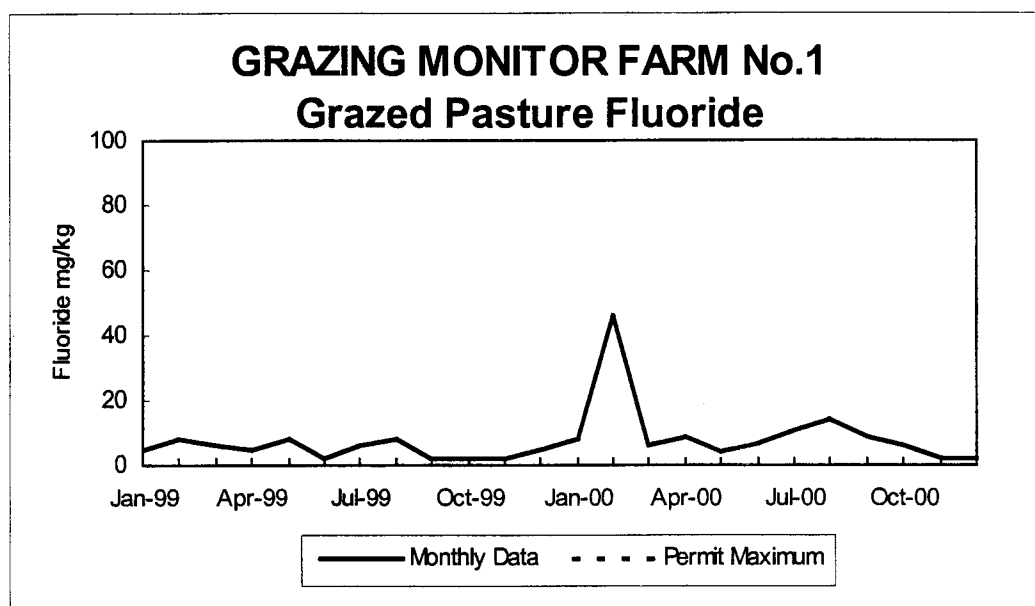
- fluoride in grazed pasture,
- cattle urinary fluoride,
- cattle bone fluoride,
- cattle dental condition, and
- comments on the monitoring.

Fluoride in grazed pasture

The following table shows the grazed pasture monitoring results for 2000.

	Units	Standard	2000
Monthly sample maximum	mg/kg	80	46
Two monthly average maximum	mg/kg	60	27
Twelve monthly running average maximum	mg/kg	40	11
Annual average	mg/kg		10

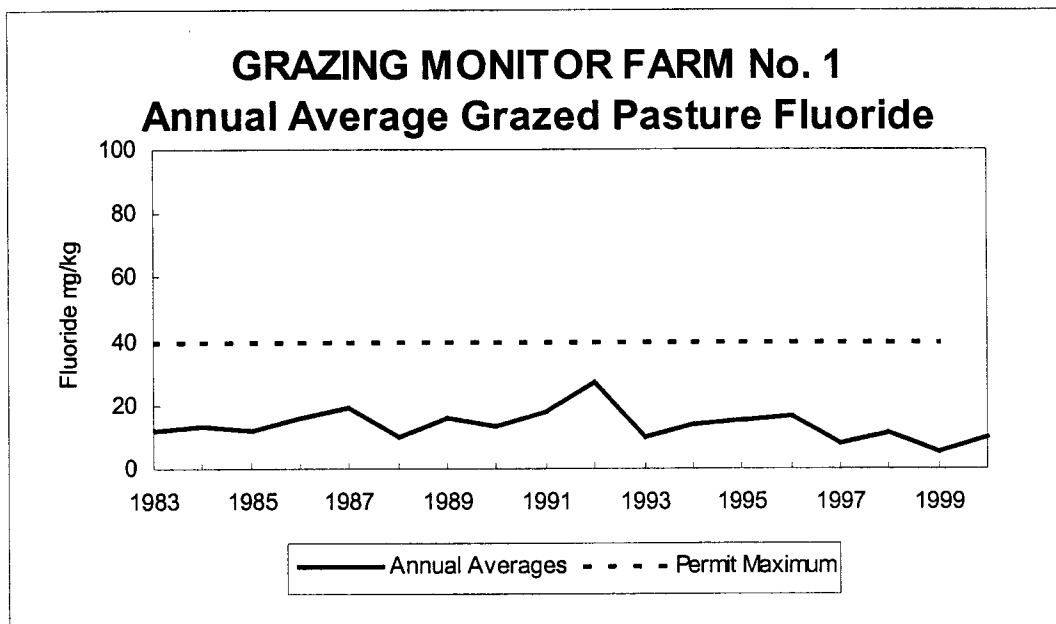
The following graph shows the results of monthly fluoride monitoring of grazed pasture during 1999 and 2000.



Grazing Monitor Farm No.1, Continued

Fluoride in grazed pasture, continued

The following graph shows the annual average fluoride concentration in grazed pasture.



Comments

The fluoride in grazed pasture was within the permit standards. The 2000 average grazed pasture fluoride concentration of 10 mg/kg was higher than the average fluoride concentration measured during 1999. This result is most certainly affected by the highest maximum value recorded (during February) for the site since the installation of the main stack dry scrubbing system. Prevailing weather patterns prior to the time of sampling do not connect the smelter with the abnormal level recorded. It is possible that the monthly maximum was due to dust from trucks carrying fertiliser to Bluff during ship unloading in early February.

Grazing Monitor Farm No. 2

Introduction

The following information is contained in this section:

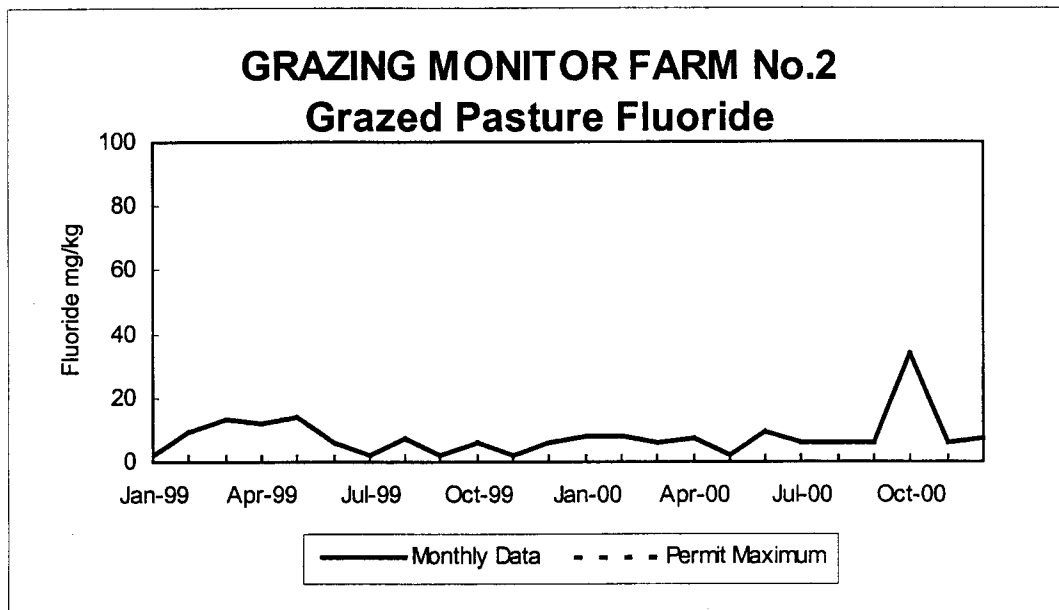
- fluoride in grazed pasture, and
- comments on the monitoring.

Fluoride in grazed pasture

The following table shows the grazed pasture monitoring results for 2000.

	Units	Standard	2000
Monthly sample maximum	mg/kg	80	34
Two monthly average maximum	mg/kg	60	20
Twelve monthly running average maximum	mg/kg	40	9
Annual average	mg/kg		9

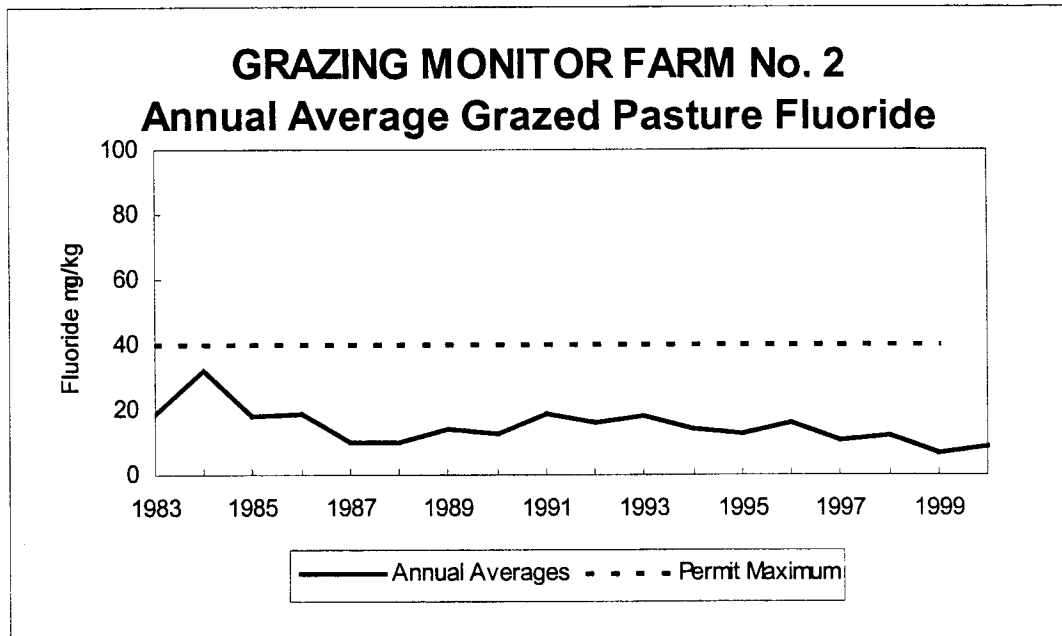
The following graph shows the results of monthly fluoride monitoring of grazed pasture during 1999 and 2000.



Grazing Monitor Farm No. 2, Continued

Fluoride in grazed pasture, continued

The following graph shows the annual average fluoride concentration in grazed pasture.



Comments

The fluoride in grazed pasture was within the permit standards. The 2000 annual average grazed pasture fluoride concentration of 9 mg/kg was similar to the concentration measured during 1999.

Grazing Monitor Farm No. 3

Introduction

The following information is contained in this section:

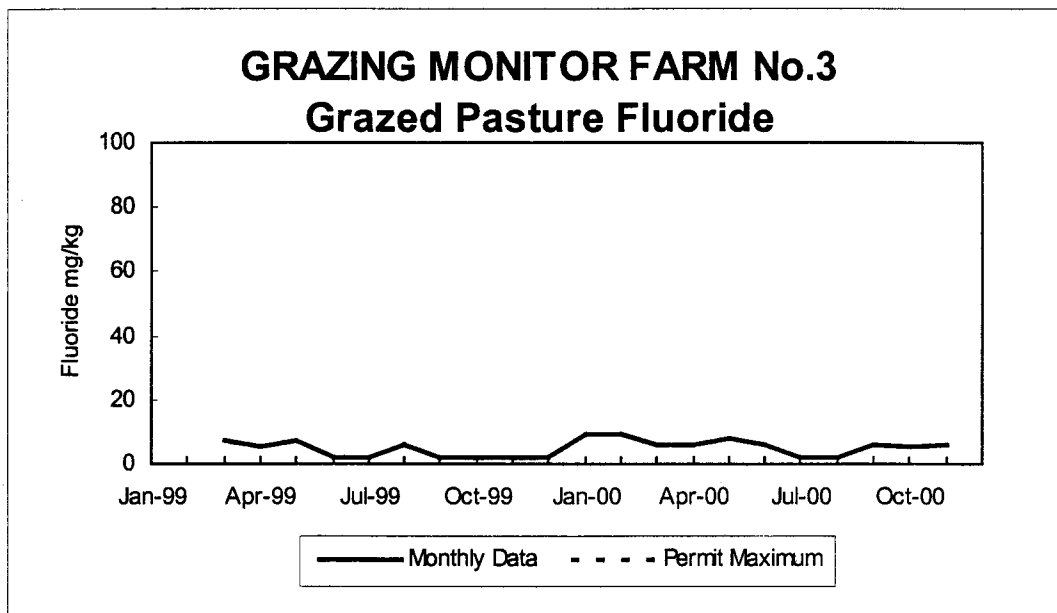
- fluoride in grazed pasture, and
- comments on the monitoring.

Fluoride in grazed pasture

The following table shows the grazed pasture monitoring results for 2000.

