New Zealand Aluminium Smelters Limited

Interdepartmental

Committee

Report

2001

REPORT TO THE INTERDEPARTMENTAL COMMITTEE ON ENVIRONMENTAL EFFECTS OF THE TIWAI ALUMINIUM SMELTER FOR THE YEAR ENDING 31 DECEMBER 2001

MEETING AT TIWAI
8 April 2001

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Main Stack

Main stack discharges to air were within permit standards and generally stable during 2001.

Potline Roof Louvres

Potline roof louvre discharges were within permit standards during 2001. The new flows and factors as per 1999 Potline Roof louvre Airflow and Discharge Report will be applied from 2002. The louvre graphs in this report show the values for 2001 with both the old and new factors and flows for comparison purposes only. Generally roof louvre discharges showed a decrease during 2001 but was this is possibly due to the plant operating under power constrains during the national electricity shortage. During the electricity shortage (May to November) there was an average of 40 cell not operating.

Dispersion

Wind speeds were generally similar to 2000. Monthly rainfall for 2001 was below average for most of the year.

Ambient Air

Ambient air gaseous and particulate fluoride concentrations during 2001 showed a slight increase on those reported for 2000 for the 1km Hut and the No. 1 Bore site but still well within permit standards.

Atmospheric Deposition

Some high fluoride and reactive aluminium results were measured during March and September. This is mostly likely due to the very low rainfall during these months. The Waituna Wetlands survey was completed in 2001.

Vegetation

The fluoride concentrations of ungrazed grass close to the smelter were generally lower than the concentrations measured in 2000. This may be due to the decrease in roof louvre discharges during 2001. Fluoride concentrations off Comalco land were similar to the fluoride concentrations reported for 2000.

Fluoride in Pinus radiata needles at Bluff and Tiwai Point showed a slight increase in fluoride concentration during 2001 while the sites on the north side of Awarua Bay were at similar levels to 2000. The two sites close to the smelter were also at similar levels to 2000. Three sites, (P3, P4 and P5) were removed during 2001 as part of an agreement with the Department of Conservation to remove exotic species from Comalco leasehold land.

The fluoride concentrations of grazed grass for all monitoring farms and cattle urine and cattle bone on GMF4 were within permit standards during 2001 and similar to previous years.

The four yearly assessment of vegetation condition was completed during 2001.

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 average free cyanide level measured in the treated effluent has increased slightly during 2001. This may be due to an increase in Line 4 cells being processed during 2001.

Landfill

Monitoring of groundwater near the NZAS landfill during 2001 generally indicated similar results to 2000. Bores located downstream of the landfill face are showing increasing concentrations of 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. MRP fines are no longer being generated so the area at the landfill will no longer be used. Bore A24 showed an elevated level of Naphthalene in the quarter three surveys. This is not thought to be of concern as the levels have varied greatly in the past.

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 Environment Southland 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 were difficult during 2001 due to the national electricity shortage. NZAS operated under power constrains from May to November with an average of 40 cells not operating. Initiatives to improve the smelters 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,
- 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 2001. The averages are equivalent to the 12 month running average for the period ending December 2001.

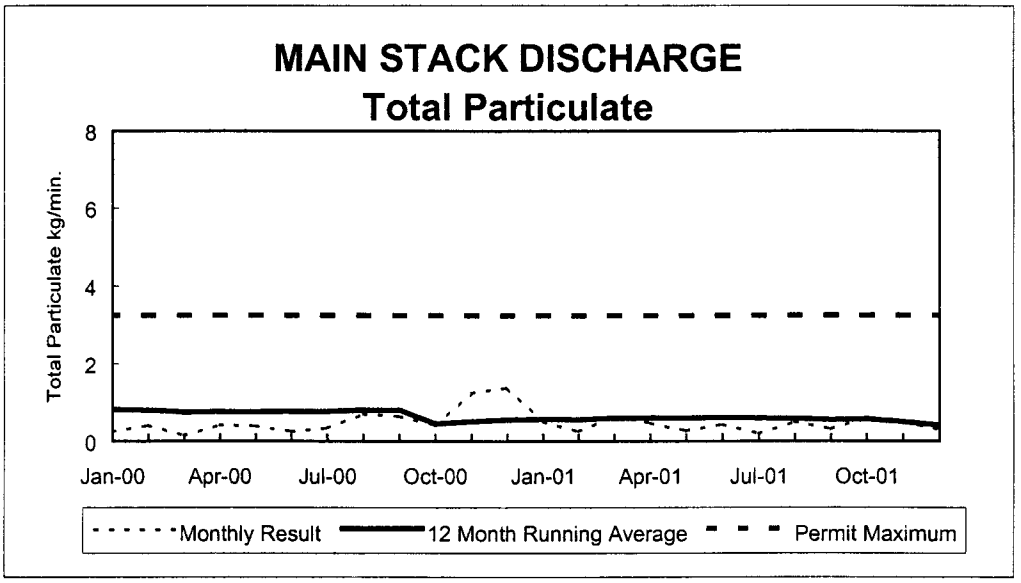
Parameter	Units	Running 12 month average		
		Standard	2001 Result	Maximum for any month
Gas flow rate	Sm^3/ min	-	59,600	-
Total particulate	kg/min	3.25	0.41	0.64
Gaseous fluoride	kg/min	0.65	0.14	0.21
Particulate fluoride	kg/min	1.94	0.01	0.02
Sulphur dioxide	kg/min	-	11.6	12.5
Total condensable hydrocarbons	kg/min	-	0.21	-
Polycyclic aromatic hydrocarbons	kg/min	-	0.03	-

Main Stack Discharges, Continued

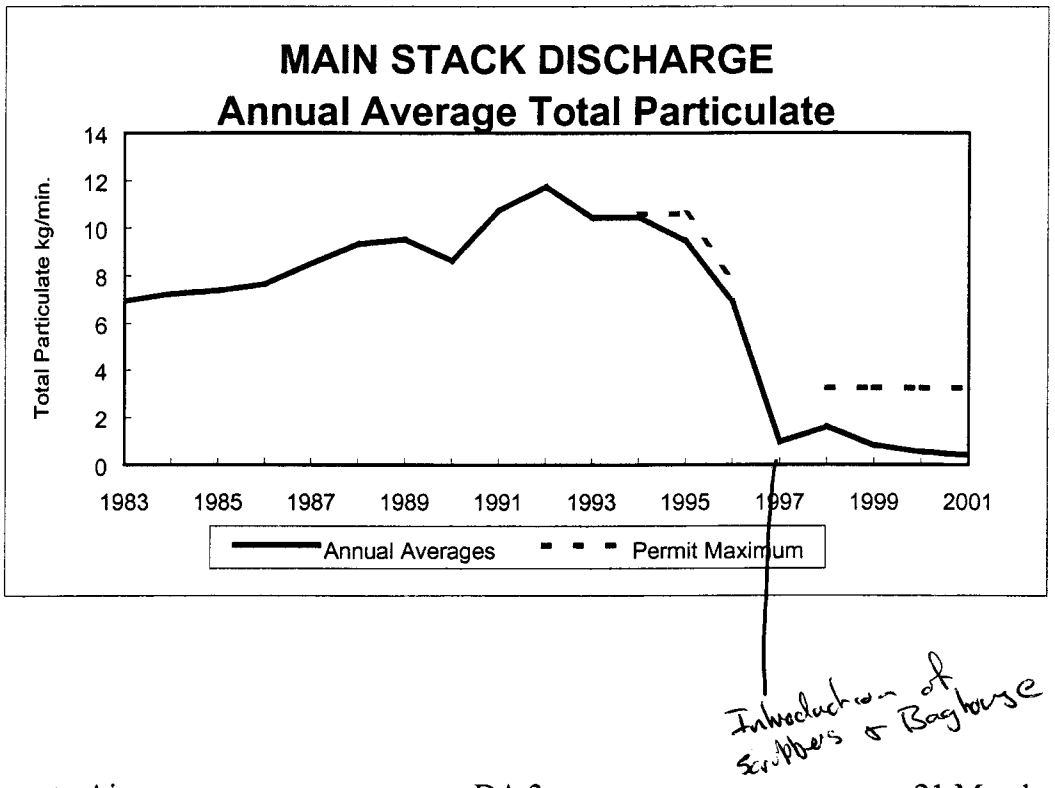
Total particulate

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 2000 and 2001.



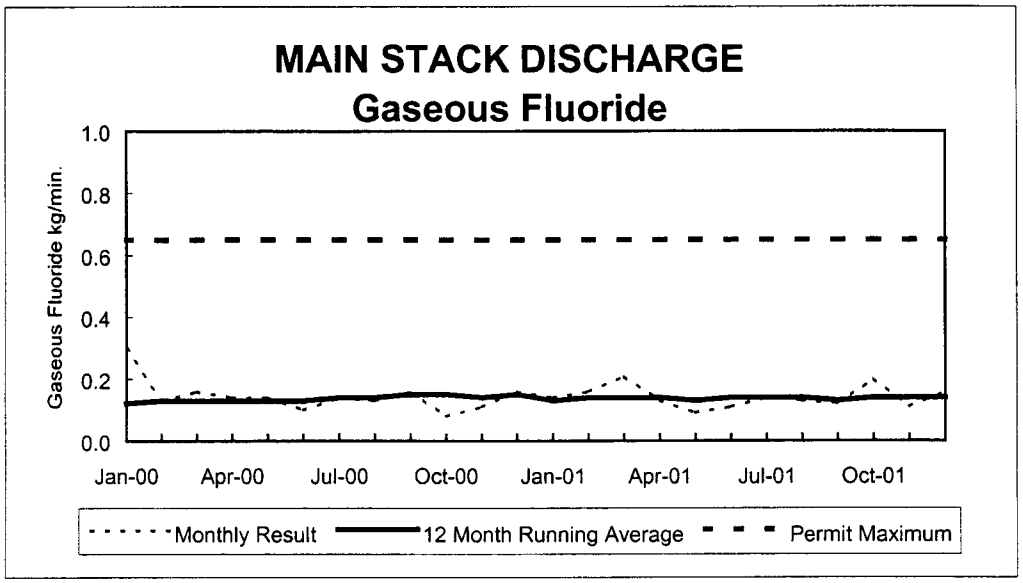
The following graph shows the annual average main stack total particulate discharge.



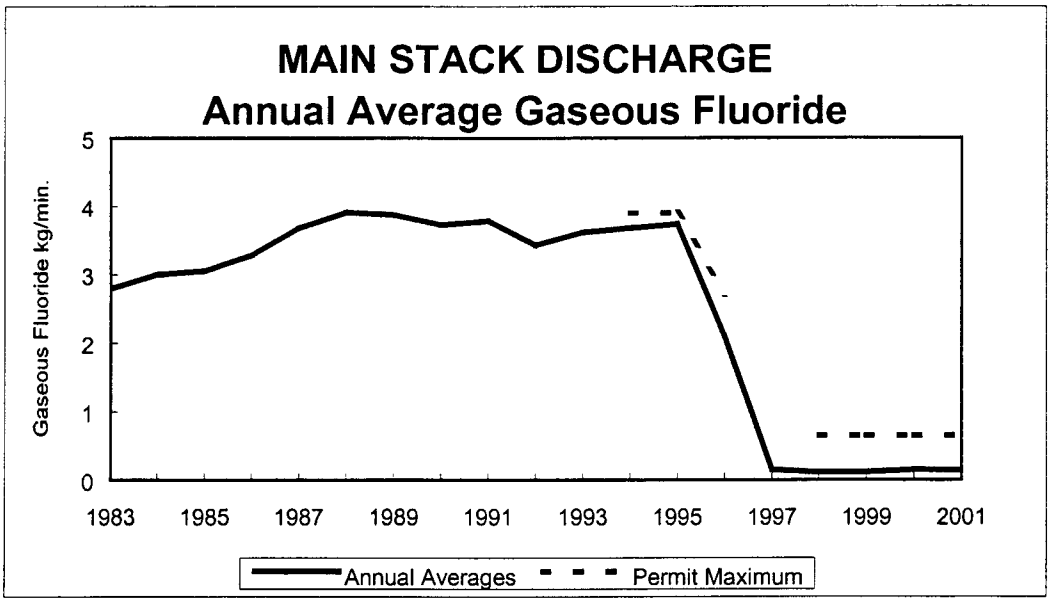
Gaseous fluoride

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 2000 and 2001.