	Units	Standard	2000
Monthly sample maximum	mg/kg	80	9
Two monthly average maximum	mg/kg	60	9
Twelve monthly running average maximum	mg/kg	40	6
Annual average	mg/kg		6

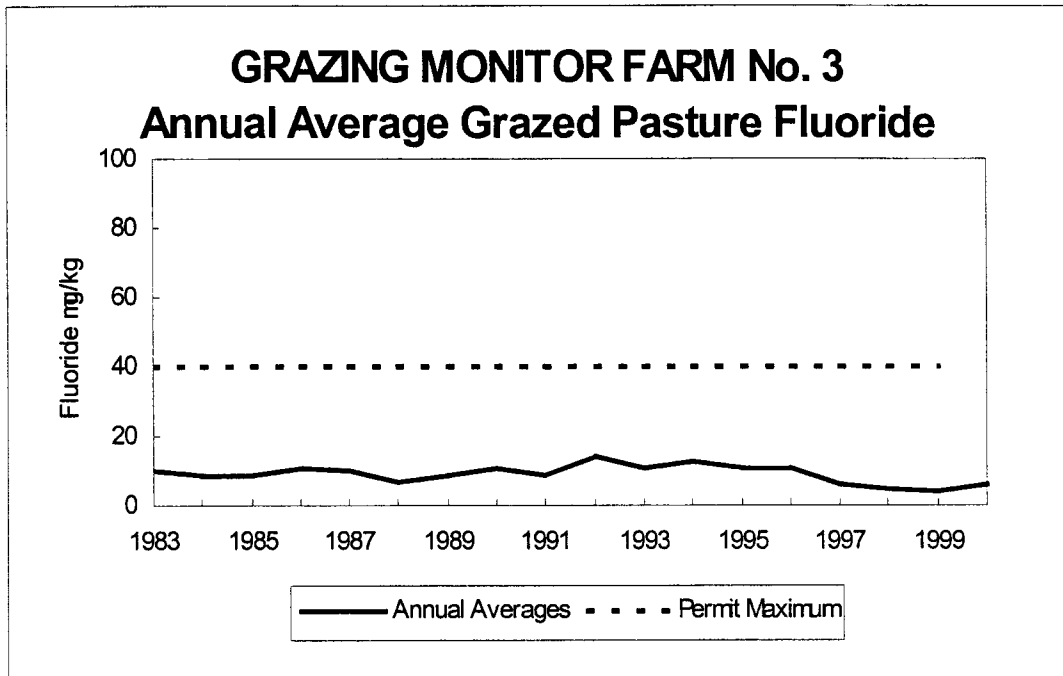
The following graph shows the results of monthly fluoride monitoring of grazed pasture during 1999 and 2000.



Grazing Monitor Farm No. 3, Continued

Fluoride in grazed pasture, continued

The following graph shows the annual average fluoride concentration in grazed pasture.



Comments

The fluoride in grazed pasture was within the permit standards. The 2000 annual average grazed pasture fluoride concentration of 6 mg/kg was similar to the concentration measured during 1999.

Grazing Monitor Farm No. 4

Introduction

The following information is contained in this section:

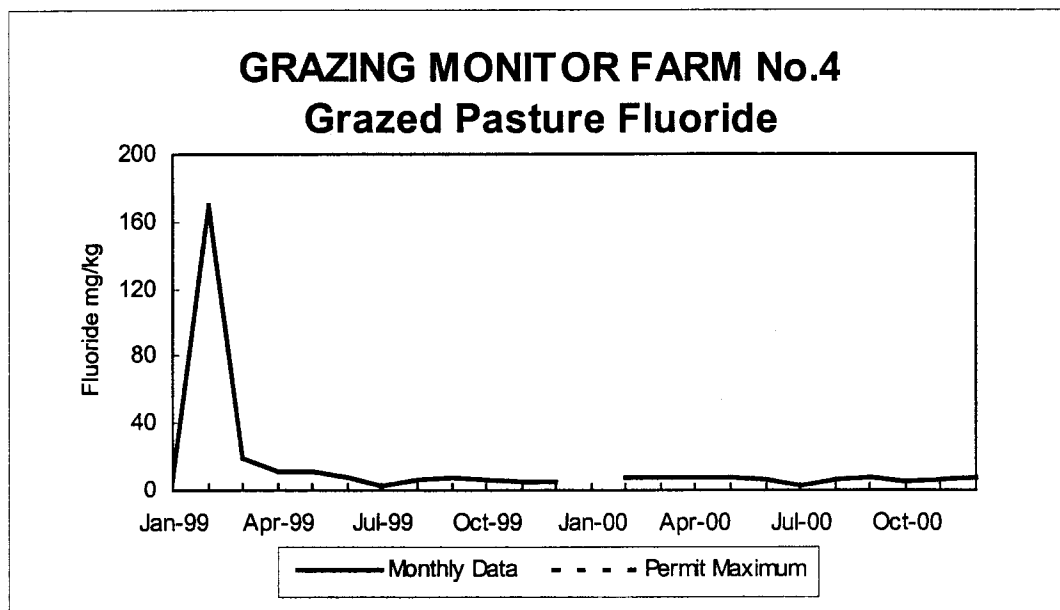
- fluoride in grazed pasture,
- cattle urinary fluoride,
- cattle bone fluoride,
- cattle dental condition, and
- comments on the monitoring.

Fluoride in grazed pasture

The following table shows the grazed pasture monitoring results for 2000.

	Units	Standard	2000
Monthly sample maximum	mg/kg	80	8
Two monthly average maximum	mg/kg	60	8
Twelve monthly running average maximum	mg/kg	40	23
Annual average	mg/kg		6

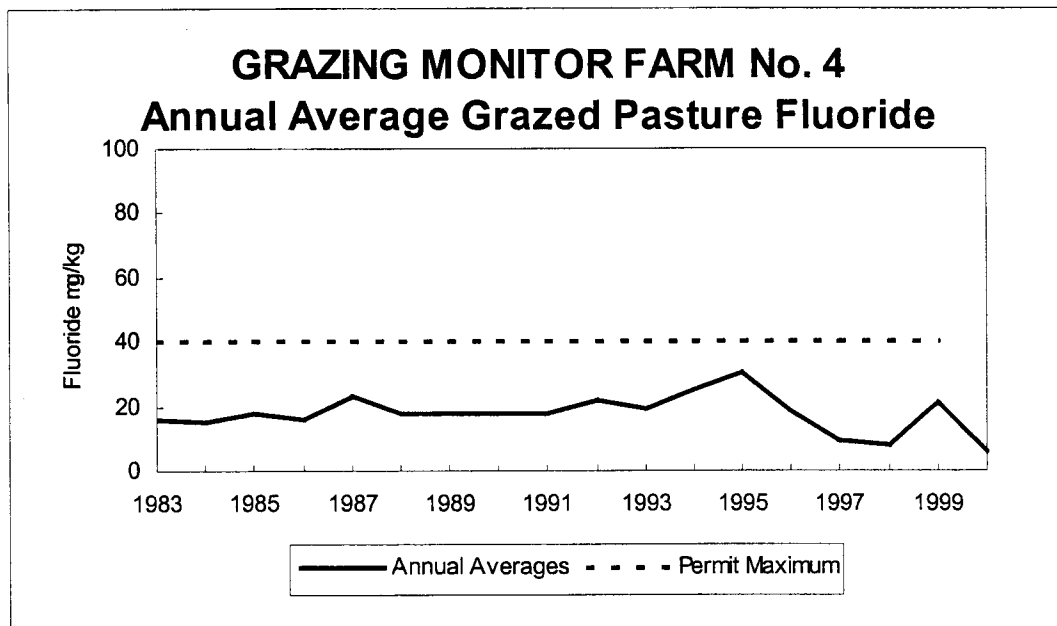
The following graph shows the results of monthly fluoride monitoring of grazed pasture during 1999 and 2000.



Grazing Monitor Farm No. 4, Continued

Fluoride in grazed pasture, continued

The following graph shows the annual average fluoride concentration in grazed pasture.



Cattle urinary fluoride

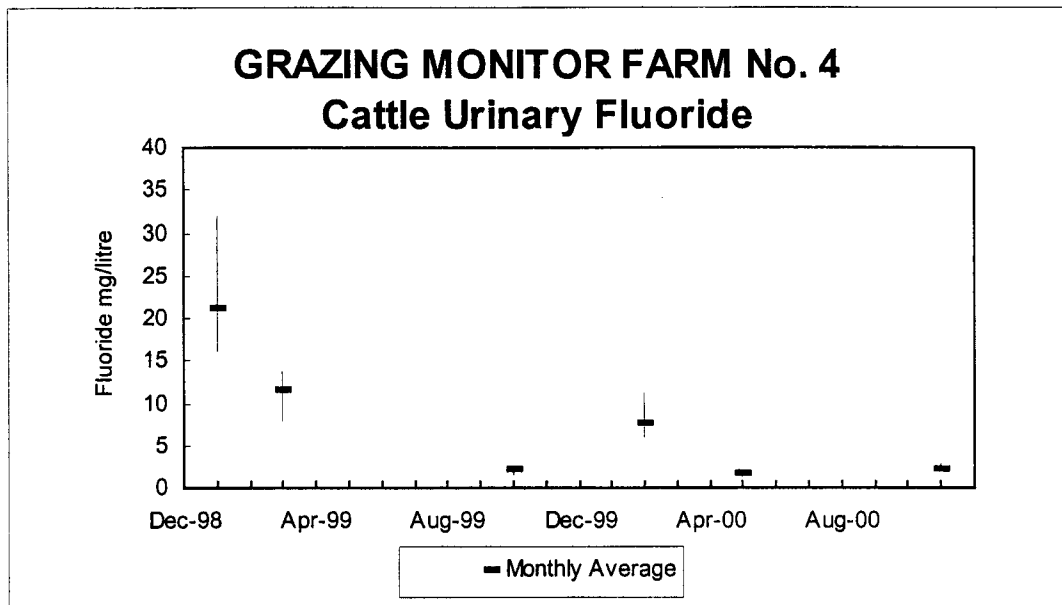
The following table summarises the results of cattle urinary fluoride monitoring during 2000.

	Units	Guideline	2000
Average fluoride concentration	mg/L	-	3.9
Maximum fluoride concentration	mg/L	10	11.3
Minimum fluoride concentration	mg/L	-	1.3
No. of samples	mg/L	-	14

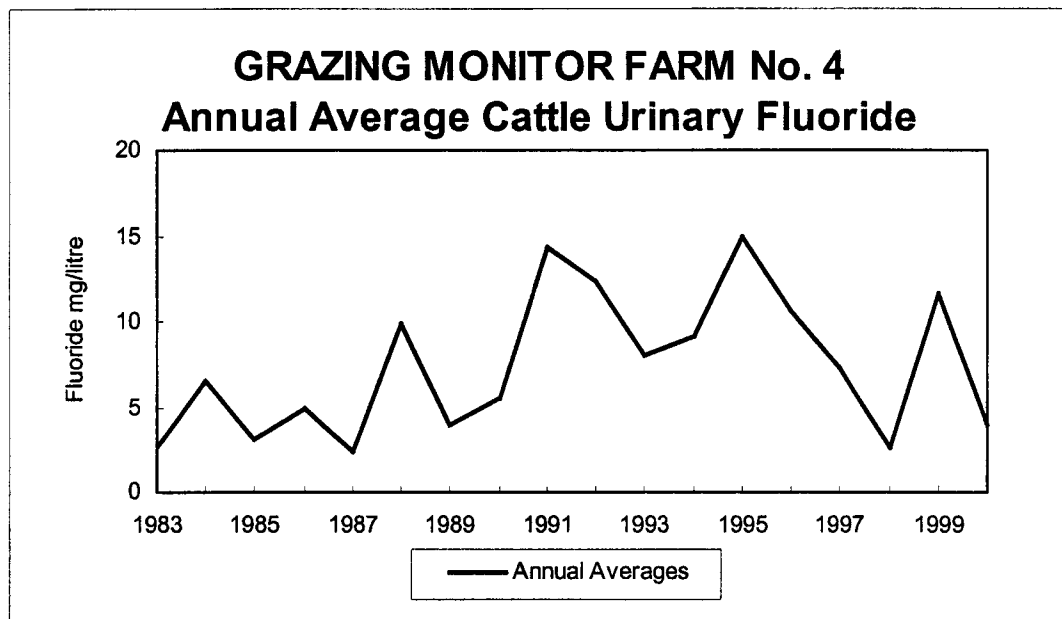
Grazing Monitor Farm No. 4, Continued

Cattle urinary fluoride, continued

The following graph shows the results of urinary fluoride monitoring of cattle during 1999 and 2000. The horizontal bars show the average concentration of the samples and the vertical bars show the range of concentrations.



The following graph shows the annual average fluoride concentration in cattle urine.



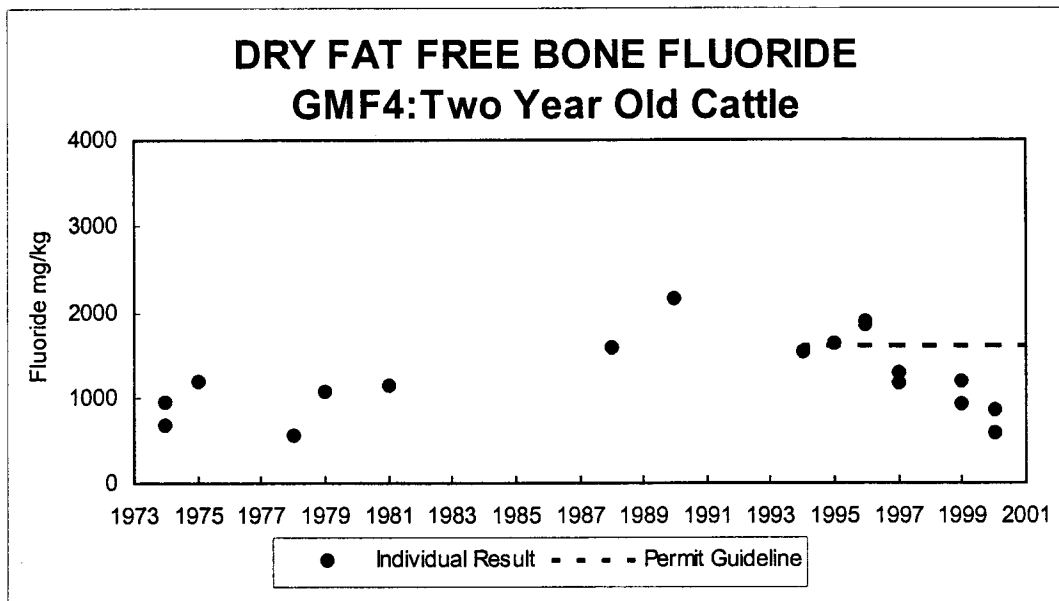
Grazing Monitor Farm No. 4, Continued

Cattle bone fluoride

The following table shows the results of bone fluoride monitoring during 2000.

Identification	Age	Units	Guideline	2000
Pet	4	mg/kg	2,379	1875
NZAS 98/8	2	mg/kg	1605	850
NZAS 98/6	2	mg/kg	1605	575
Darky	6	mg/kg	2,794	1800

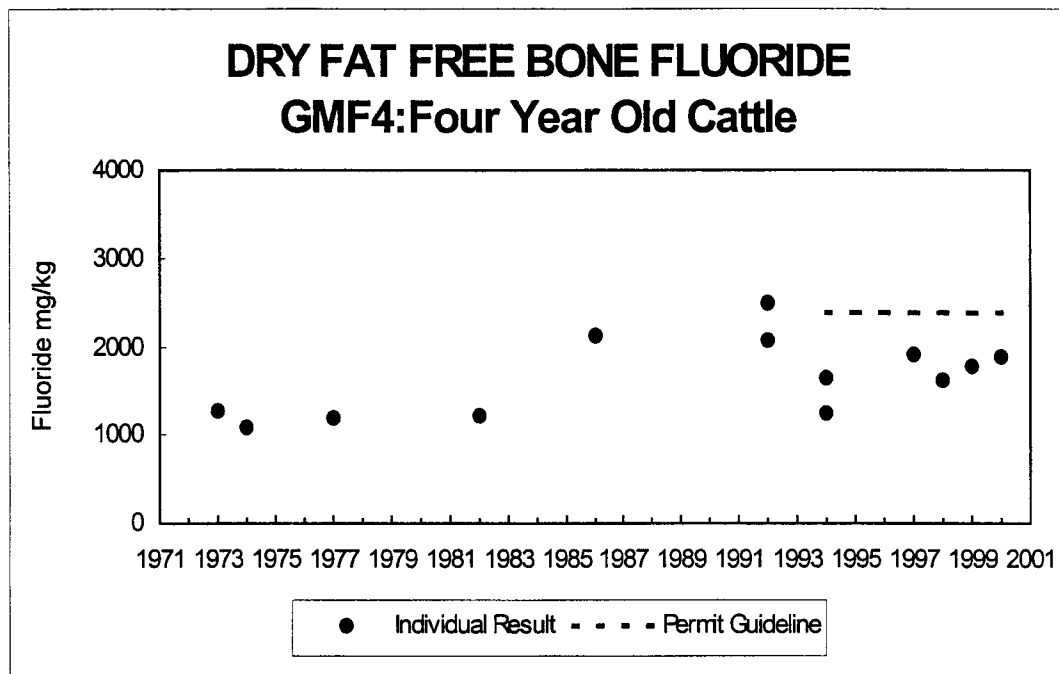
The following graph shows the bone fluoride concentration of individual biopsies collected from two year old cattle since the project began.



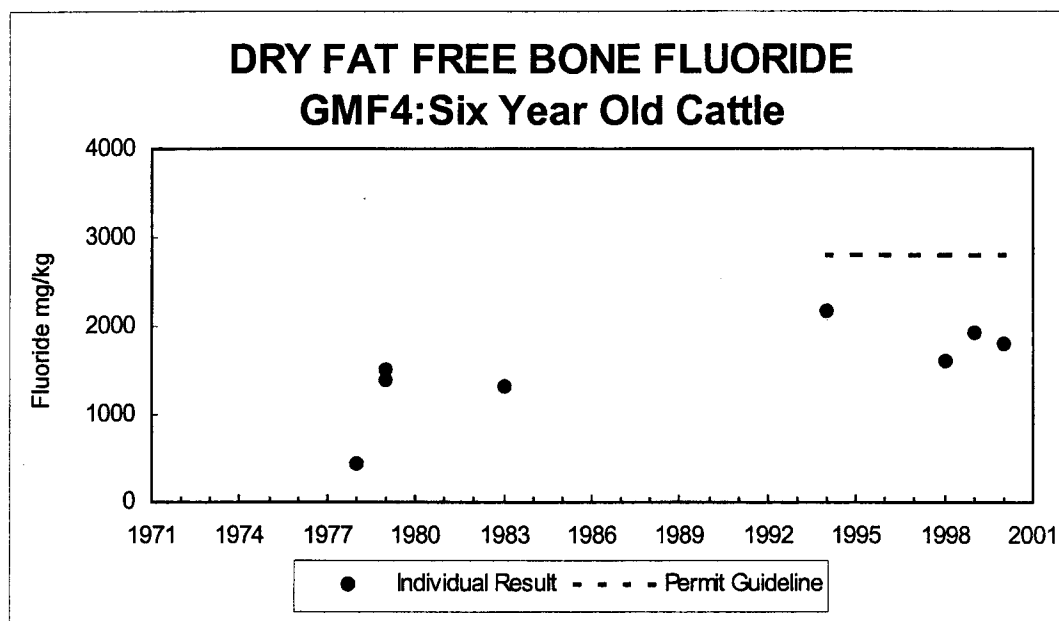
Grazing Monitor Farm No. 4, Continued

Cattle bone fluoride, continued

The following graph shows the bone fluoride concentration of individual biopsies collected from four year old cattle since the project began.



The following graph shows the bone fluoride concentration of individual biopsies collected from six year old cattle since the project began.



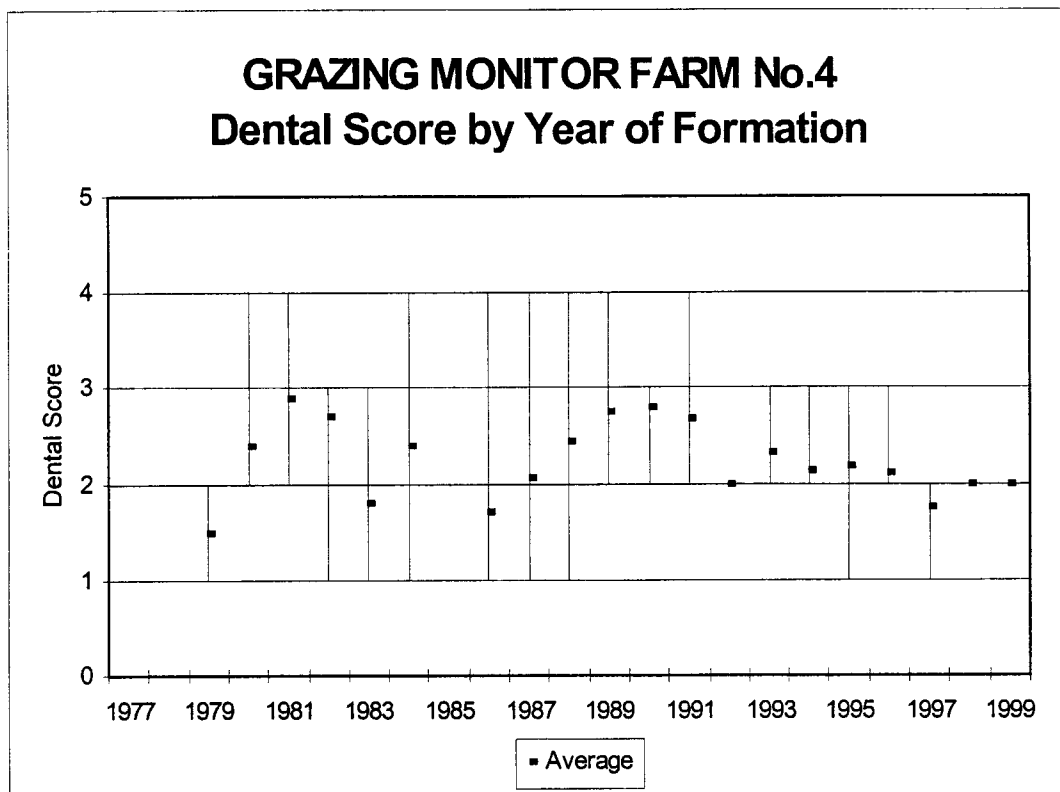
Grazing Monitor Farm No. 4, Continued

Cattle dental condition

The following table summarises combined results of the dental inspection of cattle.

Year of tooth formation	1995	1996	1997	1998	1999
Average tooth score	2.18	2.12	1.75	2	2
Maximum tooth score	3	3	2	2	2
Minimum tooth score	1	2	1	2	2
No. of cattle inspected	9	6	2	2	1

The following graph shows the average tooth score and range of tooth scores for the teeth of cattle formed since monitoring began.



Grazing Monitor Farm No. 4, Continued

Comments

The fluoride concentrations of cattle bone on GMF4 and grazed pasture were within the permit guidelines during 2000. The fluoride concentrations of cattle urine exceeded some permit conditions and guidelines during 2000.

The 2000 annual average grazed pasture fluoride concentration of 6 mg/kg was dramatically different to that determined during 1999, but similar to that determined for 1998 and 1997.

One of the 14 urinary fluoride concentrations determined during 2000 exceeded the permit guideline of 10 mg/L. This is a significant change from the eight out of 14 which exceeded the guideline during 1999. The high fluoride concentration was in a sample collected during the first quarter. The fluoride concentrations of other urine samples for that period and those collected during May and October, were all within the permit guideline. The annual average urinary fluoride concentration measured during 2000 was 3.9 mg/L compared to 11.6 mg/L measured during 1999. The maximum individual urinary fluoride concentration measured during 2000 was 11.3 mg/L compared with a maximum of 32.2 mg/L measured during 1999. The high fluoride concentration observed for the one sample during the first quarter is attributed to the normal variation in the population and related to the dry weather experienced in the area during February.

The average fluoride concentration of bones sampled from two year old cattle during 2000 was about 713 mg/kg. This is lower than the 1050 mg/kg determined in the previous two year old bones sampled in 1999 and earlier in 1998. This may indicate a decreasing trend in two year old bone fluoride concentrations observed following the commissioning of the smelter's main stack dry scrubbing system. The bone fluoride concentration of a four year old cow was higher than that measured during 1999 but is most likely showing normal variation within the population.

Likewise, the 1,800 mg/kg bone fluoride concentration measured in a six year old cow lies about the mean for bone analysed during 1998 and 1999, thus showing normal variation in a standard population.

The dental scores in cattle inspected during 2000 indicated a stabilising fluoride effect on teeth formed since 1995. This stability supports the decrease in fluoride concentrations measured on this farm since the progressive installation of the main stack dry scrubbing system started in 1996. However reduced sampling numbers over the previous two years may present a bias from the normal population. This is associated with a reduction in the number of farms currently being monitored and the closure of the Tiwai Experimental Farms.

Grazing Monitor Farm No. 11

Introduction

The following information is contained in this section:

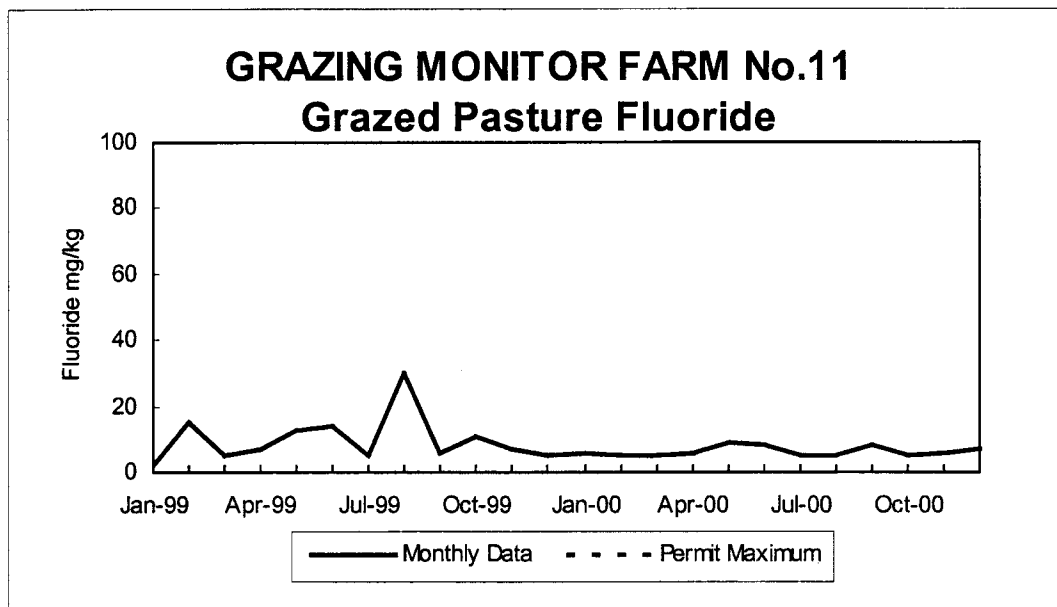
- fluoride in grazed pasture, and
- comments on the monitoring.

Fluoride in grazed pasture

The following table shows the grazed pasture monitoring results for 2000.

	Units	Standard	2000
Monthly sample maximum	mg/kg	80	9
Two monthly average maximum	mg/kg	60	9
Twelve monthly running average maximum	mg/kg	40	10
Annual average	mg/kg		6

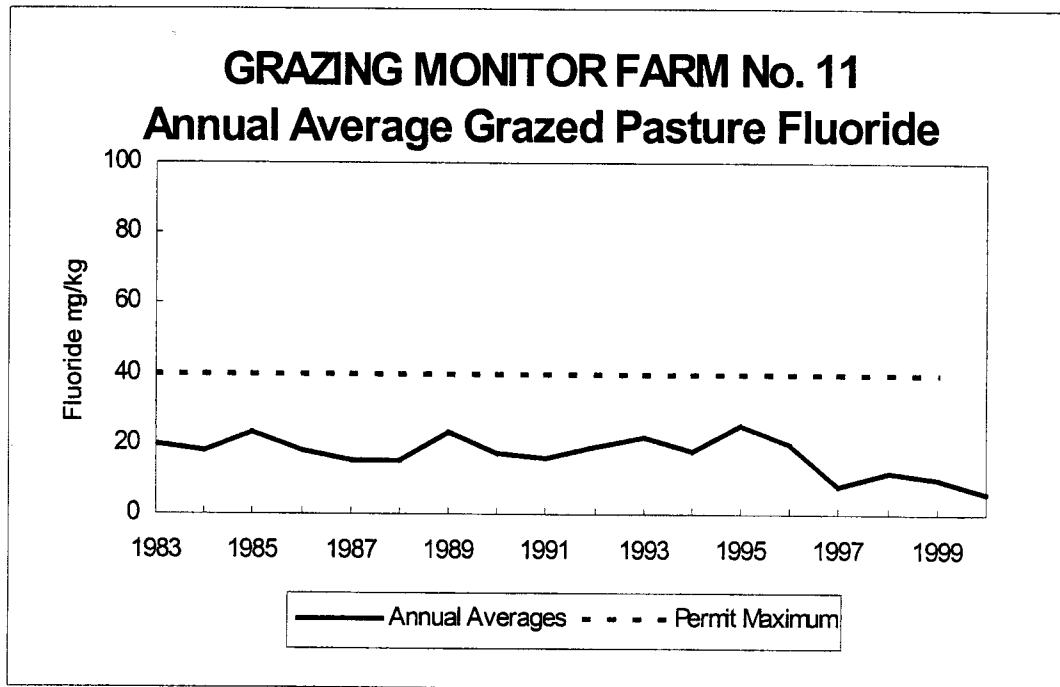
The following graph shows the results of monthly fluoride monitoring of grazed pasture during 1999 and 2000.