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

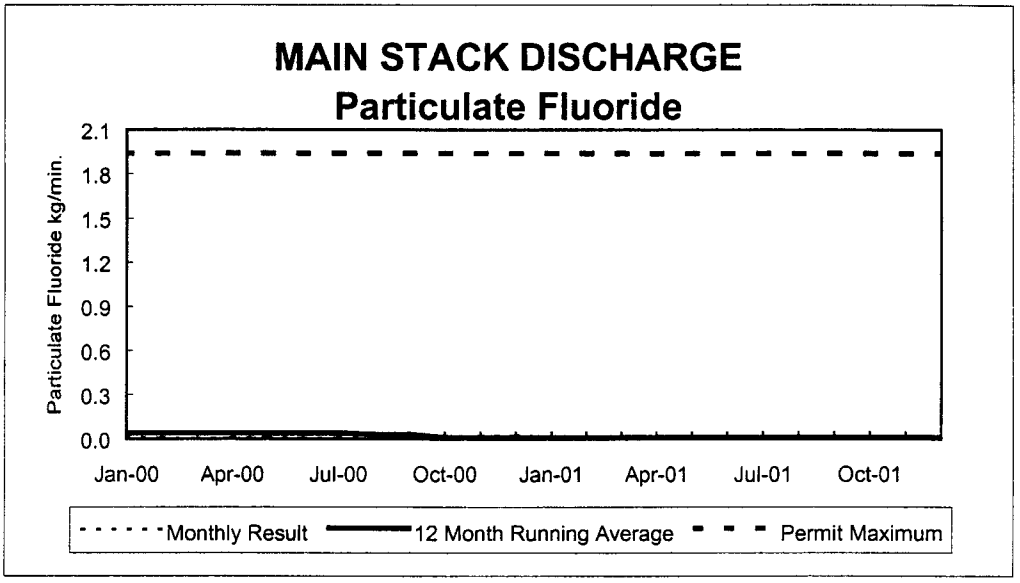


Main Stack Discharges, Continued

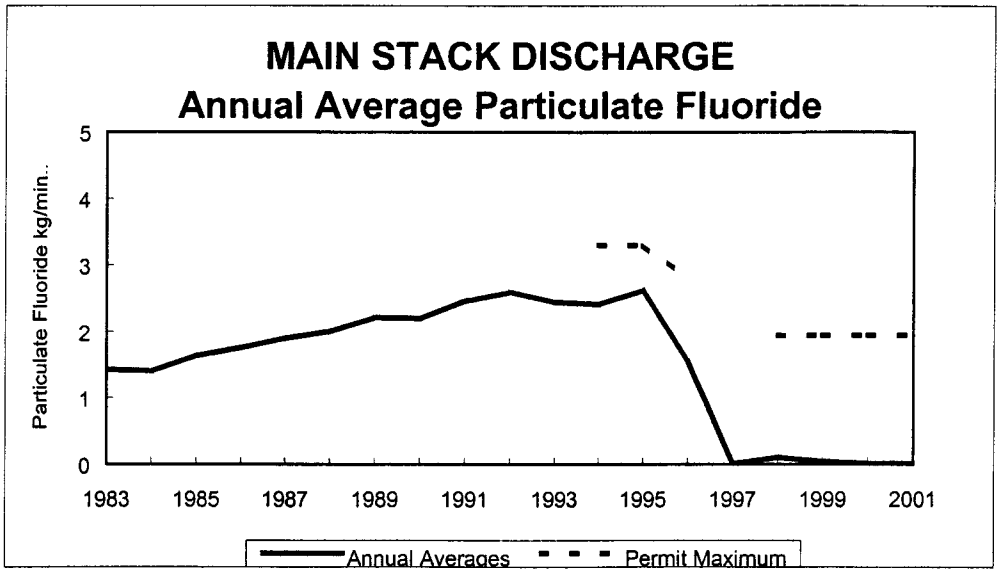
Particulate fluoride

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

The following graph shows both the average monthly, and the12 monthly running average main stack particulate fluoride discharge during 2000 and 2001.

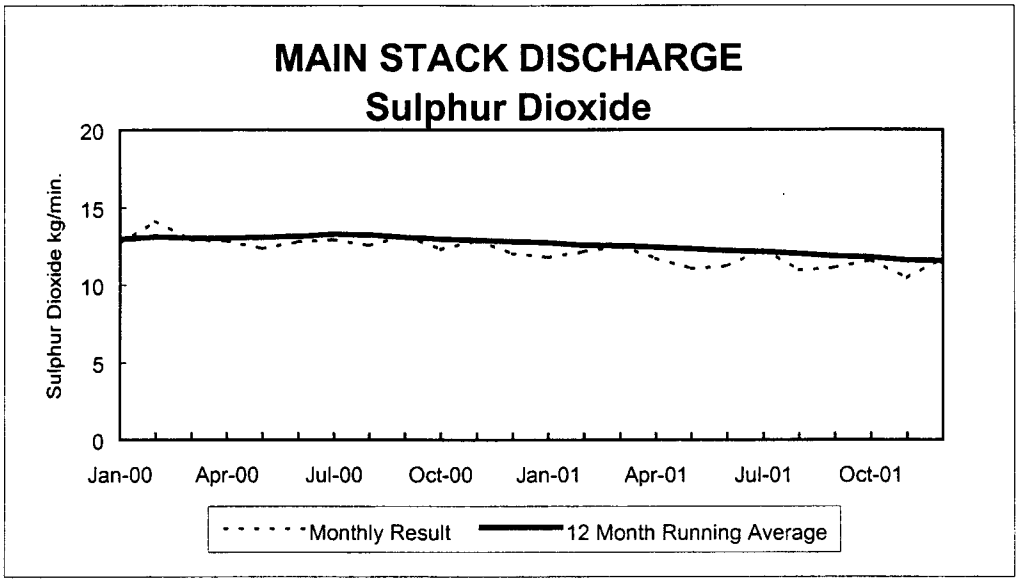


The following graph shows the annual average main stack particulate fluoride discharge.

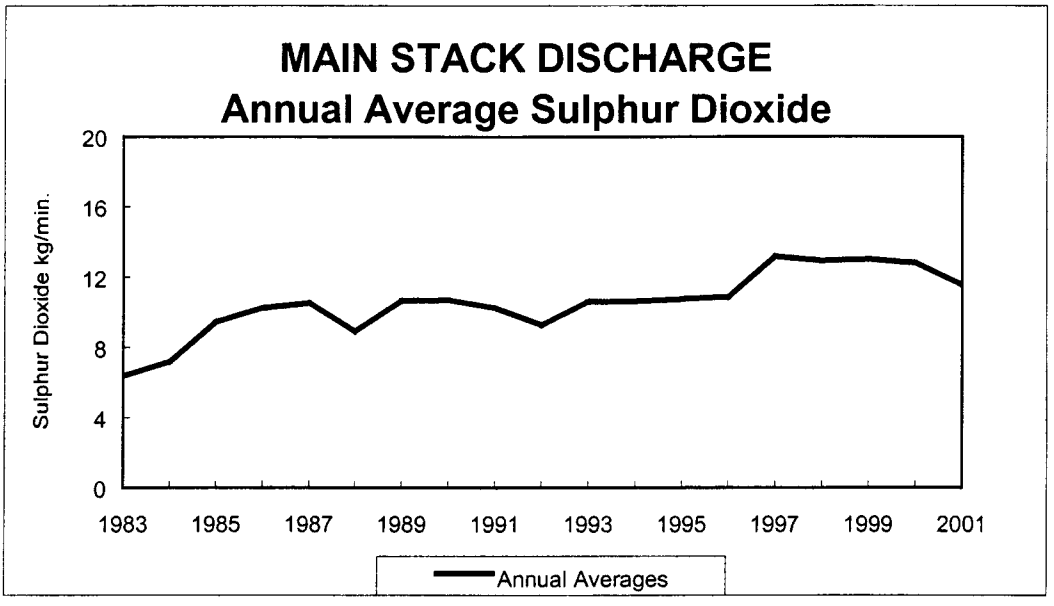


Sulphur Dioxide

The following graph shows both the average monthly and 12 monthly running average main stack sulphur dioxide discharge during 2000 and 2001.

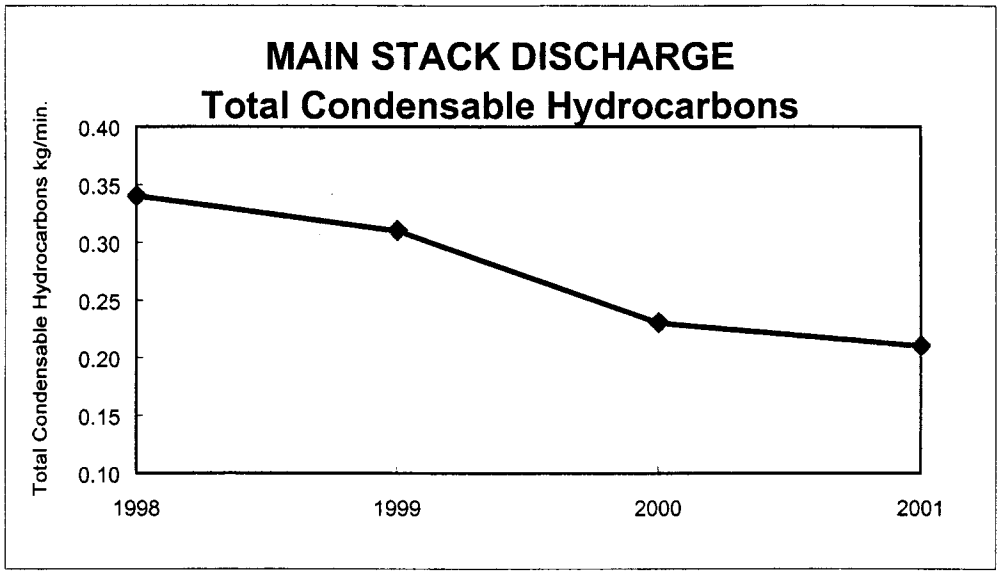


The following graph shows the annual average main stack sulphur dioxide discharge.

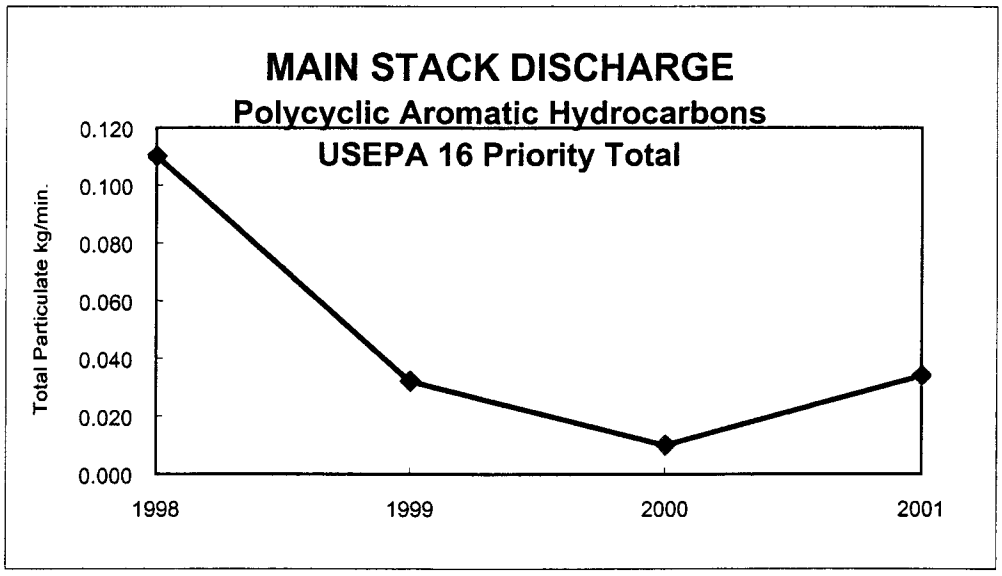


Total Condensable Hydrocarbons and Polycyclic Aromatic Hydrocarbons

The annual analysis for Total condensable hydrocarbons and 16 priority USEPA PAH was carried out during October 2001. The following graph shows the annual Total Condensable hydrocarbons discharges.



The following graph shows the annual result for 16 Priority USEPA polycyclic hydrocarbons.



Main Stack Discharges, Continued

Comments

Discharges of total particulate, gaseous fluoride and particulate fluoride from the main stack were within the permit standards throughout 2001.

From May to November due to the national electricity shortage NZAS was operating under power constraints. During this time NZAS had on average of 40 cells not operating. Cells were re-commissioned from November. At year - end 12 cells still had not been re-commissioned.

Total condensable hydrocarbons measured in October 2001 were similar to those measured in October 2000. The 16 USEPA PAH level has increased slightly from that measured in 2000 but is at a similar level to that measured in 1999.

Potline Roof Louvre Discharges

Monitoring results

The table below shows the Potline roof louvre monitoring results for 2001. The permit standards are for 12 month running averages.