Grazing Monitor Farm No. 11, Continued

Fluoride in grazed pasture, continued

The following graph shows the annual average fluoride concentration in grazed pasture.



Comments

The fluoride in grazed pasture was within the permit standards. The 2000 average grazed pasture fluoride concentration of 6 mg/kg was lower than the average fluoride concentration measured during 1999.

Grazing Monitor Farm No. 12

Introduction

The following information is contained in this section:

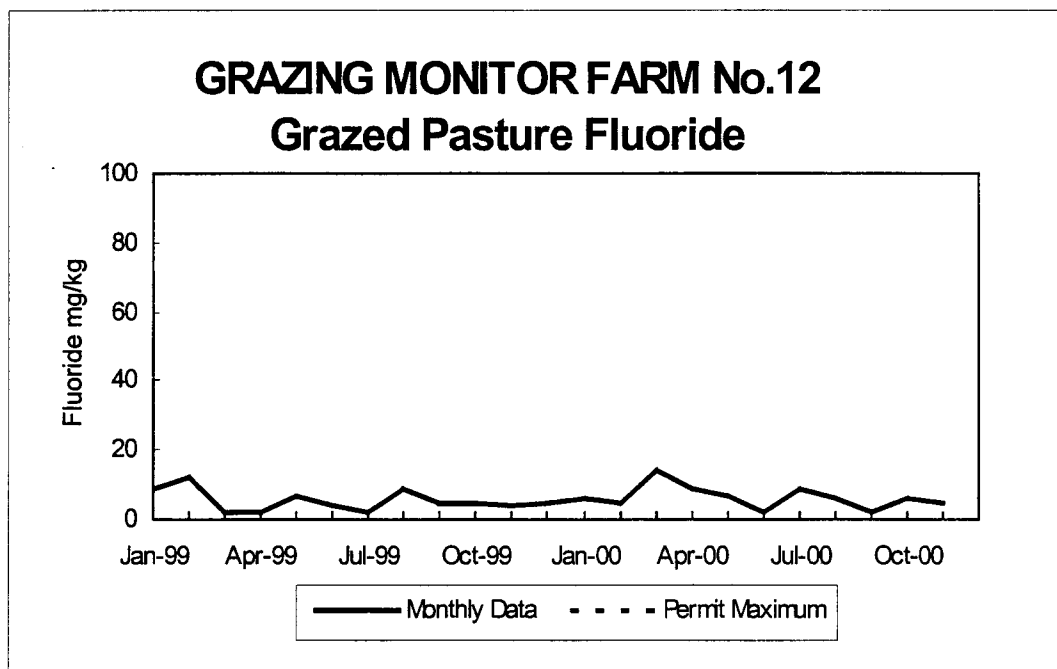
- fluoride in grazed pasture, and
- comments on the monitoring.

Fluoride in grazed pasture

The following table shows the maximum grazed pasture monitoring results for 2000.

	Units	Standard	2000
Monthly sample maximum	mg/kg	80	14
Two monthly average maximum	mg/kg	60	12
Twelve monthly running average maximum	mg/kg	40	7
Annual average	mg/kg		6

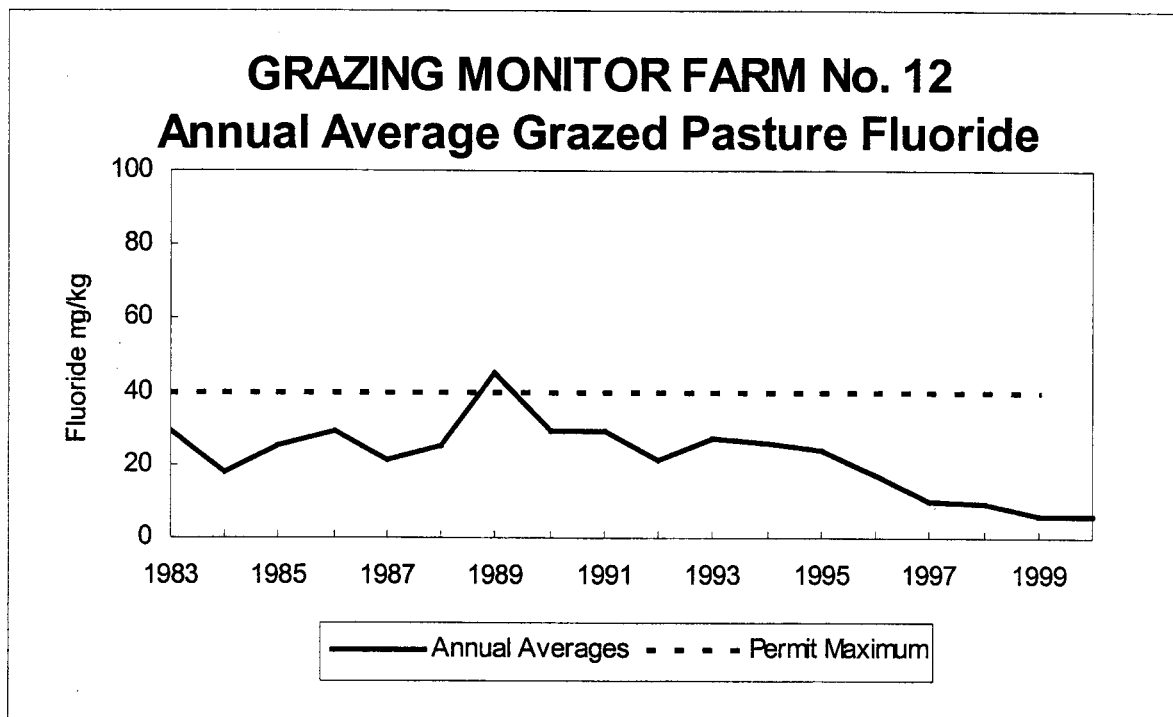
The following graph shows the results of monthly fluoride monitoring of grazed pasture during 1999 and 2000.



Grazing Monitor Farm No. 12, Continued

Fluoride in grazed pasture, continued

The following graph shows the annual average fluoride concentration in grazed pasture.



Comments

The fluoride in grazed pasture was within the permit standards. The 2000 annual average grazed pasture fluoride concentration of 6 mg/kg was similar to the average concentration measured during 1999.

Grazing Monitor Farm No. 14

Introduction

The following information is contained in this section:

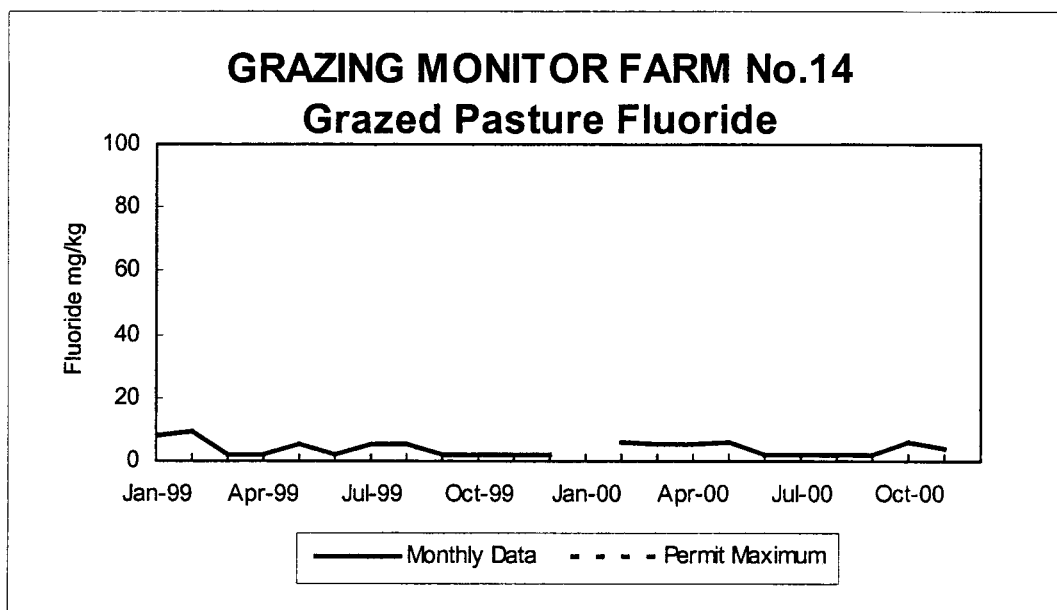
- fluoride in grazed pasture, and
- comments on the monitoring.

Fluoride in grazed pasture

The following table shows the grazed pasture monitoring results for 2000.

	Units	Standard	2000
Monthly sample maximum	mg/kg	80	6
Two monthly average maximum	mg/kg	60	6
Twelve monthly running average maximum	mg/kg	40	4
Annual average	mg/kg		4

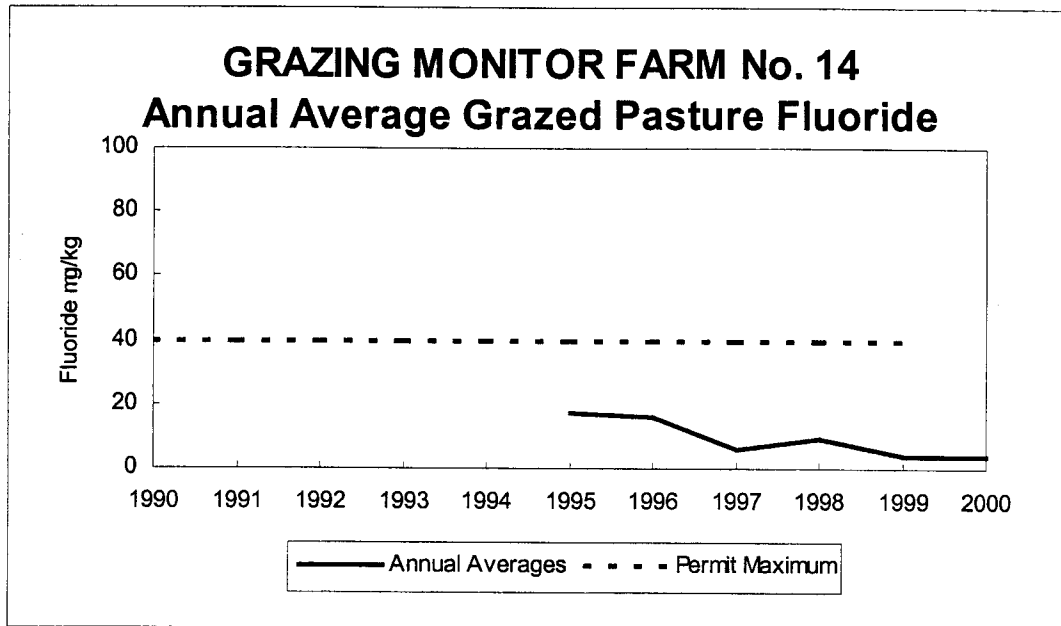
The following graph shows the results of monthly fluoride monitoring of grazed pasture during 1999 and 2000.



Grazing Monitor Farm No. 14, Continued

Fluoride in grazed pasture, continued

The following graph shows the annual average fluoride concentration in grazed pasture.



Comments

The fluoride concentrations in grazed pasture were within the permit standards during 2000. The annual average grazed pasture fluoride concentration of 4 mg/kg was similar to the average concentration measured during 1999.

Grazing Monitor Farm No. 16

Introduction

The following information is contained in this section:

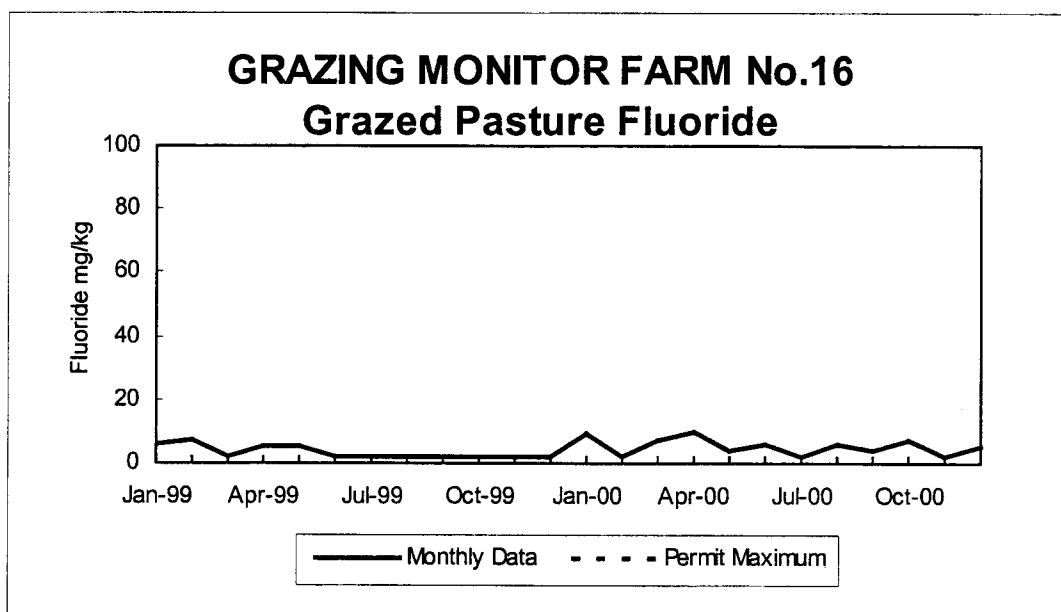
- fluoride in grazed pasture, and
- comments on the monitoring.

Fluoride in grazed pasture

The following table shows the grazed pasture monitoring results for 2000.

	Units	Standard	2000
Monthly sample maximum	mg/kg	80	10
Two monthly average maximum	mg/kg	60	9
Twelve monthly running average maximum	mg/kg	40	5
Annual average	mg/kg		5

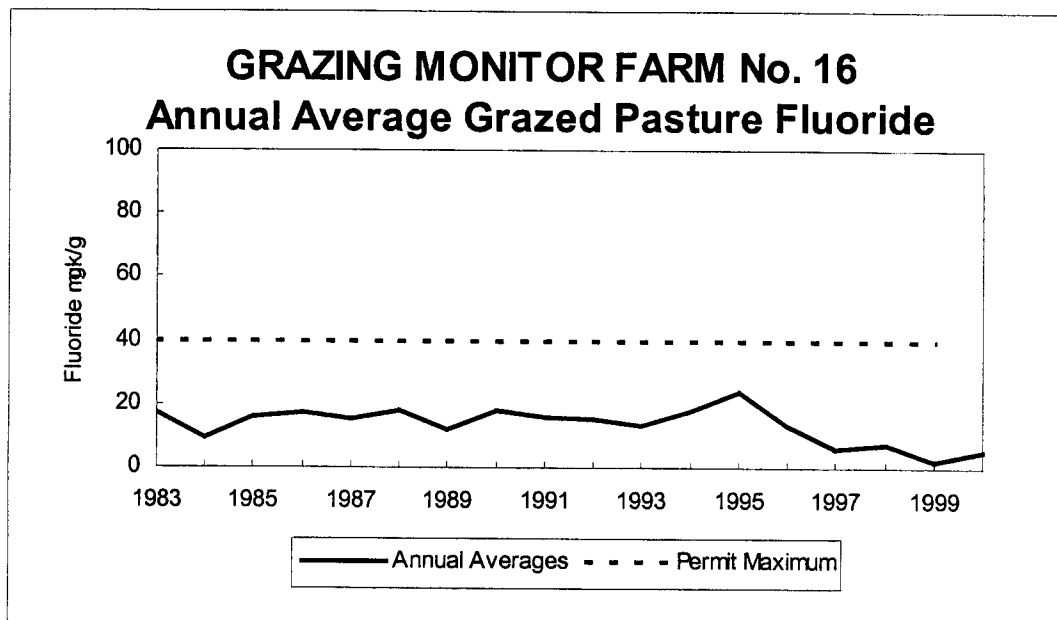
The following graph shows the results of monthly fluoride monitoring of grazed pasture during 1999 and 2000.



Grazing Monitor Farm No. 16, Continued

Fluoride in grazed pasture, continued

The following graph shows the annual average fluoride concentration in grazed pasture. Although GMF 16 was only included in the monitoring program in August 1994 an annual pasture graph has been produced including pre 1994 data from the neighbouring GMF 10 site. GMF10 was removed from the program in February 1998 as it is in the same ownership as GMF16 and pasture samples from the two farms during the years 1994 to 1998 indicated similar results.



Comments

The fluoride concentrations in grazed pasture were within the permit standards during 2000. The 2000 annual average grazed pasture fluoride concentration of 5 mg/kg shows an increase from the previous low determined during 1999.

Liquid Discharges and Their Effects

Introduction

Liquid discharges from the smelter are covered by six Coastal and Discharge Permits issued by the Southland Regional Council. These permits commenced in October 1996.

This chapter gives details of the monitoring results for each permit.

Permit Limits

The following table shows the permit limits applying to the discharges to water and onto land.

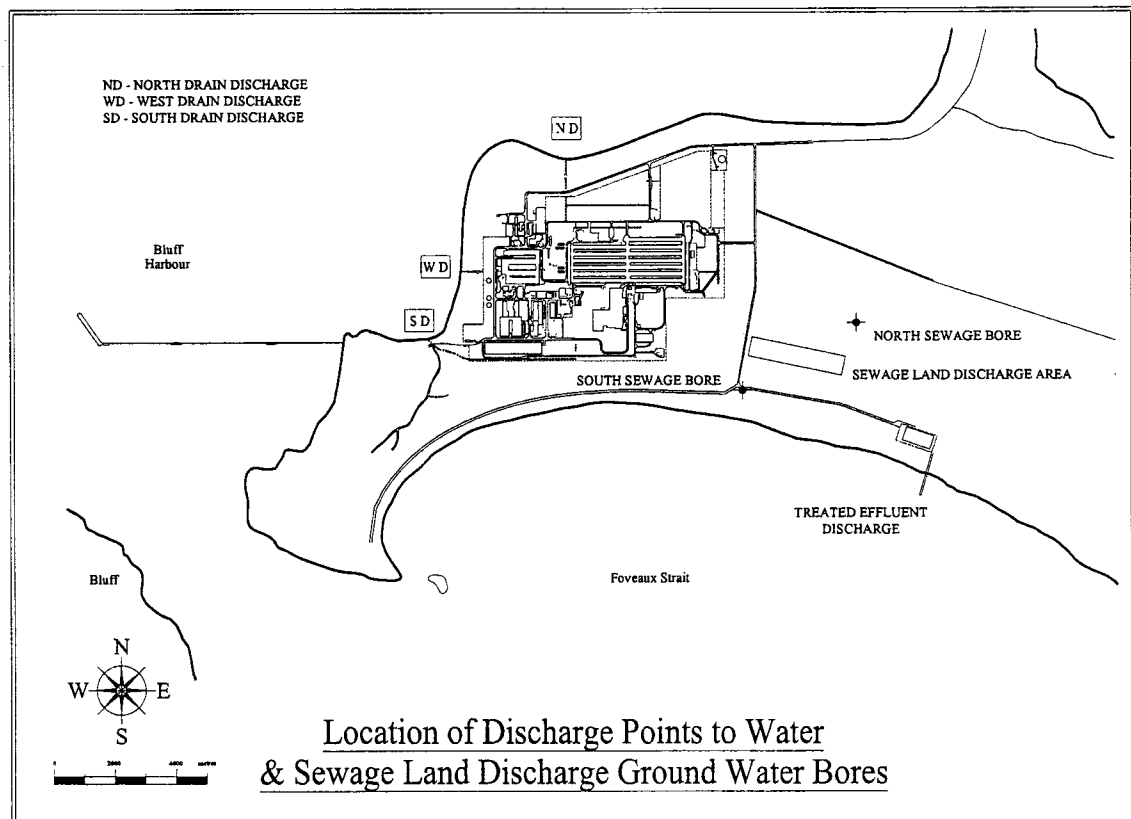
	Units	Limit
North, South, and West Drain		
• Quarterly average total suspended solids	g/m^3	30
Treated effluent		
• Maximum daily discharge	m^3/day	140
• Total suspended solids	g/m^3	100
• Free cyanide	g/m^3	20
Treated sewage		
• Maximum daily flow	m^3/day	295
• Biochemical oxygen demand	g/m^3	18
• Total suspended solids	g/m^3	8

The following permit limits apply to coastal water monitoring sites:

- the natural temperature shall not be changed by more than three degrees Celsius,
- the natural pH shall not be changed by more than 0.1 unit and at no time shall be less than 6.7 or greater than 8.5,
- there shall be no destruction of natural aquatic life by reason of a concentration of toxic substances nor shall the waters emit objectionable odours,
- the natural colour and clarity of the water shall not be changed to a conspicuous extent,
- the dissolved oxygen in solution in the waters shall not be reduced below 5 mg/litre,
- based on not fewer than five samples taken over not more than a 30 day period, the median value of the faecal coliform bacteria content of the waters shall not exceed 200/100 mL,
- there shall be no production of any conspicuous oil or grease films,
- the fluoride concentration of coastal water relating to drain discharges shall not exceed 5.0 g/m^3 , and
- the quarterly average fluoride concentration of coastal water relating to drain discharges shall not exceed 2.0 g/m^3 .

Site Locations

The locations of the liquid discharge and their effects monitoring sites are shown in the following map.



Discharge Monitoring

The discharges from the North, South and West Drains are sampled once each week. The temperature of each discharge is measured once each year as part of the annual seawater quality monitoring survey.

The discharge of treated sewage is sampled over a 24 hour period once each month.

The discharge of treated effluent is sampled once each discharge.

Coastal Water Monitoring

Coastal water quality is determined by comparing the results of monitoring at coastal water monitoring sites with the results at control sites where:

- coastal water monitoring sites are chosen to monitor the effects of discharges on coastal waters and
- control sites are chosen to best represent the background coastal water quality.

Some coastal water monitoring is undertaken each time a drain discharge is sampled. Additional coastal water monitoring for drain discharges is undertaken annually.

Annual coastal water monitoring is undertaken for the discharge of treated effluent.

Sewage Land Disposal Area Groundwater Monitoring

Groundwater near the sewage land disposal area is monitored by sampling from one bore north of the disposal area, upstream, and one bore south of the disposal area, downstream.

Monitoring is carried out at about six monthly intervals.

North Drain Discharges

Introduction

Discharges from the North Drain are covered by Coastal Permit 94501 which commenced on 8 October 1996.

Discharge monitoring results

The following table summarises the North Drain discharge monitoring results during 2000 and shows a comparison with 1999 results.

Parameter	Units	Limit	1999 Result	2000 Result
Total suspended solids				
• Annual average	g/m ³	-	10.8	11.5
• Maximum quarterly average	g/m ³	30	15.0	13.6
• No. of times quarterly average > 30 g/m ³		0	0	0

Coastal water monitoring results

The following table summarises the North Drain weekly coastal water monitoring results during 2000 and shows a comparison with 1999 results.

Parameter	Units	Limit	1999 Result	2000 Result
Fluoride				
• Annual average	g/m ³	-	1.3	1.4
• Maximum quarterly average	g/m ³	2.0	1.4	1.4
• No. of times quarterly average > 2.0 g/m ³		0	0	0
• Maximum individual sample	g/m ³	5.0	2.5	1.7
• No. of times individual sample > 5.0 g/m ³		0	0	0
pH				
• Maximum difference		0.1	0.2	0.1
• No. of times > 0.1		0	1	0
Visible oil				
• No. of times observed		0	0	0

The following table summarises the North Drain annual coastal water monitoring results during 2000 and shows a comparison with 1999 results.

Parameter	Units	Limit	1999 Result	2000 Result
Difference in temperature	° C	3.0	0.1	0.1
Minimum dissolved oxygen concentration	mg/litre	5.0	8.1	9.1

Comments

Discharges from the North Drain were within permit limits during 2000.

South Drain Discharges

Introduction

Discharges from the South Drain are covered by Coastal Permit 94503 which commenced on 8 October 1996.

Discharge monitoring results

The following table summarises the South Drain discharge monitoring results during 2000 and shows a comparison with 1999 results.

Parameter	Units	Limit	1999 Result	2000 Result
Total suspended solids				
• Annual average	g/m ³	-	3.1	3.0
• Maximum quarterly average	g/m ³	30	4.5	3.8
• No. of times quarterly average > 30 g/m ³		0	0	0

Coastal water monitoring results

The following table summarises the South Drain weekly coastal water monitoring results during 2000 and shows a comparison with 1999 results.

Parameter	Units	Limit	1999 Result	2000 Result
Fluoride				
• Annual average	g/m ³	-	1.3	1.3
• Maximum quarterly average	g/m ³	2.0	1.3	1.3
• No. of times quarterly average > 2.0 g/m ³		0	0	0
• Maximum individual sample	g/m ³	5.0	1.5	1.5
• No. of times individual sample > 5.0 g/m ³		0	0	0
pH				
• Maximum difference		0.1	0.1	0.1
• No. of times > 0.1		0	0	0
Visible oil				
• No. of times observed		0	0	0

The following table summarises the South Drain annual coastal water monitoring results during 2000 and shows a comparison with 1999 results.

Parameter	Units	Limit	1999 Result	2000 Result
Difference in temperature	°C	3.0	0.7	1.4
Minimum dissolved oxygen concentration	mg/litre	5.0	8.1	8.9

Comments

Discharges from the South Drain were within permit limits during 2000.

West Drain Discharges

Introduction

Discharges from the West Drain are covered by Coastal Permit 94502 which commenced on 8 October 1996.

Discharge monitoring results

The following table summarises the West Drain discharge monitoring results during 2000 and shows a comparison with 1999 results.

Parameter	Units	Limit	1999 Result	2000 Result
Total suspended solids				
• Annual average	g/m ³	-	8.9	10.6
• Maximum quarterly average	g/m ³	30	15.4	14.8
• No. of times quarterly average > 30 g/m ³		0	0	0

Coastal water monitoring results

The following table summarises the West Drain weekly coastal water monitoring results during 2000 and shows a comparison with 1999 results.

Parameter	Units	Limit	1999 Result	2000 Result
Fluoride				
• Annual average	g/m ³	-	1.3	1.3
• Maximum quarterly average	g/m ³	2.0	1.3	1.3
• No. of times quarterly average > 2.0 g/m ³		0	0	0
• Maximum individual sample	g/m ³	5.0	1.4	1.4
• No. of times individual sample > 5.0 g/m ³		0	0	0
pH				
• Maximum difference		0.1	0.2	0.3
• No. of times > 0.1		0	1	1
Visible oil				
• No. of times observed		0	0	0

The following table summarises the West Drain annual coastal water monitoring results during 2000 and shows a comparison with 1999 results.

Parameter	Units	Limit	1999 Result	2000 Result
Difference in temperature	° C	3.0	0.1	0.7
Minimum dissolved oxygen concentration	mg/litre	5.0	8.0	9.3

West Drain Discharges, Continued

Comments

Discharges from the West Drain were within permit limits during 2000.