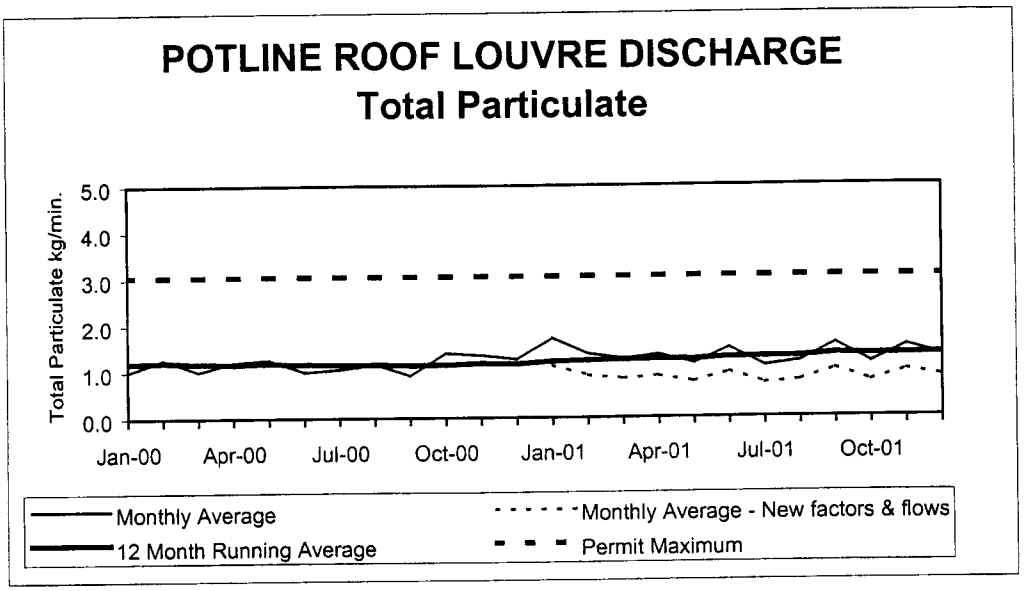
Parameter	Units	Running 12 month average		
		Standard	2001 Result	Maximum for any month
Total particulate	kg/min	3.05	1.35	1.70
Gaseous fluoride	kg/min	0.38	0.12	0.16
Particulate fluoride	kg/min	0.38	0.18	0.23
Sulphur dioxide	kg/min	-	0.31	0.45

Potline Roof Louvre Discharges, Continued

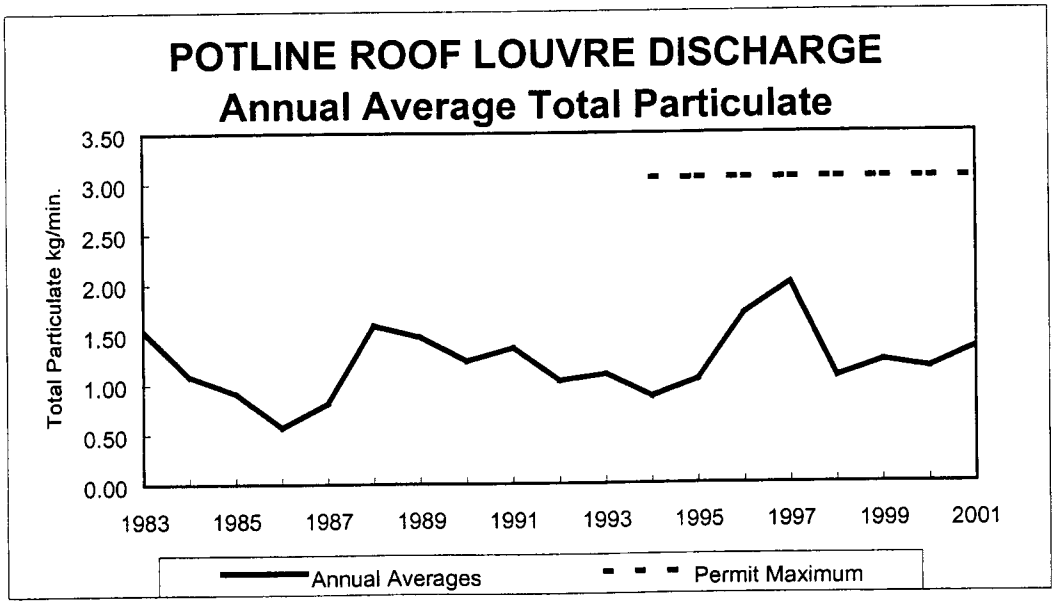
Total particulate

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 2000 and 2001. It also shows the monthly average for 2001 applying the new flows and factors as per 1999 Potline Roof Louvre Airflow & Discharge Report.



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



The report also recommended that a photographic record of selected flax be established to assist in the four-yearly vegetation health assessments. This is being implemented.

Impacts on Awarua and Waituna Wetlands

NZAS undertook monitoring of the water quality from surface water in both the Awarua and Waituna wetlands. Whilst some minor elevation of fluoride was located in the Awarua wetlands, this was not significant.

The report determined that the largest impact on the adjoining vegetation, and species mix, was due to the natural low pH of the water in this area. There was no evidence of detrimental impacts resulting from NZAS activities.

Regular monitoring

NZAS has continued its routine monitoring, with monthly, quarterly and annual reports being supplied as required.

Split sample comparisons have been good, however despite the extended time frames for ambient gaseous and particulate fluoride monitoring, results still remain below the 0.1 $\mu g/m^3$ detection levels.

JDR (James) Holloway
Environmental Compliance Manager

In the 1997 report, it was believed that the vertical component of gas flow was between 99 and 100% of total flow. However in 1999, after the side louvres had been raised, the vertical component was measured and found to be 83% of total flow. This required an anemometer which would determine the vertical velocity only. Production and calibration of such an anemometer took some time.

The result of the 1999 measurements were that the total flow was 593,900 standard cubic metres per minute, with a 95% confidence interval of 3.6% of total flow. This was a substantial reduction on the 1997 measurement of 853,800 standard cubic metres per minute. As a consequence of the reduction in air flow out the roof louvres there is a step-wise reduction in contaminant mass discharged, due to the reduced gas volume.

Average concentrations of contaminants were generally similar between the 1997 and 1999 measurements, with only the gaseous fluoride showing a small increase from 0.14 mg/m^3 to 0.19 mg/m^3. The result of the reduced air flows and reasonably similar contaminant concentrations, was a 10% decrease in gaseous fluoride, 10% decrease in sulphur dioxide, 34% decrease in total particulate, and 27% decrease in particulate fluoride compared to the 1997 values. Both sets of calculations will be reported to the Committee to enable members to see the changes occurring as a result of the new measurements.

Irrespective of the method of calculation, the resultant discharges were all well below consent limits.

4 Vegetation Health Assessment

The four-yearly report on the condition of vegetation, both on and off the Tiwai Peninsula was also undertaken in 2001. The report generally concluded that the ecosystems on the Tiwai Peninsula and Waituna Wetlands are in satisfactory health.

There appeared to be progressive increases in the density of species such as native flax on the Peninsula since the elimination of grazing. It was also considered that no intervention is required to improve the condition of the ecosystems beyond the continuation of existing programmes for the control of weed and pest species.

The report noted that visible injury to native flax plants was detectable for distances up to approximately 800 metres east of the Smelter, and approximately 900 metres along the access road from the entrance drive. Generally the extent of injury to the east of the Smelter was about one quarter of that recorded in 1997.

The Botanical Consultant, Dr Doley, from the Department of Botany, University of Queensland, concluded that native flax appeared to be relatively sensitive to gaseous fluoride. His report noted that the question of using flax as a monitoring species to replace pinus radiata should be considered. This is especially in light of the declining numbers of pinus radiata available for monitoring, due to the progressive removal of the species from the Peninsula. However, given the current state of fluoride discharges, and the results of the vegetation monitoring, it would be difficult to justify costs of developing suitable protocols for flax analyses. As a consequence, no work will be undertaken to determine the suitability of flax as a monitoring species.

Report to the Interdepartmental Committee NZ Aluminium Smelters

environment SOUTHLAND
Te Taiao Tonga

(compiled by James Holloway, Environmental Compliance Division Manager)

(File N015-020)

Air Discharges

2001 was a relatively busy year for the Smelter and Environment Southland.

The Smelter has requested and received, in January 2001, approval to use the Inter-governmental Panel on Climate Change Best Practice Guidelines Calculation Methods for the calculations of perfluorocarbon discharges. The Best Practice Guidelines recommended changes to the calculations which are specific to the various Smelter designs and cell types. The IPCC calculation method resulted in approximately a 25% reduction for CF4 and 4% reduction in C2F6, when compared to the previous calculation methods.

Irrespective of changes in the calculation methodology, there has been an ongoing trend of reducing anode effects, and consequently reducing perfluorocarbon discharges as a consequence.

Potline roof louvre air flow and discharge report

In 1999 work was commenced on the potline roof gas flow measurement, in accordance with condition D3.3, which requires the measurement and reporting to the Council at two yearly intervals. However, during the 1999 measurements, a number of technical difficulties were discovered. The technical difficulties have been resolved, but in resolution, indicated that previous monitoring work (undertaken in 1997) may have been incorrectly estimating the total gas flows.

There are two areas of significance. One was the increased reported flows as a consequence of using sensor extension cables on a number of measurements, and the second is a non-vertical vector in the air flow measurements.

The discovery that two sensor extension cables with the anemometer resulted in the velocity measurements being over-estimated by approximately 23%, was unexpected, and has not previously been noted by either the manufacturer or supplier. It did raise the interesting issue that calibration of the equipment by bodies such as CSIRO had only ever used the single cable, and the addition of cables to enable measurements at longer distances had always been assumed to have negligible effect.

The Smelter has increased the height of the side louvres to improve working conditions for potline operators. The increased air flows through the opened louvres is believed to have changed the velocity profiles through the potline roof.

The levels of contaminants in the groundwater are unlikely to have any significant effect on the surrounding environment.

Martin D Keller
Senior Technical Officer Water and Wastewater

Report to the Interdepartmental Committee NZ Aluminium Smelters

environment SOUTHLAND
Te Taiao Tonga

(compiled by Martin Keller, Senior Technical Officer Water and Wastewater)

(File N015-020)

North Drain, West Drain, and South Drain Discharges

The discharges from these drains complied with consent limits throughout the year. The effects of the discharge on the receiving coastal environment is likely to be minor. The results show a decrease in the amount of suspended solids when the annual average of the 2000 year are compared to the 2001 year.

Treated Effluent Discharge

The monitoring data of the treated effluent shows compliance with discharge limits on all occasions. The suspended solids content decreased considerably in the year 2001 compared to 2000 (annual averages). The free cyanide concentrations in the discharge however, are showing an increasing trend over the last few years. This is believed to be due to an increase in the number of cells relined from Line 4. The coastal monitoring undertaken October 2001 does not indicate any adverse effects on the receiving waters.

Treated Sewage Discharge

The quality of the treated sewage is very good with regard to BOD_5 and total suspended solids, and well below consent limits. The monitoring of the groundwater shows a slight increase in nitrogen species in the South Bore (downstream) compared to the North Bore (upstream). The levels are, however, lower than the average over the year 2000. I do not consider these levels to indicate any significant adverse effects from the sewage discharge.

Water Take

The water take did not exceed the daily limit of 4,546 m^3.

Landfill Groundwater Monitoring

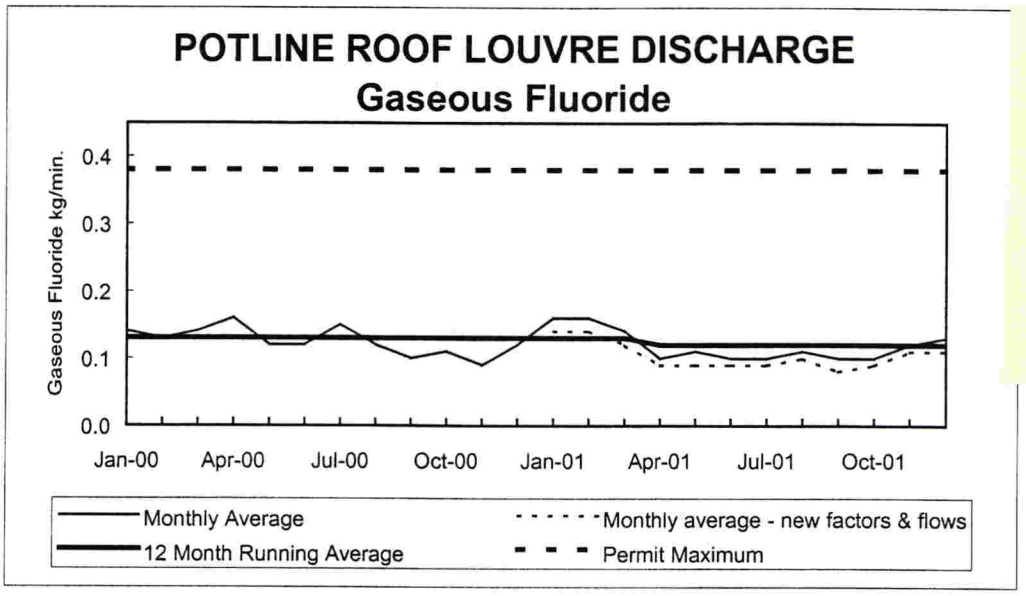
Most parameters monitored in the six groundwater bores around the landfill have been within the range of previous monitoring results. In Bore A24 to the east and downstream of the landfill, increasing levels of Naphthalene have been detected. In Bores 6 and 24, increased levels of fluoride have also been found.

The fluctuating levels of contaminants are most likely associated with the MRP fines storage area. However, deposition of MRP fines has stopped during quarter three.