The maximum difference in pH of 0.3 between the coastal water and control samples occurred in October. This result was reported in the quarterly report. The difference in pH was attributed to a large presence of seaweed in the control sample. The pH of the coastal seawater site (which is closer to the Drain Discharge point) was within the normal range for seawater.

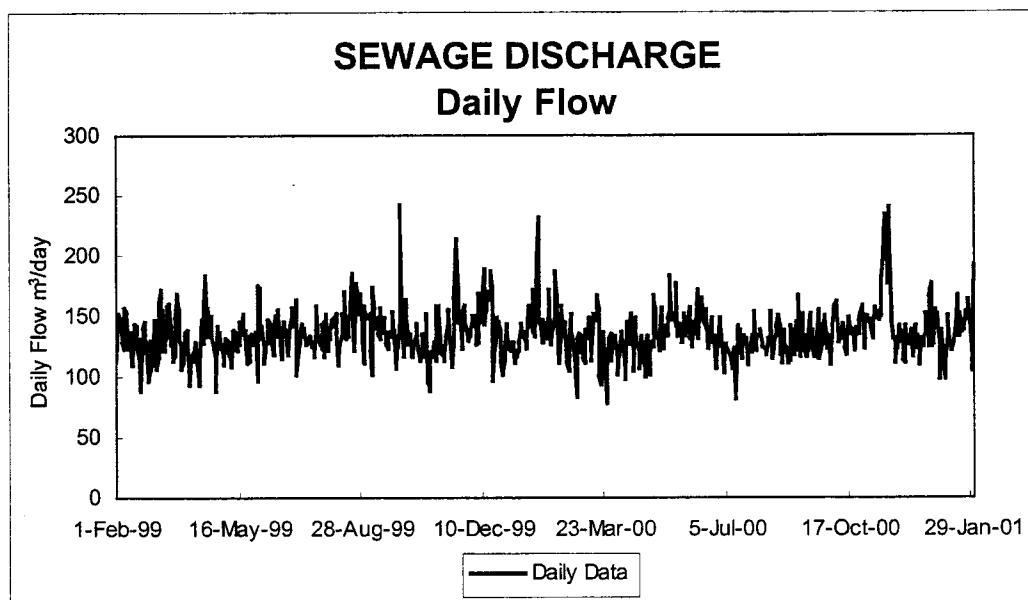
Treated Sewage Discharges

Introduction

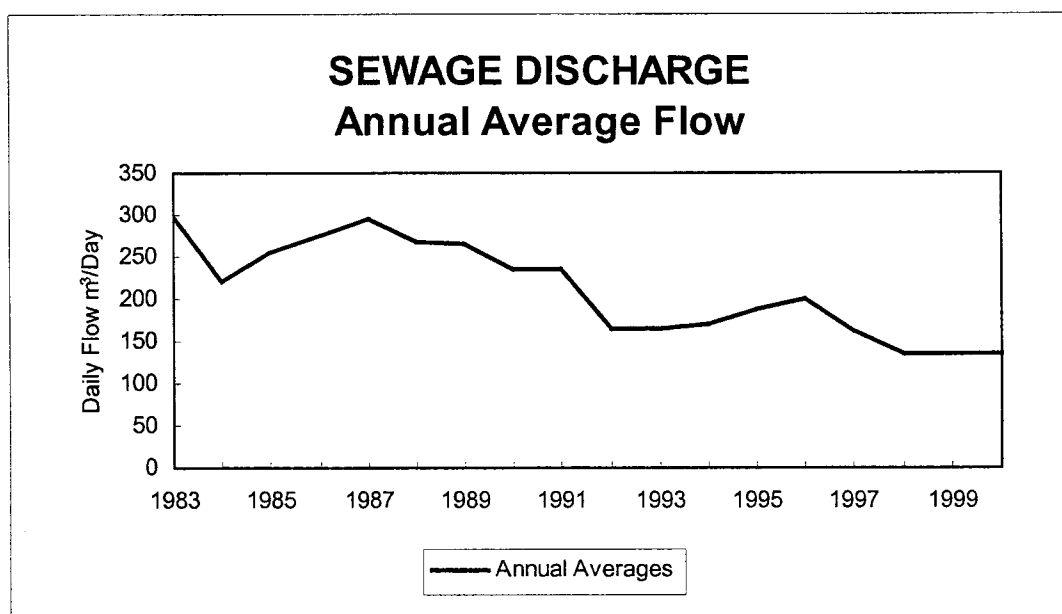
Discharges of treated sewage onto land are covered by Discharge Permit Number 96122, which was granted on 16 October 1996.

Discharge monitoring results

The following graph shows the daily sewage discharge flow during 1999 and 2000. The permit limit for daily flow is 295 m³/day.



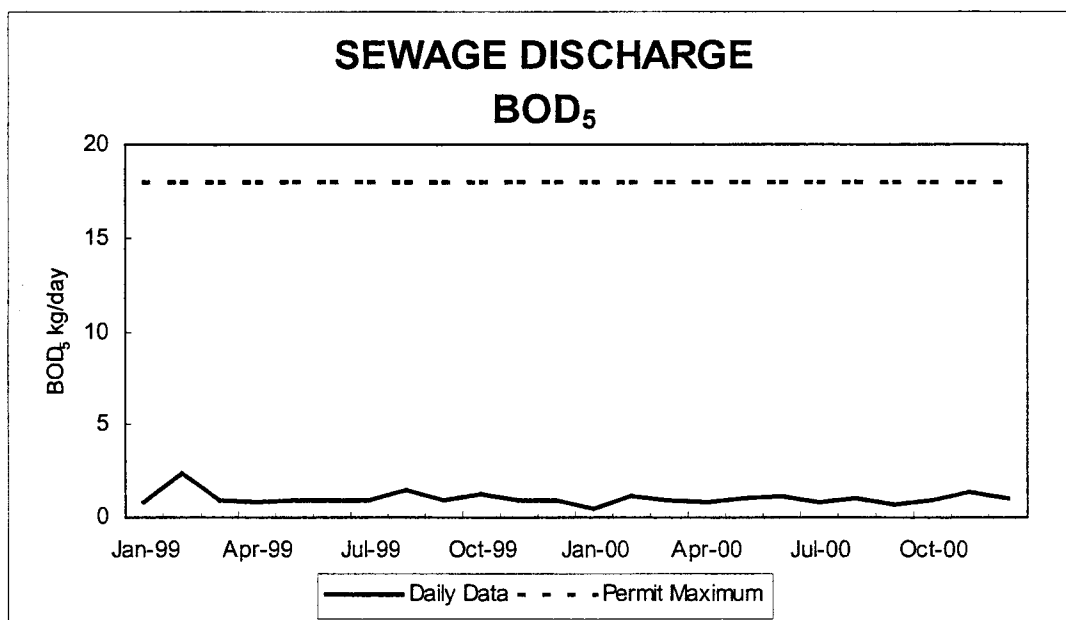
The following graph shows the annual average daily sewage discharge flow.



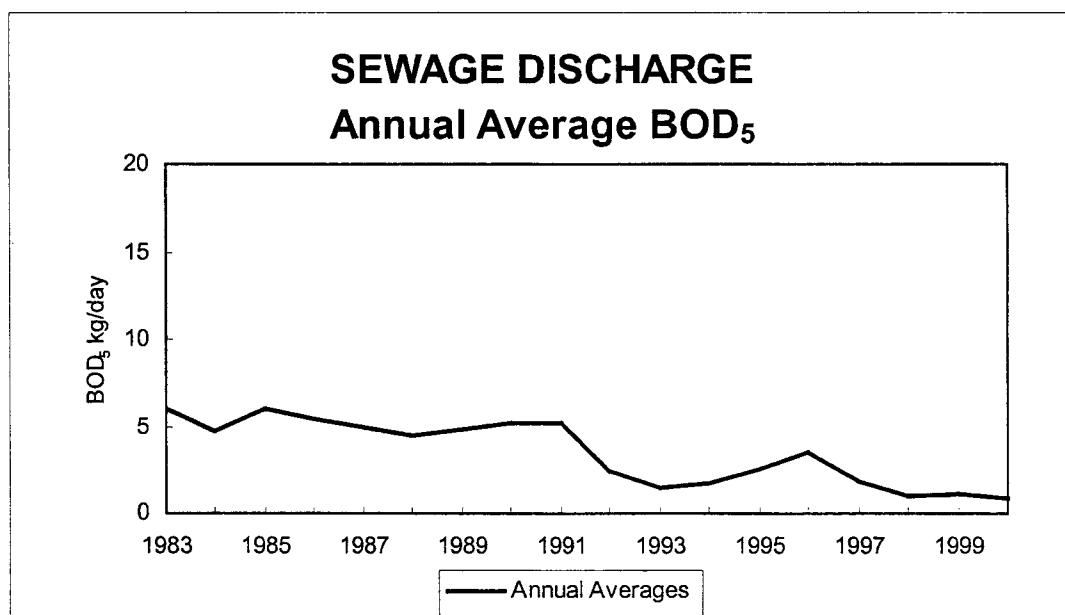
Treated Sewage Discharges, Continued

Discharge monitoring results, continued

The following graph shows the monthly biochemical oxygen demand (BOD₅) discharge from the sewage treatment plant during 1999 and 2000. The permit limit for BOD₅ is 18kg/day.



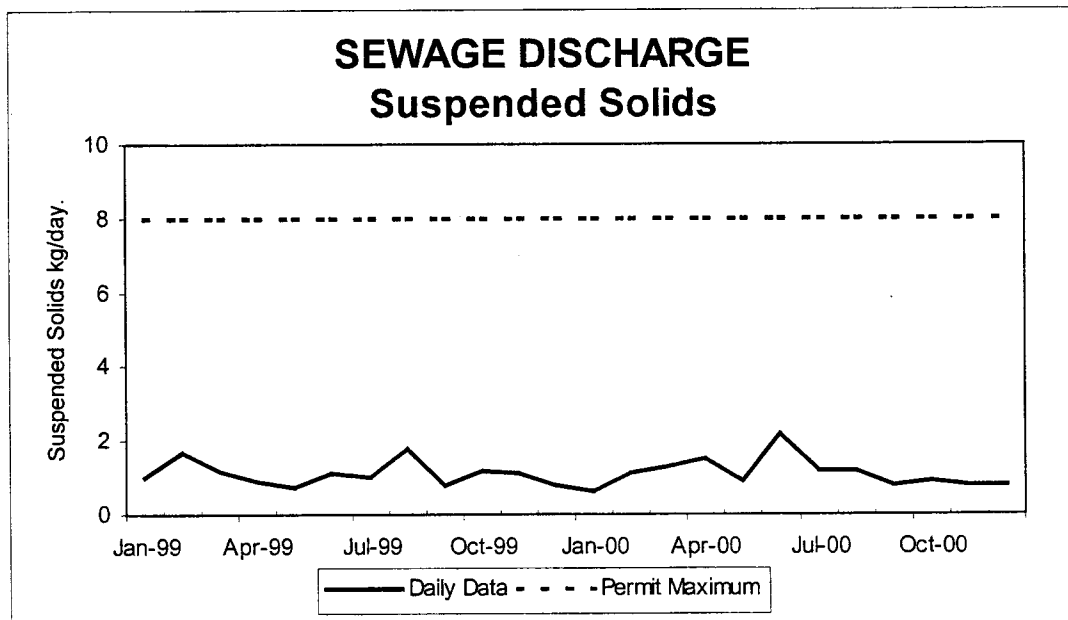
The following graph shows the annual average BOD₅ discharge from the sewage treatment plant.



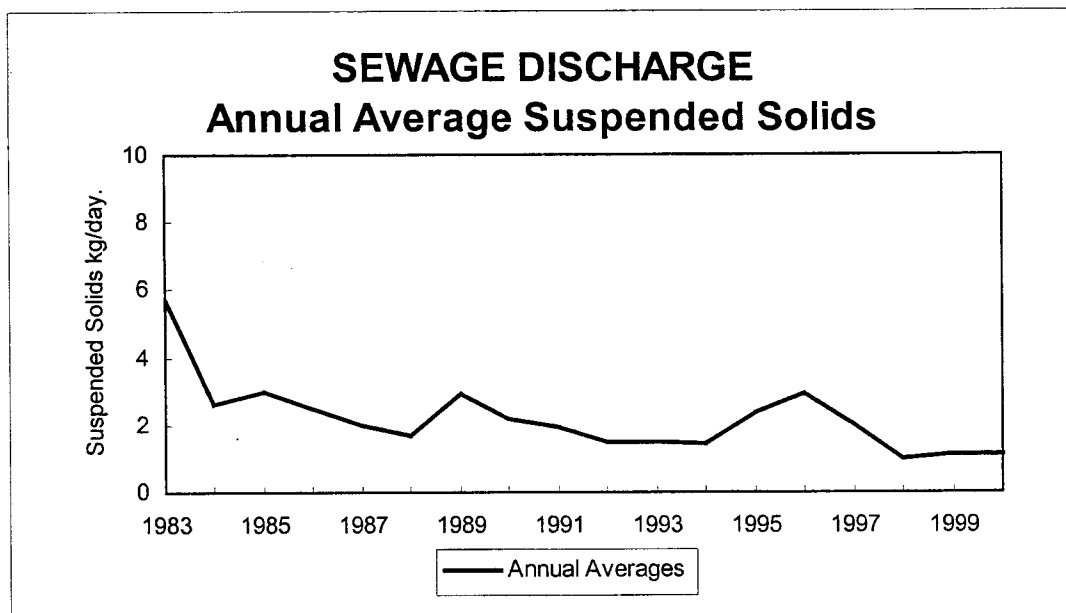
Treated Sewage Discharges, Continued

Discharge monitoring results, continued

The following graph shows the monthly suspended solids discharge from the sewage treatment plant during 1999 and 2000. The permit limit for suspended solids is 8 kg/day.



The following graph shows the annual average suspended solids discharge from the sewage treatment plant.