Gaseous fluoride

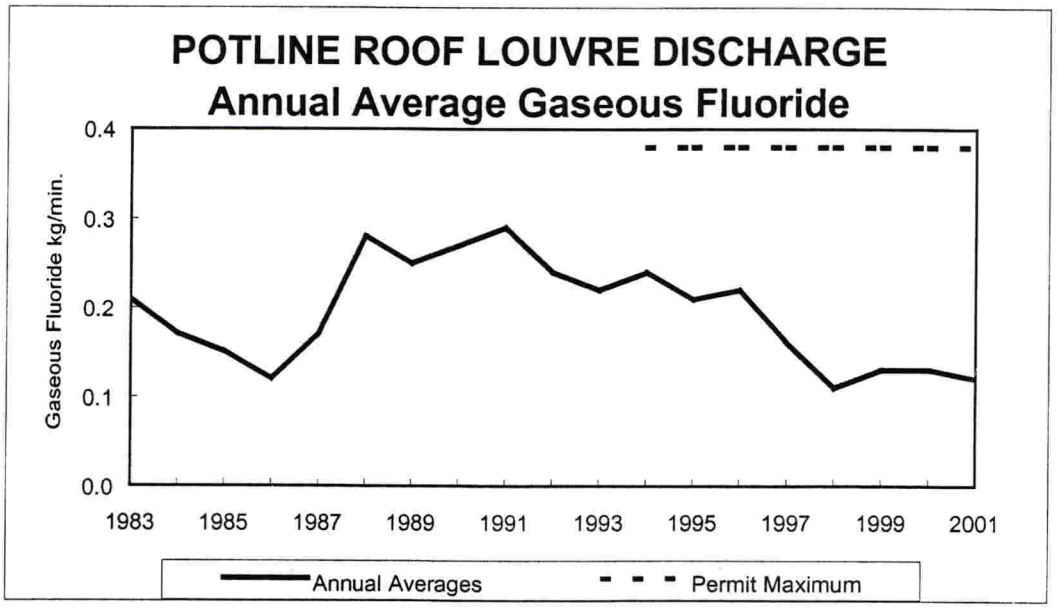
Standard: 12 month running average not to exceed 0.38 kg/min.

The following graph shows both the average monthly and 12 month running average Potline roof louvre gaseous fluoride discharge during 2000 and 2001. It also shows the monthly average for 2001 applying the new flows and factors as per 1999 Potline Roof Louvre Airflow & Discharge Report.



Note in place of revised gas flows

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

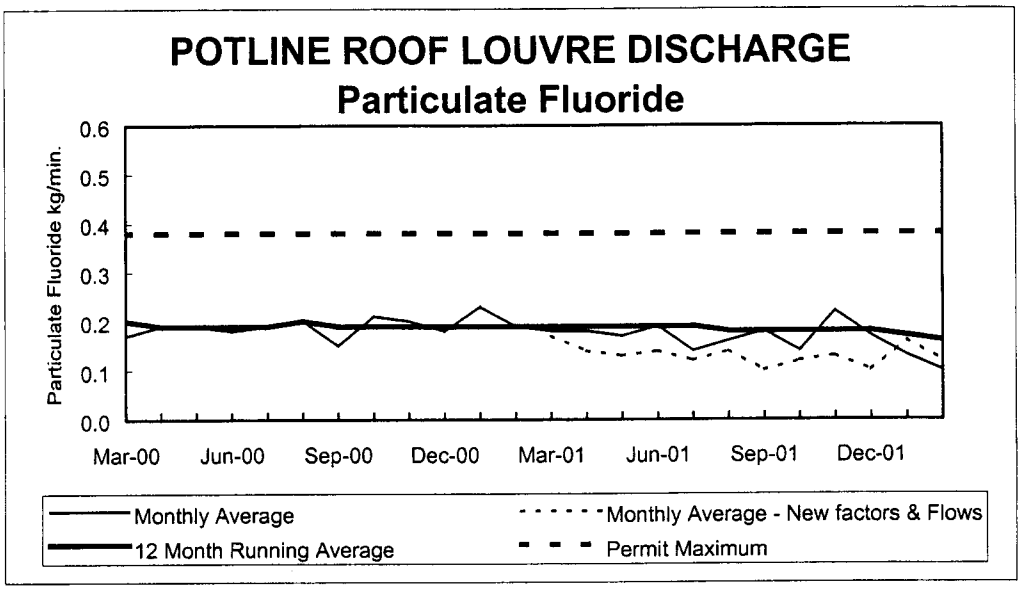


Potline Roof Louvre Discharges, Continued

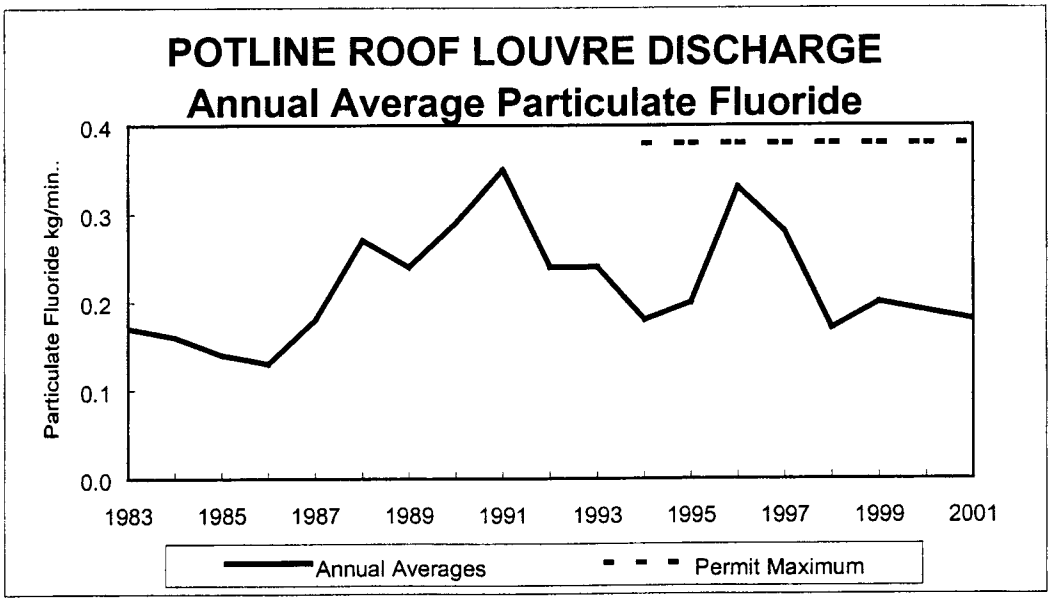
Particulate fluoride

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 2000 and 2001. It also shows the monthly average for 2001 applying the new flows and factors as per 1999 Potline Roof Louvre Airflow & Discharge Report.

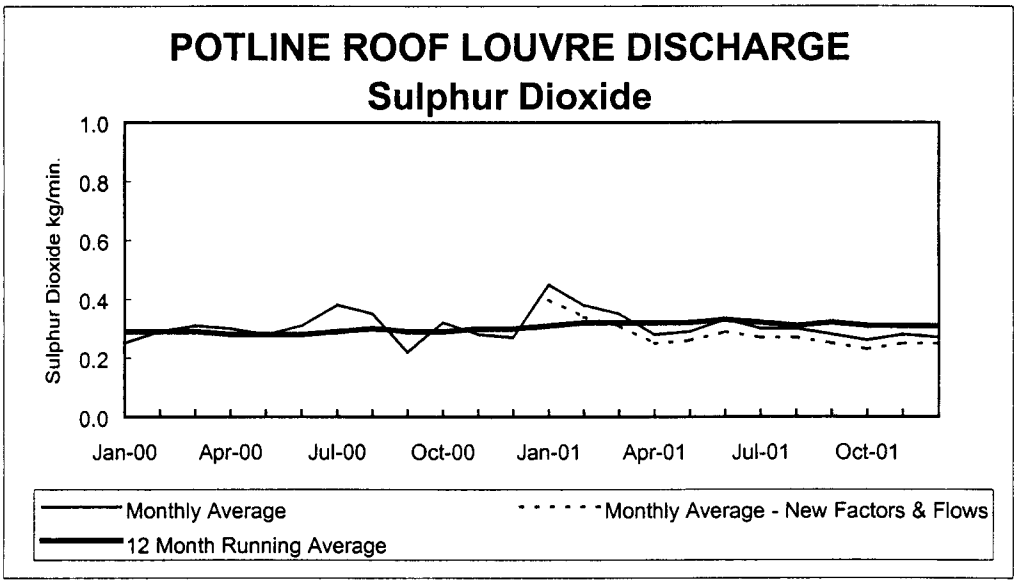


The following graph shows the annual average data for Potline roof louvre particulate fluoride discharge.

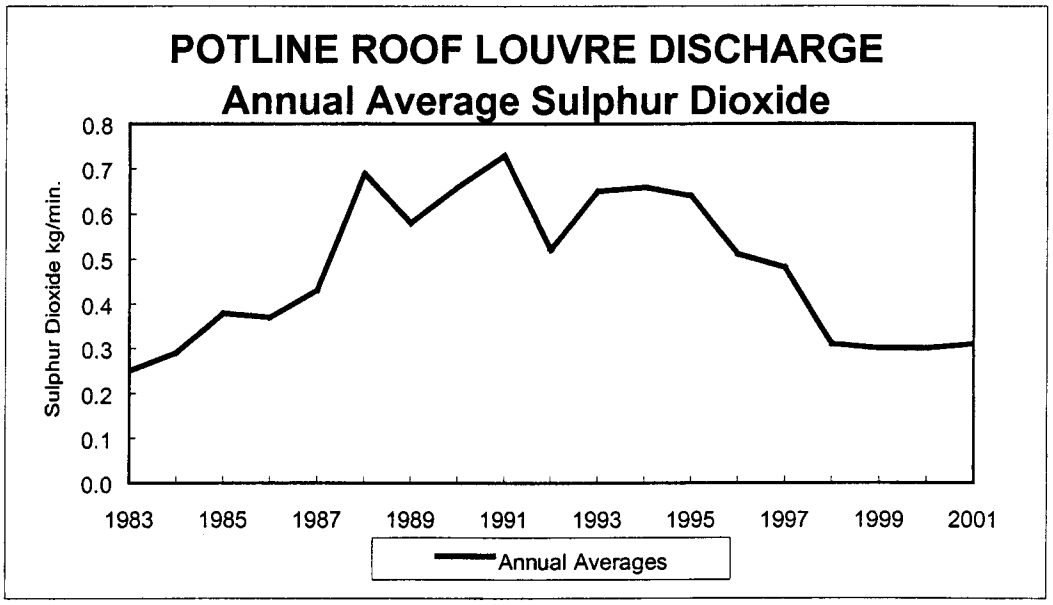


Sulphur dioxide

The following graph shows both the average monthly and 12 month running Potline roof louvre sulphur dioxide discharge during 2000 and 2001. It also shows the monthly average for 2001 applying the new flows and factors as per 1999 Potline Roof Louvre Airflow & Discharge Report.



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



Comments

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

From May to November due to the electricity shortage NZAS was operating under power constraints. During this time NZAS had on average of 40 cells not operating. Cells were re-commissioned from November. At year - end 12 cells still had not been re-commissioned.

The two yearly measurement of Potline roof louvre gas flow and verification of the Line 2A sampling manifold, due 1999/2000 was completed and issued in November 2001. The new flows and factors will be applied from January 2002. The Monthly average graphs show 2001 data both with the old flows and factors and the new flows and factors for comparison purposes.

The new flows and factors appear to decrease the discharges but as mentioned in the 1999 Potline Roof Louvre Airflow and Discharge report, comparing the 1999 concentration data to the 1997 data:

- gaseous fluoride has increased due to increased AlF_3 usage, increased metal production and some process instability,
- sulphur dioxide and particulate fluoride is unchanged, and
- total particulate has decreased due to better housekeeping.

The measured 1999 flow was 593,900Sm^3/min compared to the 1997 measured flow of 853,800 Sm^3/min. It is believed that the 1999 flow is correct and it has not decreased from the reported 1997 flow. The 1997 flow is suggested to be too high due to a number of factors as outline in the report.

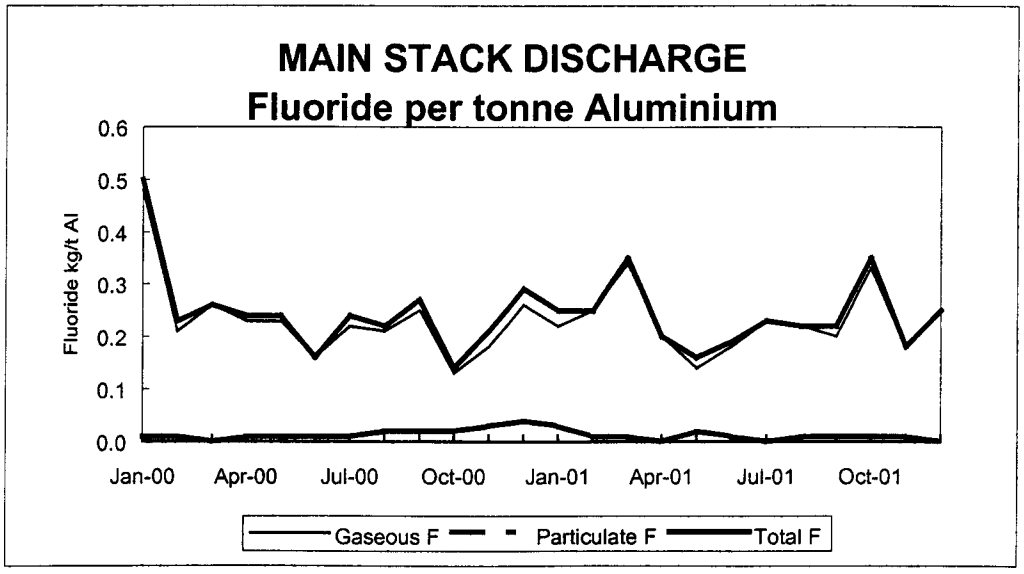
Fluoride Discharges

Performance data

The table below shows the fluoride discharges expressed as a ratio of hot aluminium metal production during 2001.

Parameter	Units	2001 Result	Maximum for any month
Main Stack			
• Gaseous fluoride	kg/t Al	0.23	0.34
• Particulate fluoride	kg/t Al	0.01	0.03
• Total fluoride	kg/t Al	0.24	0.35
Reduction Line Roof Louvres			
• Gaseous fluoride	kg/t Al	0.19	0.25
• Particulate fluoride	kg/t Al	0.29	0.36
• Total fluoride	kg/t Al	0.48	0.62
Plant			
• Gaseous fluoride	kg/t Al	0.42	0.56
• Particulate fluoride	kg/t Al	0.30	0.39
• Total fluoride	kg/t Al	0.72	0.86

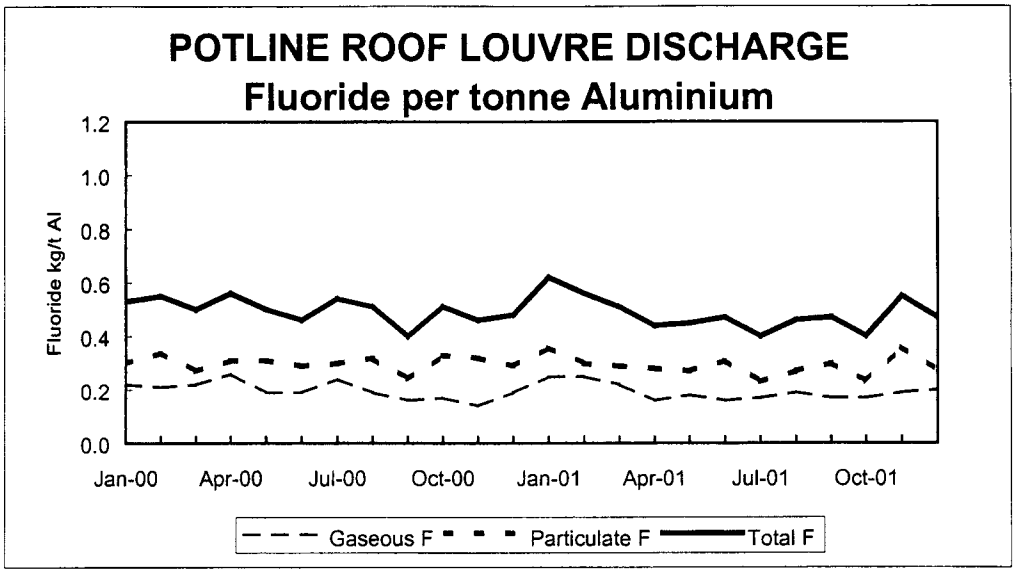
The following graph shows the monthly main stack fluoride per tonne aluminium discharge during 2000 and 2001.



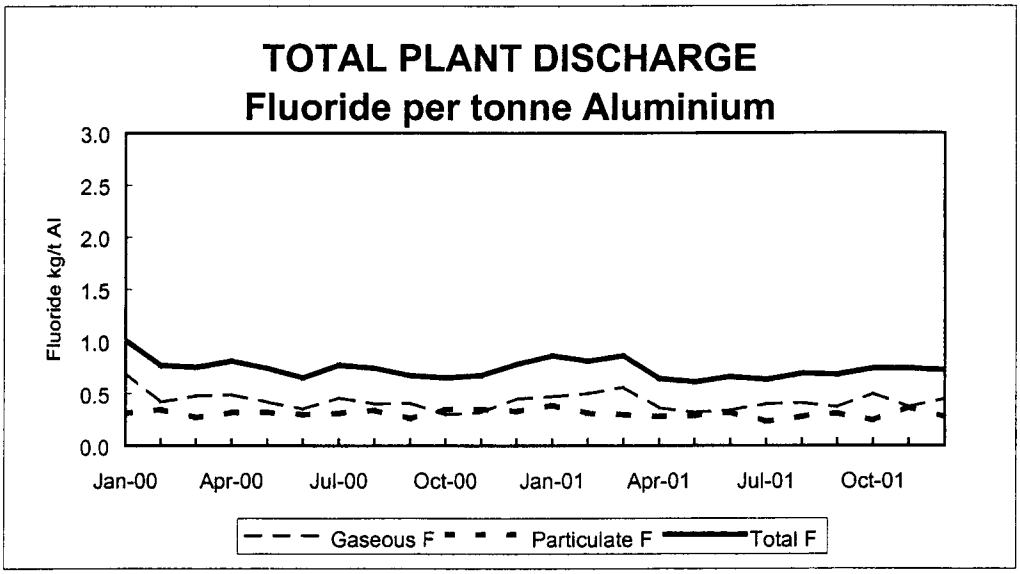
Fluoride Discharges, Continued

Performance data, Continued

The following graph shows the average monthly Potline roof louvre fluoride per tonne aluminium discharge during 2000 and 2001.



The following graph shows the average total plant fluoride per tonne aluminium during 2000 and 2001.



Comments

The fluoride discharge rate from the plant showed a decrease during 2001 due to the cut back in production as a result of the power constraints NZAS operated under during 2001.

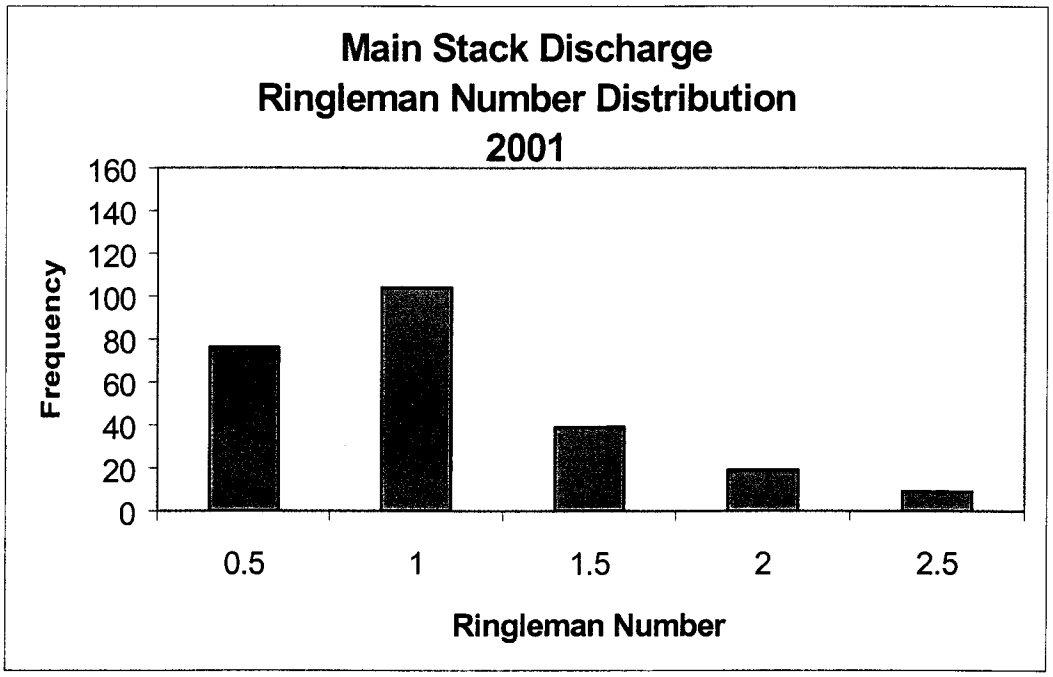
Baghouse Discharges

The Regular inspection of the baghouse discharges in some areas of plant continued during 2001. These inspections were in addition to the on-going operational surveillance of this equipment. Monthly inspections across these dust collectors reported emissions (using the six-point observation scale) to be on average between 0 and 1, a score of 1 being "barely discernible emissions", with a maximum of a 3.

The monthly visual inspections in the Carbon area of plant were not carried out during 2001 so no estimate of emissions was assessed. Preventative maintenance on a scheduled basis only was carried out in this area. Routine monthly inspections are expected to be recommenced during 2002.

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 2001.



There has been an increase in the number of observations of a Ringleman number of 1 and greater during 2001.

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 2001.

Material	Units	Permit Maximum	2001 Annual Average	2001 Maximum	2001 Minimum
Petroleum Coke	%	3.0	2.67	2.76	2.58
Pitch	%	1.0	0.43	0.44	0.42
Heavy Fuel Oil	%	3.5	2.17	2.42	1.94

Comments

All shipments of raw materials and fuels during the 2001 met permit standards for sulphur contents.

The average sulphur content of the raw materials and fuels during 2001 was similar to that reported in 2000.

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.

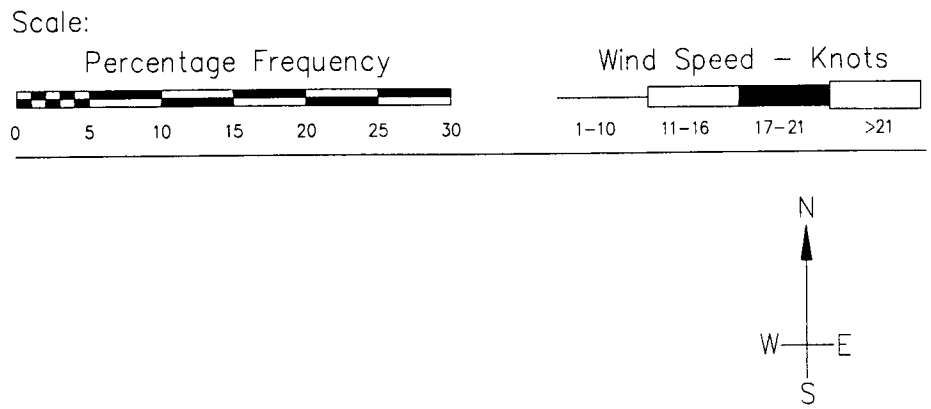
Meteorological Conditions

The mean wind frequency diagram on the following page shows that the 2001 wind pattern was dominated by westerly, north westerly and south westerly winds.

The following table shows the predominant winds and total rainfall recorded for each month during 2001.

Month	Predominant Wind Direction	Rainfall (mm)
January	West, and south west	60
February	West and north west	48
March	West and north west	36
April	West and north west	90
May	West, east, south west and north west	137
June	West, and north west	83
July	West, and north west	53
August	West, north west and north east	65
September	West, and north west	89
October	East, west and north east	49
November	West, south, and south west	101
December	West, east and south west	65

NEW ZEALAND ALUMINIUM SMELTERS LIMITED – TIWAI POINT
WORKPLACE AND ENVIRONMENTAL MONITORING OUTPUT TEAM
MEAN WIND FREQUENCY (%) OF SURFACE WIND DIRECTIONS
PERIOD: 2001



% Time at	
1–10 Knots	59
11–16 Knots	20.3
17–21 Knots	10.1
>21 Knots	10
Calm	0.62

Ambient Air

Introduction

This chapter covers the monitoring for gaseous and particulate fluorides in ambient air at six monitoring sites. At all sites, except the 1km Hut site, sampling is by a method based on up to a one-month sampling period. The 1km Hut site is sampled on a weekly basis.