Treated Sewage Discharges, Continued

Land disposal area groundwater monitoring results

The following table summarises the results of groundwater monitoring near to the area where sewage is discharged to land. The location of the bores is shown in the map on page LD.2.

Parameter	Units	1999 Average	2000 Average	Range (Post Commission)
North Bore (Upstream)				
Faecal coliforms	MPN/100ml	< 2	< 2	< 2
Total phosphorus	g.m ⁻³	0.09	0.08	0.07- 0.15
Total ammoniacal-N	g.m ⁻³	0.02	< 0.01	<0.01 – 0.03
Nitrate-N	g.m ⁻³	0.028	0.015	<0.01 – 0.058
Total nitrogen	g.m ⁻³	0.18	0.12	0.12 – 0.20
pH		7.9	8.0	7.8 – 8.1
Conductivity	μS.cm ⁻¹	313	309	309 – 323
South Bore (Downstream)				
Faecal coliforms	MPN/100mL	12	<2	< 2 – 23
Total phosphorus	g.m ⁻³	0.04	0.02	0.02– 0.035
Total ammoniacal-N	g.m ⁻³	0.02	<0.01	< 0.01– 0.02
Nitrate-N	g.m ⁻³	0.28	0.22	0.123– 0.345
Total nitrogen	g.m ⁻³	0.54	0.42	0.36 – 0.62
pH		7.6	7.8	7.4 – 7.9
Conductivity	μS.cm ⁻¹	319	415	252 – 415

Treated Sewage Discharges, Continued

Comments

The discharges of treated sewage onto land during 2000 were within permit limits.

The daily discharge flow was higher than normal on 25 and 26 January and from 14 to 21 November. This may be due to stormwater entering the sewerage system during heavy rainfall events. Such influxes have been investigated, however the location of possible stormwater entry has not been determined.

The nitrate nitrogen and total nitrogen concentrations in the groundwater downstream of the sewage land disposal area are lower than the prior year (1999) and are more aligned with previous years results

In contrast to 1999 results (23 MPN/100 mL), the faecal coliform content of the ground water downstream of the sewage land disposal area for 2000 has returned to a more normal level (0.6 MPN/100 mL). The high result previously reported for 1999 was considered unlikely to have a significant effect on the receiving seawater. It was expected that most, if not all, of the bacteria would have died off by the time the ground water travelled to the coast.

Treated Effluent Discharges

Introduction

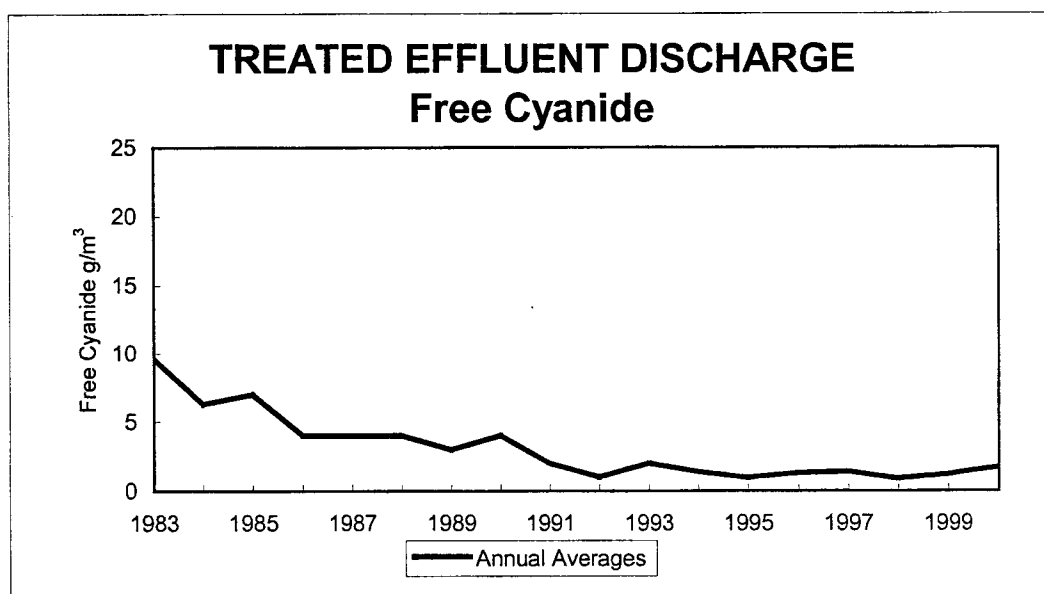
Discharges of treated effluent into Foveaux Strait are covered by Coastal Permit Number 94488 which commenced on 11 October 1996.

Discharge monitoring results

The following table summarises the results of treated effluent discharge monitoring during 2000 and shows a comparison with the 1999 results.

Parameter	Units	Limits	1999 Result	2000 Result
Maximum daily discharge	m ³ /day	140	80	80
Suspended solids				
Maximum concentration	g.m ⁻³	100	26.0	58
Average concentration	g.m ⁻³	-	7.3	9.63
No. of times > 100 g.m ⁻³		0	0	0
Free cyanide				
Maximum concentration	g.m ⁻³	20	5.8	8.7
Average concentration	g.m ⁻³	-	1.2	1.7
No. of times > 100 g.m ⁻³		0	0	0

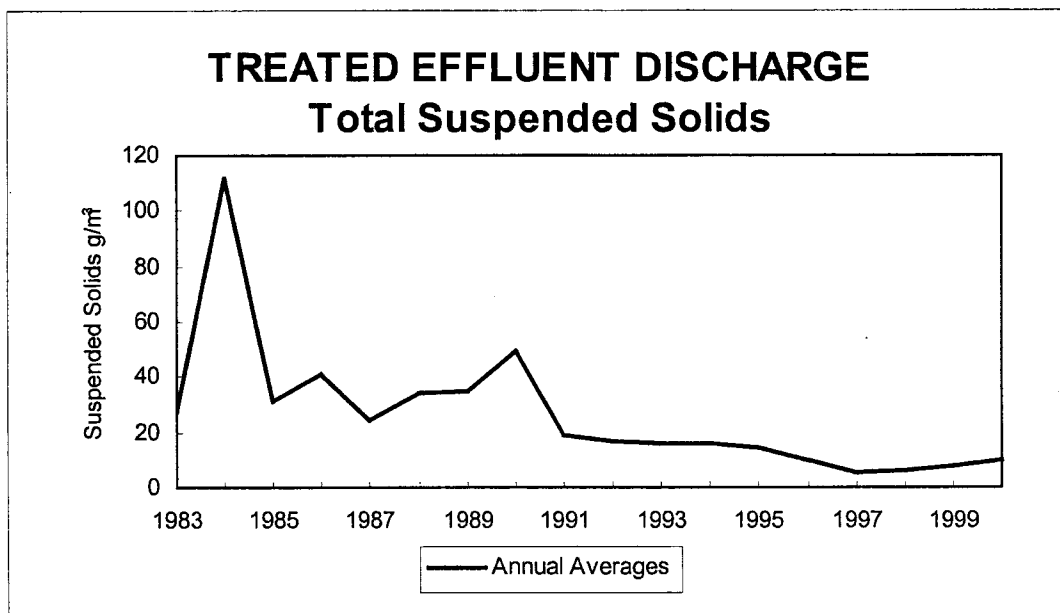
The following graph shows the annual average free cyanide concentration of treated effluent discharged.



Treated Effluent Discharges, Continued

Discharge monitoring results, continued

The following graph shows the annual average total suspended solids concentration of treated effluent discharged.



Coastal water monitoring results

The following table summarises the treated effluent annual coastal water monitoring results during 2000 and shows a comparison with 1999 results.

Parameter	Units	Limit	1999 Result	2000 Result
Difference in temperature	° C	3.0	0.0	0
Minimum dissolved oxygen concentration	mg/litre	5.0	7.8	8.4
Change to pH		0.1	0.0	0
No. of times visible oil observed		0	0	0

Comments

All discharges of treated effluent were within permit limits during 2000.

Landfill Operations

Introduction

Operation of the landfill on the smelter's Tiwai Point property is covered by Discharge Permit No. 94460 issued by the Southland Regional Council on 30 October 1995.

This report covers:

- proposed operation at the landfill for the next twelve months,
- the amount and type of materials deposited at the landfill, and
- groundwater monitoring.

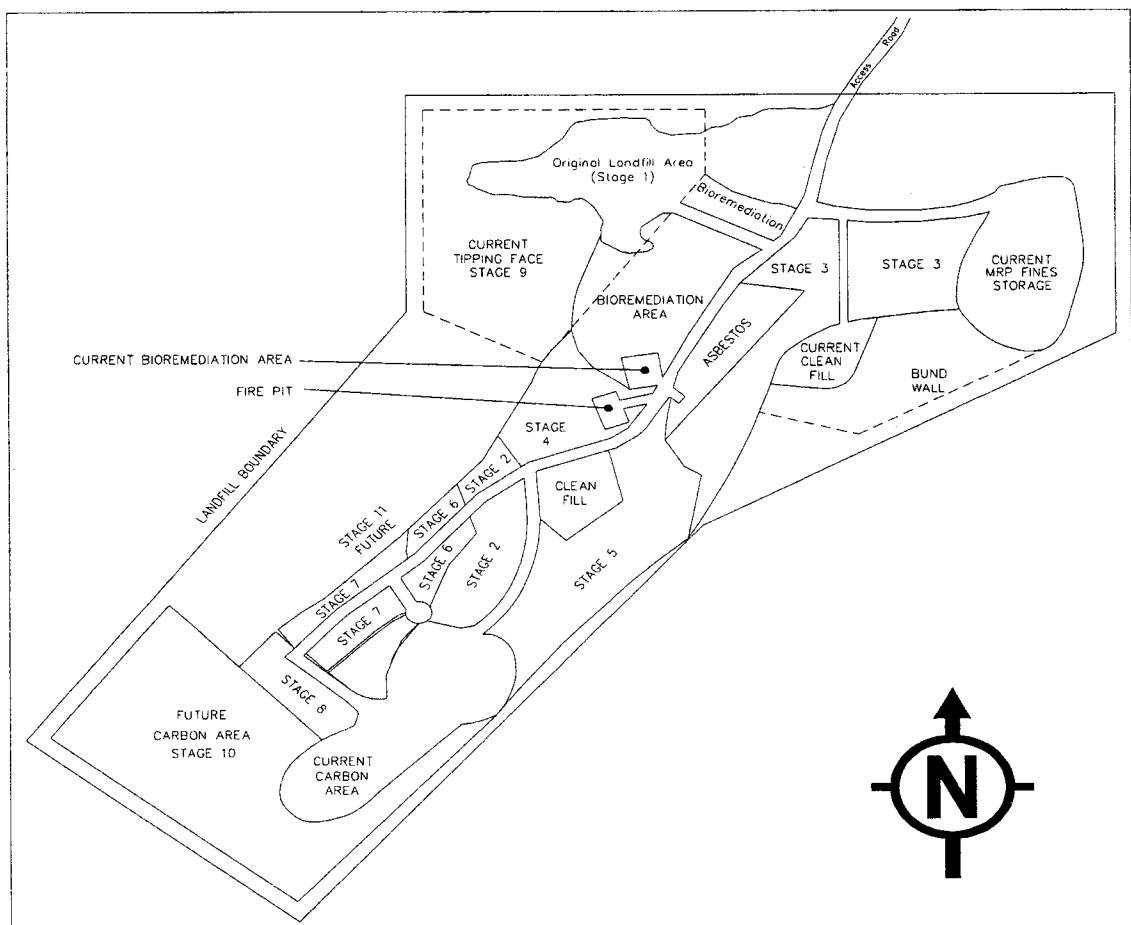
Proposed Operation For 2001

Introduction

The proposed operation of the landfill for 2001 as outlined in the NZAS Landfill Management Plan. Additional details on the proposed operations during 2001 are included in the following sections.

Landfill areas being developed or extended

The following map shows the current landfill disposal and storage areas.



Proposed Operation For 2001, Continued

Landfill areas being developed or extended, continued

Development and extension work during 2000 has largely been completed.

Continued use of the landfill face at stage 8 for the disposal of general waste will cease in March 2001.

The current landfill site for the disposal of general waste will be at stage 9, the north west end, from April 2001.

Active landfill areas will be defined by concrete sleepers.

NZAS aims to revegetate the completed Landfill Cells with native plants, typical of the Tiwai Peninsula and reduce the visual impact of the Landfill.

Stormwater control

NZAS plans to cover the following areas with a layer of pea gravel:

- the surface area up to the current face of the landfill, and
- new sections of the general waste disposal area, as they are completed.

After covering, NZAS plans to continue its practice of levelling and contouring these areas to maximise stormwater run-off and minimise the visual impact of the landfill.

Amount and Type of Materials Deposited

Introduction

Each year the smelter surveys the amount and type of material deposited at the Tiwai Point Landfill. The survey is usually conducted over a period of about four weeks during early summer.

Survey procedure

The survey period for took place from 15 January to 16 February 2001.

- Each truck load of waste was weighed
- The contents and source of each truckload is recorded
- The amount of waste measured during the survey is used to estimate the annual deposition.
- Annual estimates are corrected to account for any special events that may occur during the annual survey.