Permit Standards

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

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

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

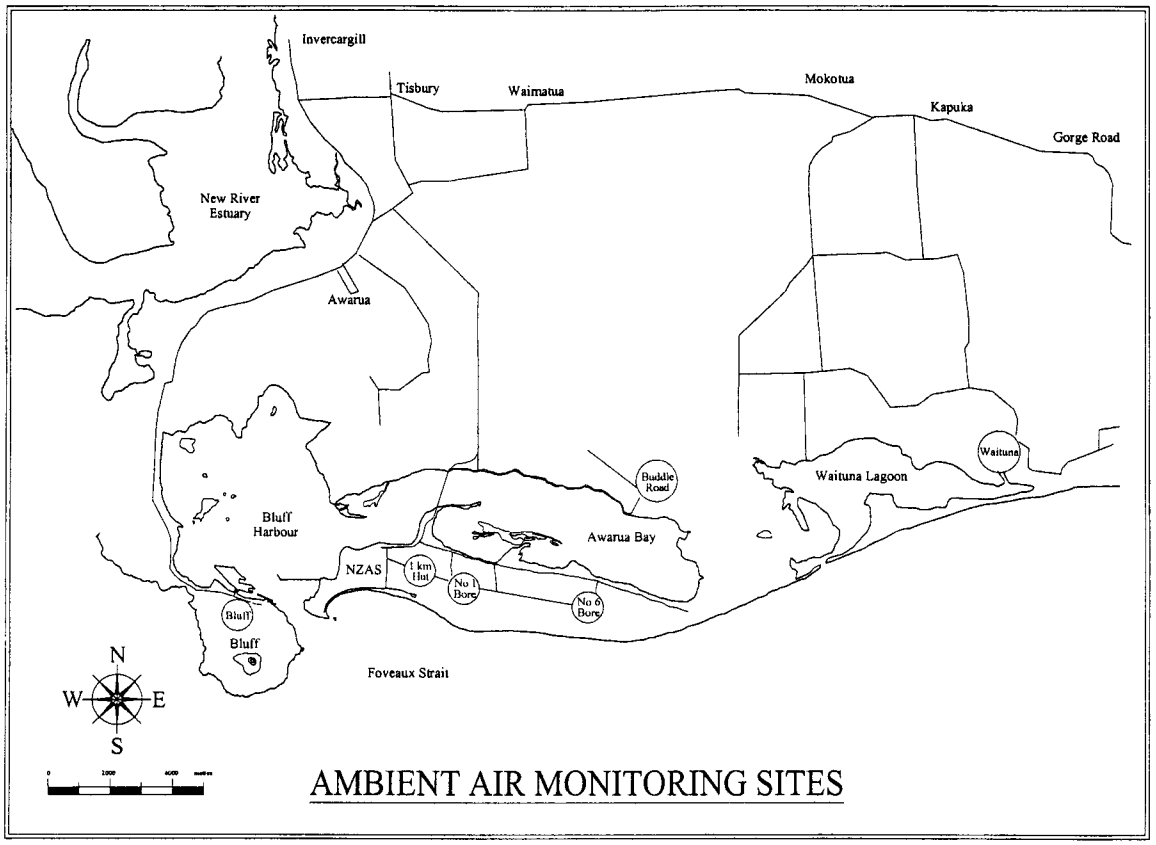
The standards apply to measurements on land off Tiwai Peninsula and on Tiwai Peninsula east of Comalco New Zealand Ltd's freehold land.

At sites other than 1km Hut, if two consecutive monthly results exceed 0.3 micrograms per cubic metre gaseous fluoride, then the monitoring shall revert to a seven-day sampling period. Sampling on a longer time basis may be resumed when two consecutive seven day results are each less than 0.3 micrograms per cubic metre.

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

Site Locations

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



Ambient Air at 1 Kilometre Hut

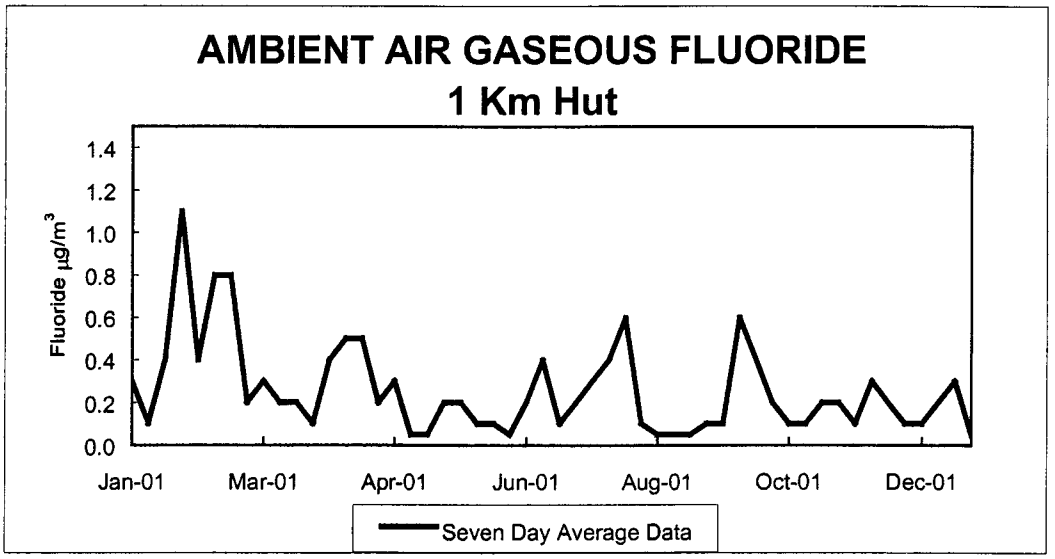
Monitoring results

The following table summarises the monitoring results during 2000 and 2001. The sampling frequency for ambient air fluoride at this site is seven days.

Parameter	Units	Standard	2000	2001
Gaseous Fluoride Concentration		-		
• Max 7 day average	ug/m^3	-	0.80	1.10
• Max monthly average	ug/m^3	-	0.40	0.60
• Annual averge	ug/m^3	-	0.25	0.28
Particulate fluoride concentration		-		
• Max 7 day average	ug/m^3	-	0.30	0.40
• Max monthly average	ug/m^3	-	0.10	0.20
• Annual averge	ug/m^3	-	< 0.1	< 0.1

Gaseous fluoride

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

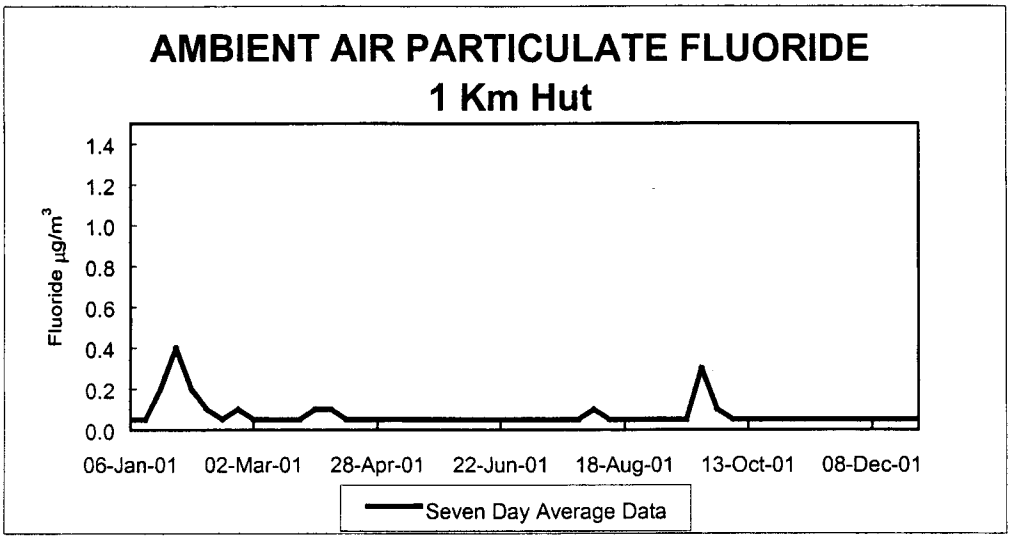


Note: Concentrations less than 0.1 µg/m^3 are plotted as 0.05 µg/m^3

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 $\mu g/m^3$ are plotted as 0.05 $\mu g/m^3$

Comments

The levels have shown a slight increase this year from those reported in 2000 but are at a similar level to those reported in 1999.

Ambient Air at Other Sites on Tiwai Peninsula

Monitoring results

The following table summarises the monitoring results during 2000 and 2001 for the two other sites located on Tiwai Peninsula.

Site	Parameter	Units	Standard	2000	2001
No. 1 Bore	Gaseous Fluoride Concentration				
	• Max 7 day average	ug/m^3	1.0	N.D.	N.D.
	• Max monthly average	ug/m^3	0.5	< 0.1	0.20
	• Annual averge	ug/m^3		< 0.1	< 0.1
	Particulate fluoride concentration				
	• Max 7 day average	ug/m^3		N.D.	N.D.
	• Max monthly average	ug/m^3		< 0.1	< 0.1
	• Annual averge	ug/m^3		< 0.1	< 0.1
No. 6 Bore	Gaseous Fluoride Concentration				
	• Max 7 day average	ug/m^3	1.0	N.D.	N.D.
	• Max monthly average	ug/m^3	0.5	< 0.1	< 0.1
	• Annual averge	ug/m^3		< 0.1	< 0.1
	Particulate fluoride concentration				
	• Max 7 day average	ug/m^3		N.D.	N.D.
	• Max monthly average	ug/m^3		< 0.1	< 0.1
	• Annual averge	ug/m^3		< 0.1	< 0.1

N.D: Not Done

Comments

Gaseous and particulate fluoride concentrations were close to or below the detection limit of the Australian standard (ASTM 3580.1991) method at these sites and were within the permit standards throughout 2001. The maximum monthly average of $0.2\mu g/m^3$ at No. 1 Bore site occurred in June. Winds during the month were mainly moderate to strong and from the west, which may have influenced the concentration measured at this site.

Ambient Air at Sites off Tiwai Peninsula

Monitoring results

The following table summarises the monitoring results during 2000 and 2001 for the three ambient air monitoring sites located off Tiwai Peninsula.

Site	Parameter	Units	Standard	2000	2001
Buddle Road	Gaseous Fluoride Concentration				
	• Max 7 day average	ug/m^3	1.0	N.D.	N.D.
	• Max monthly average	ug/m^3	0.5	< 0.1	< 0.1
	• Annual averge	ug/m^3		< 0.1	< 0.1
	Particulate fluoride concentration				
	• Max 7 day average	ug/m^3		N.D.	N.D.
	• Max monthly average	ug/m^3		< 0.1	< 0.1
	• Annual averge	ug/m^3		< 0.1	< 0.1
Waituna	Gaseous Fluoride Concentration				
	• Max 7 day average	ug/m^3	1.0	N.D.	N.D.
	• Max monthly average	ug/m^3	0.5	< 0.1	< 0.1
	• Annual averge	ug/m^3		< 0.1	< 0.1
	Particulate fluoride concentration				
	• Max 7 day average	ug/m^3		N.D.	N.D.
	• Max monthly average	ug/m^3		< 0.1	< 0.1
	• Annual averge	ug/m^3		< 0.1	< 0.1
Bluff	Gaseous Fluoride Concentration				
	• Max 7 day average	ug/m^3	1.0	N.D.	N.D.
	• Max monthly average	ug/m^3	0.5	< 0.1	< 0.1
	• Annual averge	ug/m^3		< 0.1	< 0.1
	Particulate fluoride concentration				
	• Max 7 day average	ug/m^3		N.D.	N.D.
	• Max monthly average	ug/m^3		< 0.1	< 0.1
	• Annual averge	ug/m^3		< 0.1	< 0.1

N.D: Not Done.

Comments

All permit standards were met at the three sites off Tiwai Peninsula throughout 2001.

All gaseous and particulate fluoride concentrations were at or below the detection limit of the Australian standard method at these sites during 2001.

Atmospheric Deposition

Introduction

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

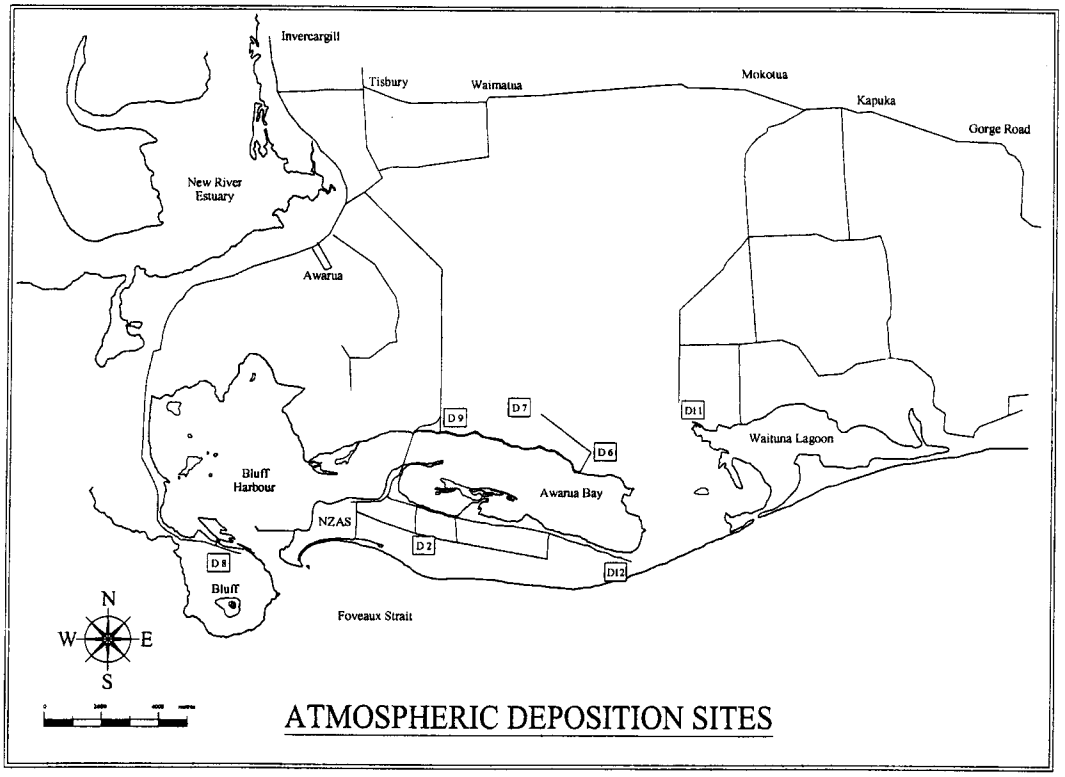
Permit Guidelines

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 2001 is summarised in the following table.

Site	Units	2001 average	Maximum for any month	Minimum for any month
D2. No.1 Bore[1]	g/m^3	0.29	0.62	0.08
D12 TEF2[1]	g/m^3	0.07	0.10	<0.05
D6 Buddle Road	g/m^3	0.10	0.30	<0.05
D7 Gibson's Farm	g/m^3	0.10	0.31	<0.05
D8 Bluff	g/m^3	0.08	0.40	<0.05
D9 Awarua Bay Road	g/m^3	0.10	0.38	<0.05
D11 Marshall Road	g/m^3	0.08	0.35	<0.05

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

Reactive Aluminium Deposition

The reactive aluminium atmospheric deposition during 2001 is summarised in the following table.

Site	Units	2001 average	Maximum for any month	Minimum for any month
D2. No.1 Bore[1]	g/m^3	0.08	0.21	<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	<0.03	<0.03
D8 Bluff	g/m^3	<0.03	<0.03	<0.03
D9 Awarua Bay Road	g/m^3	<0.03	0.04	<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 2001. Fluoride and reactive aluminium deposition during 2001 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 2001 were determined during March and September. This was most likely due to the very low rainfalls during these months, which resulted in low dilution of material deposited on the raingauge collection surface.

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.

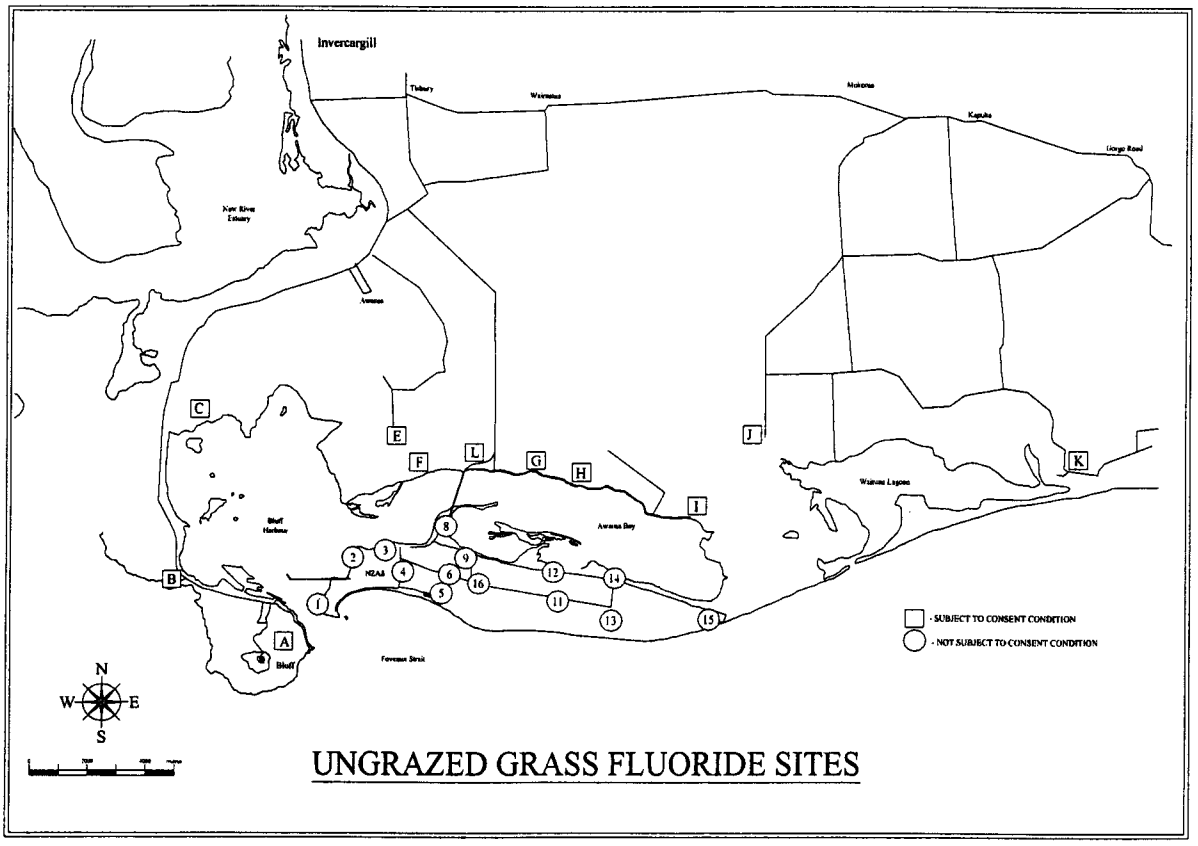
Permit Guidelines

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.

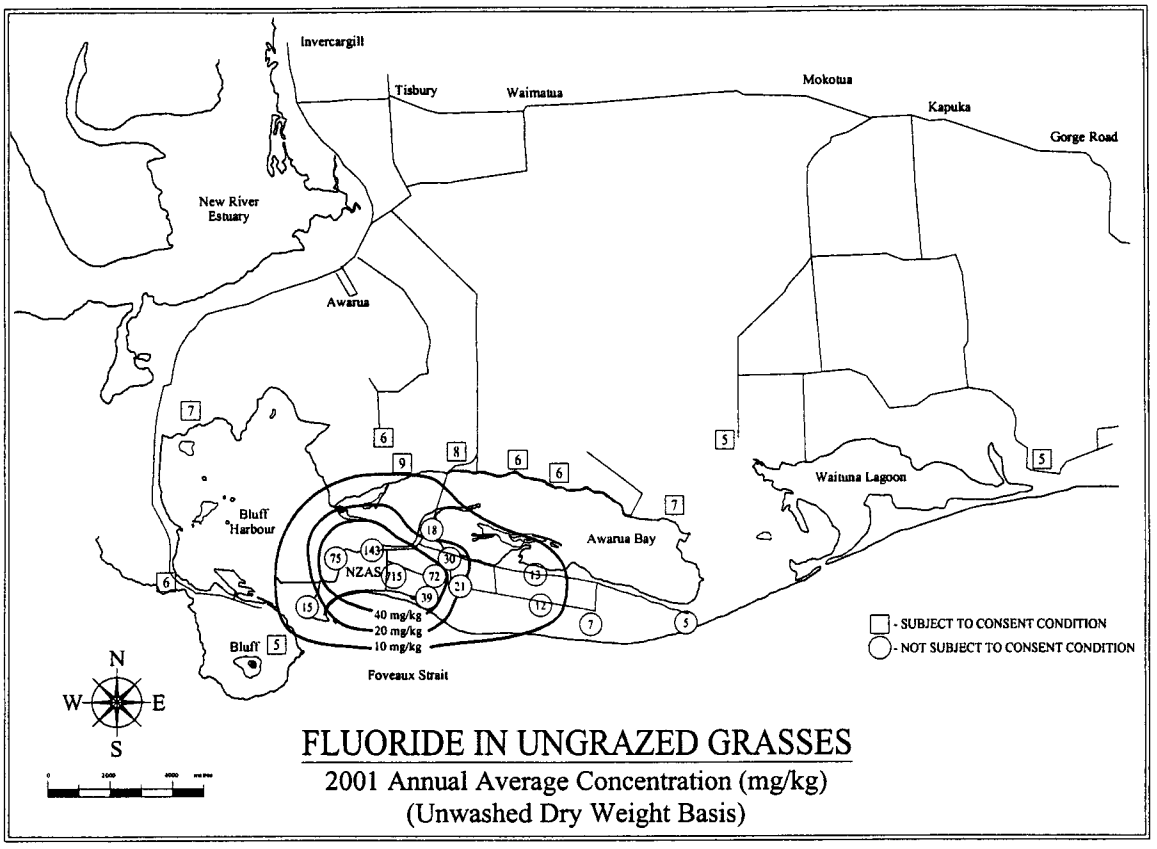


UNGRAZED GRASS FLUORIDE SITES

Ungrazed Grass Monitoring Results

Annual average fluoride concentrations

The 2001 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 2001.

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	13
Ungrazed Grass Site B	80	24
Ungrazed Grass Site C	80	29
Ungrazed Grass Site E	80	16
Ungrazed Grass Site F	80	15
Ungrazed Grass Site G	80	14
Ungrazed Grass Site H	80	9
Ungrazed Grass Site I	80	10
Ungrazed Grass Site J	80	10
Ungrazed Grass Site K	80	7
Ungrazed Grass Site L	80	15

The monthly fluoride concentration in ungrazed grass was within the permit guideline for all sites during 2001.

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 2001.

Sites off Tiwai Peninsula	Permit Guideline mgF/kg	Maximum Two Month Running Average During 2001 mgF/kg
Ungrazed Grass Site A	60	10
Ungrazed Grass Site B	60	17
Ungrazed Grass Site C	60	19
Ungrazed Grass Site E	60	11
Ungrazed Grass Site F	60	15
Ungrazed Grass Site G	60	11
Ungrazed Grass Site H	60	8
Ungrazed Grass Site I	60	10
Ungrazed Grass Site J	60	6
Ungrazed Grass Site K	60	7
Ungrazed Grass Site L	60	13

The two month running average fluoride concentration in ungrazed grass was within the permit guideline for all sites during 2001.

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 2001 mgF/kg
Ungrazed Grass Site A	40	8
Ungrazed Grass Site B	40	6
Ungrazed Grass Site C	40	8
Ungrazed Grass Site E	40	6
Ungrazed Grass Site F	40	10
Ungrazed Grass Site G	40	7
Ungrazed Grass Site H	40	6
Ungrazed Grass Site I	40	7
Ungrazed Grass Site J	40	5
Ungrazed Grass Site K	40	5
Ungrazed Grass Site L	40	9

The 12 month running average fluoride concentration in ungrazed grass was within the permit guideline for all sites during 2001.

Fluoride in Ungrazed Grasses, Continued

Comments

The 2001 annual average fluoride concentrations in ungrazed grass sites off Tiwai Peninsula are similar to the annual average fluoride concentration levels in 2000.

Sites on Tiwai Peninsula and close to the smelter show a decrease in the annual average fluoride concentration levels and are similar to the levels in 1999

The maximum monthly concentrations recorded at sites A, B, and C (13, 24 and 29 mg F/kg, respectfully) were observed during the month of August. These vegetation sites may have been affected by smelter discharges to air as winds were mainly from the east, west and north for the seven days prior to sampling.

Fluoride in *Pinus radiata*

Introduction

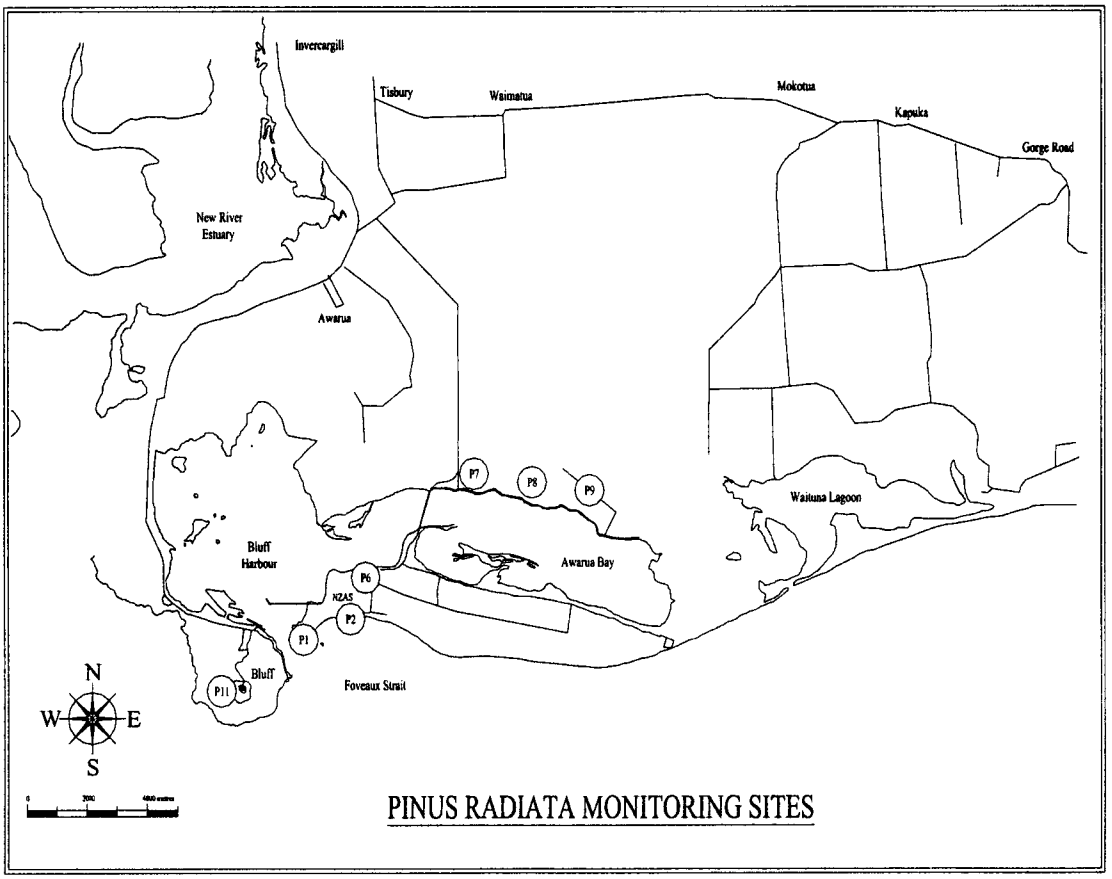
This chapter covers the monitoring of fluoride in *Pinus radiata* at 7 monitoring sites located at Bluff, Awarua Plains, Waituna and Tiwai Peninsula.