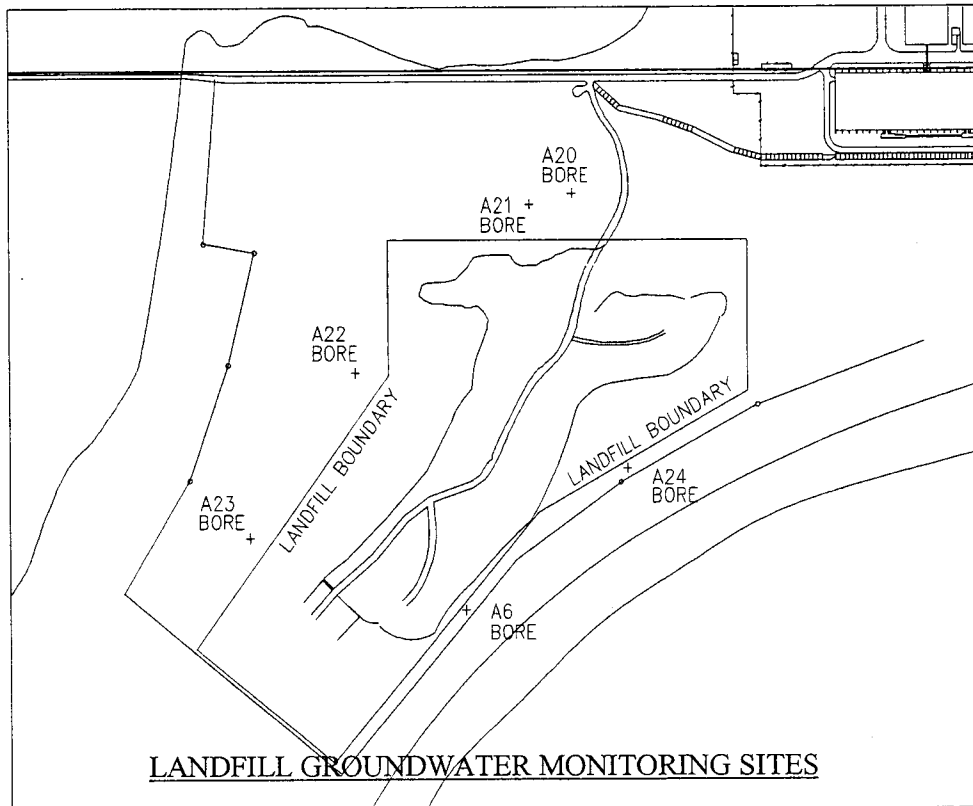
Results for 2000 and estimated 2001 usage

2001	(kg) Per	Yearly	1999/ 2000	(kg) Per	Yearly
TYPE OF WASTE	Month	Estimate (t)	TYPE OF WASTE	Month	Estimate (t)
MRP	103278	1348	MRP	109947	1429
Carbon	229275	2981	Carbon	202762	2636
Bricks	45810	596	Bricks	18650	242
General Waste	40620	528	General Waste	54052	703
Dust Collector Bags	190	2	Dust Collector Bags	20903	272
Furnace Slag	2040	27	Furnace Slag	7120	93
Reject Bath	24280	316	Alumina	18990	247
Resistor Coke	5130	67	Resistor Coke	18420	239
Plastic	820	11	Plastic	970	13
Concrete	15940	207	Concrete	5460	71
Timber	2980	39	Timber	8921	116
Paper	1490	19	Cardboard	1550	20
Furnace Elements	500	7	Furnace Elements	610	8
Gravel	11750	153	Other	2108	
Grass	30	0			27
TOTAL	484133	6293	TOTAL	470463	6116

Landfill Groundwater Monitoring

Site locations

The locations of the groundwater monitoring bores are as shown in the following map. Two of the bores are north (upstream) of the landfill, and there are two bores south east and two bores west (downstream) of the landfill.



Landfill Groundwater Monitoring, Continued

Bore A20 monitoring results

The table below shows a summary of results from samples collected from bore A20 during 1999 and 2000. Bore A20 is located north of the landfill (upstream).

Analyte	Units	1999 Average	2000 Average	Range (since Commissioning)
pH	g.m^{-3}	6.3	6.1	5.8 - 7.2
Alkalinity	g.m^{-3}	77	49	38 - 146
Conductivity	$\mu\text{S.cm}^{-1}$	753	838	676 - 845
Carbonaceous BOD ₅	g.m^{-3}	2	2	1 - 6
Fluoride	g.m^{-3}	0.13	0.17	0.03 - 0.16
Sulphate	g.m^{-3}	34	37	27 - 47
Total Iron	g.m^{-3}	3.4	8.4	0.72 - 13.5
Ammoniacal-Nitrogen	g.m^{-3}	0.11	0.07	0.04 - 0.16
Total Nitrogen	g.m^{-3}	0.42	0.38	0.1 - 1.3
Total Petroleum Hydrocarbons	g.m^{-3}	N.D.	< 2	0.5 - 11.6
Anthracene	mg.m^{-3}	< 0.005	< 0.005	-
Fluoranthene	mg.m^{-3}	< 0.005	< 0.005	-
Naphthalene	mg.m^{-3}	< 0.05	< 0.05	-
Phenanthrene	mg.m^{-3}	< 0.005	< 0.005	-

Landfill Groundwater Monitoring, Continued

Bore A21 monitoring results

The table below shows a summary of results from samples collected from bore A21 during 1999 and 2000. Bore A21 is located north of the landfill (upstream).

Analyte	Units	1999 Average	2000 Average	Range (since Commissioning)
pH	g.m^{-3}	5.8	5.6	5.1 - 6.3
Alkalinity	g.m^{-3}	85	18	10 - 160
Conductivity	$\mu\text{S.cm}^{-1}$	1180	932	683 - 1723
Carbonaceous BOD ₅	g.m^{-3}	9	1	1 - 16
Fluoride	g.m^{-3}	0.46	0.35	0.19 - 0.83
Sulphate	g.m^{-3}	42	57	29 - 101
Total Iron	g.m^{-3}	54.9	8.5	3.16 - 94.6
Ammoniacal-Nitrogen	g.m^{-3}	2.34	0.20	0.05 - 4.6
Total Nitrogen	g.m^{-3}	4.55	1.00	0.99 - 8
Total Petroleum Hydrocarbons	g.m^{-3}	N.D.	< 2	0.005 - 7.3
Anthracene	mg.m^{-3}	< 0.005	< 0.005	0.0025 - 0.03
Fluoranthene	mg.m^{-3}	< 0.005	< 0.005	0.0025 - 0.01
Naphthalene	mg.m^{-3}	< 0.05	< 0.05	0.0025 - 0.1
Phenanthrene	mg.m^{-3}	< 0.005	< 0.005	0.0025 - 0.02

Landfill Groundwater Monitoring, Continued

Bore A22 monitoring results

The table below shows the averages of results from samples collected from bore A22 during 1999 and 2000. Bore A22 is located west of the landfill.

Analyte	Units	1999 Average	2000 Average	Range (since Commissioning)
pH	g.m^{-3}	5.6	4.7	4.2 - 7.3
Alkalinity	g.m^{-3}	18	4	0.5 - 294
Conductivity	$\mu\text{S.cm}^{-1}$	473	608	450 - 1204
Carbonaceous BOD ₅	g.m^{-3}	4	1	1 - 12
Fluoride	g.m^{-3}	1.07	1.99	0.38 - 2.3
Sulphate	g.m^{-3}	12	21	10 - 44
Total Iron	g.m^{-3}	1.7	2.1	0.9 - 3.45
Ammoniacal-Nitrogen	g.m^{-3}	0.22	0.08	0.05 - 0.47
Total Nitrogen	g.m^{-3}	0.85	1.90	0.42 - 2.75
Total Petroleum Hydrocarbons	g.m^{-3}	N.D.	< 2	0.25 - 10.7
Anthracene	mg.m^{-3}	< 0.005	< 0.005	-
Fluoranthene	mg.m^{-3}	< 0.005	< 0.005	-
Naphthalene	mg.m^{-3}	< 0.05	< 0.05	-
Phenanthrene	mg.m^{-3}	< 0.005	< 0.005	-

Landfill Groundwater Monitoring, Continued

Bore A23 monitoring results

The table below shows a summary of results from samples collected from bore A23 during 1999 and 2000. Bore A23 is located west of the landfill.

Analyte	Units	1999 Average	2000 Average	Range (since Commissioning)
pH	g.m^{-3}	5.9	5.8	5.4 - 5.9
Alkalinity	g.m^{-3}	48	42	33 - 60
Conductivity	$\mu\text{S.cm}^{-1}$	589	563	554 - 745
Carbonaceous BOD ₅	g.m^{-3}	1	2	1 - 5
Fluoride	g.m^{-3}	0.04	0.16	0.025 - 0.36
Sulphate	g.m^{-3}	1	2	0.5 - 30
Total Iron	g.m^{-3}	6.4	8.5	5.16 - 13
Ammoniacal-Nitrogen	g.m^{-3}	1.30	0.96	0.05 - 1.4
Total Nitrogen	g.m^{-3}	2.15	1.95	0.88 - 2.7
Total Petroleum Hydrocarbons	g.m^{-3}	N.D.	< 2	0.25 - 7.2
Anthracene	mg.m^{-3}	< 0.005	< 0.005	-
Fluoranthene	mg.m^{-3}	< 0.005	< 0.005	-
Naphthalene	mg.m^{-3}	< 0.05	< 0.05	-
Phenanthrene	mg.m^{-3}	< 0.005	< 0.005	-

Landfill Groundwater Monitoring, Continued

Bore A24 monitoring results

The table below shows a summary of results from samples collected from bore A24 during 1999 and 2000. Bore A24 is located south east of the landfill.

Analyte	Units	1999 Average	2000 Average	Range (since Commissioning)
pH	g.m^{-3}	7.2	7.3	6.9 - 7.4
Alkalinity	g.m^{-3}	1065	798	565 - 1182
Conductivity	$\mu\text{S.cm}^{-1}$	3650	2875	2110 - 4410
Carbonaceous BOD ₅	g.m^{-3}	10	9	2 - 17
Fluoride	g.m^{-3}	3.04	8.80	0.49 - 21
Sulphate	g.m^{-3}	26	21	5 - 312
Total Iron	g.m^{-3}	18.2	20.8	13 - 24
Ammoniacal-Nitrogen	g.m^{-3}	105.35	68.95	44 - 146
Total Nitrogen	g.m^{-3}	116.50	86.00	16.8 - 152
Total Petroleum Hydrocarbons	g.m^{-3}	N.D.	< 2	0.25 - 18.6
Anthracene	mg.m^{-3}	< 0.005	< 0.005	0.005 - 0.26
Fluoranthene	mg.m^{-3}	< 0.005	< 0.005	0.0025 - 0.036
Naphthalene	mg.m^{-3}	< 0.05	< 0.05	0.861 - 82
Phenanthrene	mg.m^{-3}	< 0.005	< 0.005	0.0025 - 0.07

Landfill Groundwater Monitoring, Continued

Bore A6 monitoring results

The table below shows a summary of results from samples collected from bore A6 during 1999 and 2000. Bore A6 is located south east of the landfill.

Analyte	Units	1999 Average	2000 Average	Range (since Commissioning)
pH	g.m^{-3}	6.7	6.7	6.4 - 6.8
Alkalinity	g.m^{-3}	694	652	568 - 850.5
Conductivity	$\mu\text{S.cm}^{-1}$	3745	3545	158 - 5689
Carbonaceous BOD ₅	g.m^{-3}	3	2	1 - 6
Fluoride	g.m^{-3}	10.01	27.25	1.5 - 104
Sulphate	g.m^{-3}	1035	901	798 - 2050
Total Iron	g.m^{-3}	15.8	13.4	9.9 - 22.6
Ammoniacal-Nitrogen	g.m^{-3}	20.25	13.50	1.25 - 31.5
Total Nitrogen	g.m^{-3}	29.50	27.00	9.7 - 44
Total Petroleum Hydrocarbons	g.m^{-3}	N.D.	< 2	0.25 - 9.2
Anthracene	mg.m^{-3}	< 0.005	< 0.005	0.05 - 0.62
Fluoranthene	mg.m^{-3}	< 0.005	< 0.005	0.0025 - 0.09
Naphthalene	mg.m^{-3}	< 0.05	< 0.05	0.0025 - 0.05
Phenanthrene	mg.m^{-3}	< 0.005	< 0.005	0.005 - 0.07

Landfill Groundwater Monitoring, Continued

Comments

Apart from Bore A24 and A6 the groundwater monitoring data from the bores near the landfill do not indicate any significant trends in the general groundwater quality during 2000.

Samples collected from Bore A24 and A6 in Quarter Four of 1999 contained higher concentrations of nitrogen species and fluoride than previously measured at this bore.

The increased concentrations are unlikely to have an impact on the receiving seawater in Foveaux Strait.

High fluoride concentrations observed for these bores prompted further sampling and analysis at 2-monthly intervals during 2000.

The results for A24 and A6 returned to previously recorded annual levels.

The increase in analyte concentrations at Bores A24 and A6 most likely indicate the proximity of the bore to the MRP fines storage area. It is likely that:

- variations in the analyte concentrations are related to variations in the amount of leachate entering the groundwater, and
- increased analyte concentrations represent periods when high rainfall produces larger volumes of leachate.

The hydraulic conductivity of groundwater eastern side of the landfill was estimated at about 2.5 m/day in 1994 by consultants employed by NZAS. Bore A24 is about 200 metres south west of the MRP fines storage area and A6 a further 300 m. Variation of analyte concentrations in groundwater sampled at Bore A24 and A6 are likely to represent variation in leachate volume near the MRP fines storage area at least three months previously.

Groundwater

Spent Cathode Pad leachate

As a result of the SRC decision (1999) that recommended a cessation of monitoring of the Spent Cathode Pad leachate and the annual monitoring of the Bioremediation of Diesel Contamination for a period of three years, no annual report is available. Monitoring will resume at both sites whereby a "snapshot" study after the three year period in 2002 will determine the necessity of future monitoring.

In the interim, NZAS has decided to maintain a limited monitoring program of the Spent Cathode Pad leachate to ensure any future leakage is determined early and appropriate action may be taken to avoid damage to the environment.

This monitoring includes measuring the conductivity in the groundwater of three monitoring wells at six-monthly intervals, and a further six wells at 12 monthly intervals.

Spent Cell Lining Storage Shed

Monitoring of the membranes under the Spent Cell Lining storage shed continued during 2000. Minor leakage into the leak detection system continued from 1999. The volume of the leachate was low and there is no indication that the liquid was able to escape from the detection system. Contaminant concentrations in the leachate for the deeper ports increased slightly from 1999 levels but remained low and due to their containment, they are unlikely to be a risk to the groundwater.