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.

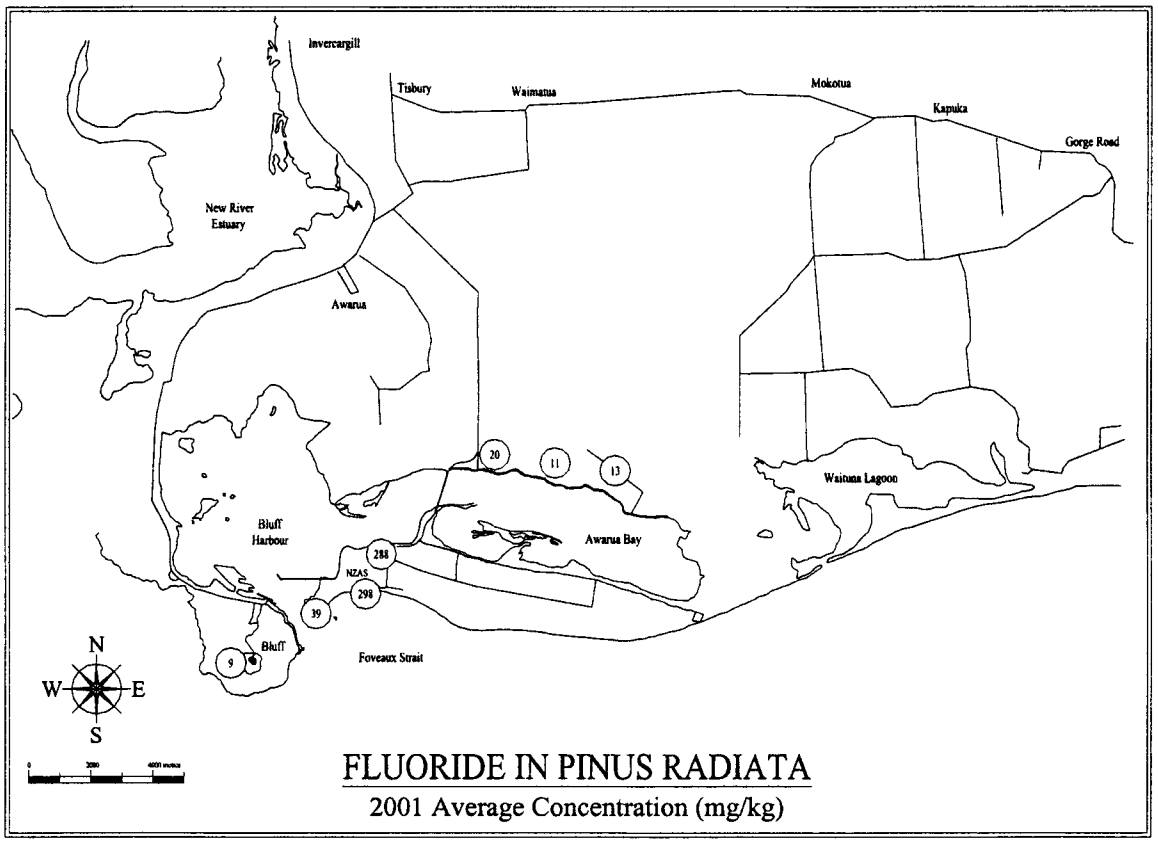
Site Locations

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



Pinus radiata Monitoring Results

The 2001 annual average fluoride concentrations of pine needle samples collected from the monitoring sites are shown in the following map.



Comments

Fluoride concentrations in *Pinus radiata* needles were within the permit guideline during 2001.

Three sites (P3, P4, and P5) were removed during 2001 as part of the agreement with the Department of Conservation to remove exotic species from Comalco leasehold land.

Fluoride concentrations of pine needles at all sites were similar to the 2000 levels. Site P2 has shown a slight decrease this year while site P6 is at a similar level to 2000. Site P2 is downwind from the MRP fines area at the landfill. Levels at this site are expected to improve as deposition of MRP fines ceased during 2001.

The tree at site P2 may need replacement in the future, as it old, exposed to salt laden winds and is starting to encroach on the road causing a hazard. During 2001 side by side sampling was carried out with another Pinus radiata tree in the vicinity to accumulate some long-term data.

The Health of Farm Livestock

Grazing Monitor Project

Summary

The fluoride concentration of grazed pasture on all grazing monitor farms were within permit standard during 2001.

Cattle urinary fluoride concentrations on GMF4 measured during 2001 were within the guidelines.

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

Dental scores in cattle teeth formed on GMF4 since 1995 were similar to those measured in 2000.

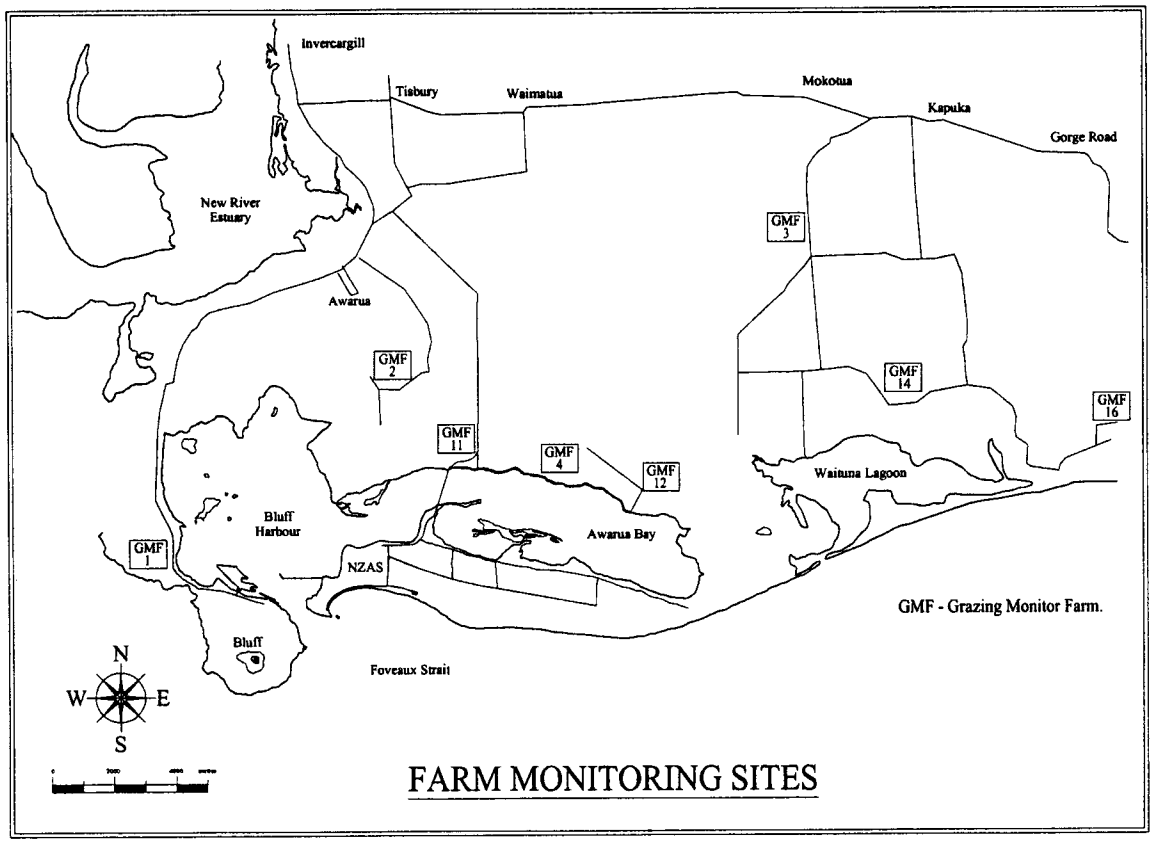
Introduction

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.



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:

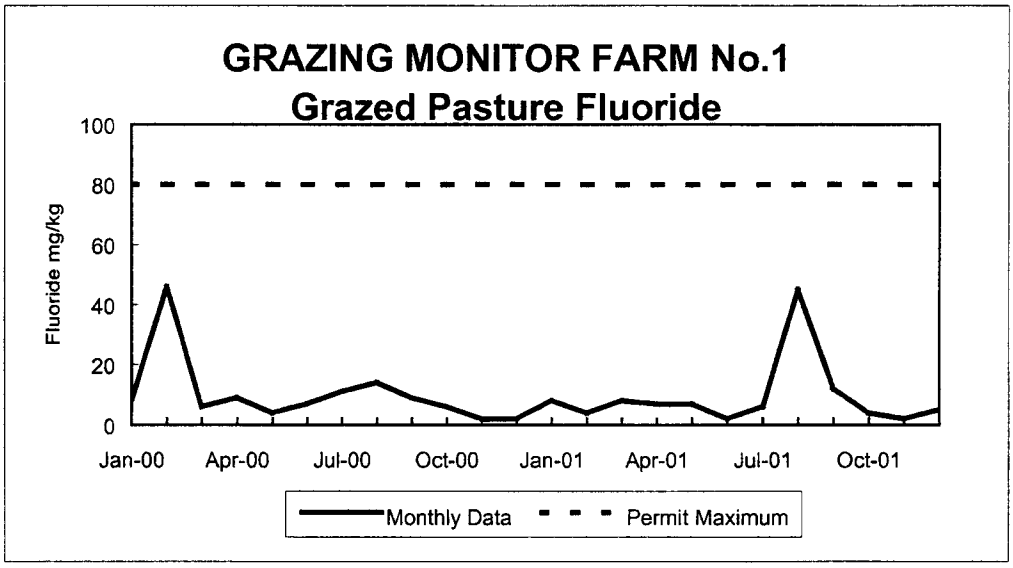
- fluoride in grazed pasture, and
- comments on the monitoring.

Fluoride in grazed pasture

The following table shows the grazed pasture monitoring results for 2001.

	Units	Standard	2001
Monthly sample maximum	mg/kg	80	45
Two monthly average maximum	mg/kg	60	29
Twelve monthly running average maximum	mg/kg	40	10
Annual average	mg/kg		9

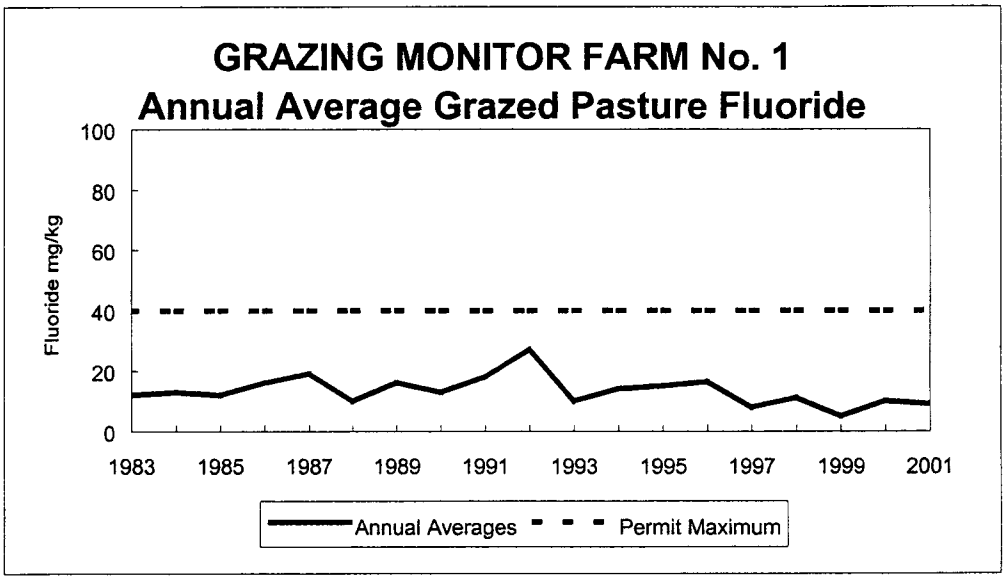
The following graph shows the results of monthly fluoride monitoring of grazed pasture during 2000 and 2001.



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 2001 average grazed pasture fluoride concentration of 10 mg/kg was similar to the 2000 average. This result is affected by the high result in August. Prevailing winds at the time may have transported smelter discharges towards this site or the high concentration may be due to dust from trucks transporting fertiliser along Bluff Road during August. Other monitoring sites, ungrazed grass sites B and C, in the area also showed elevated fluoride levels during August.

Grazing Monitor Farm No. 2

Introduction

The following information is contained in this section:

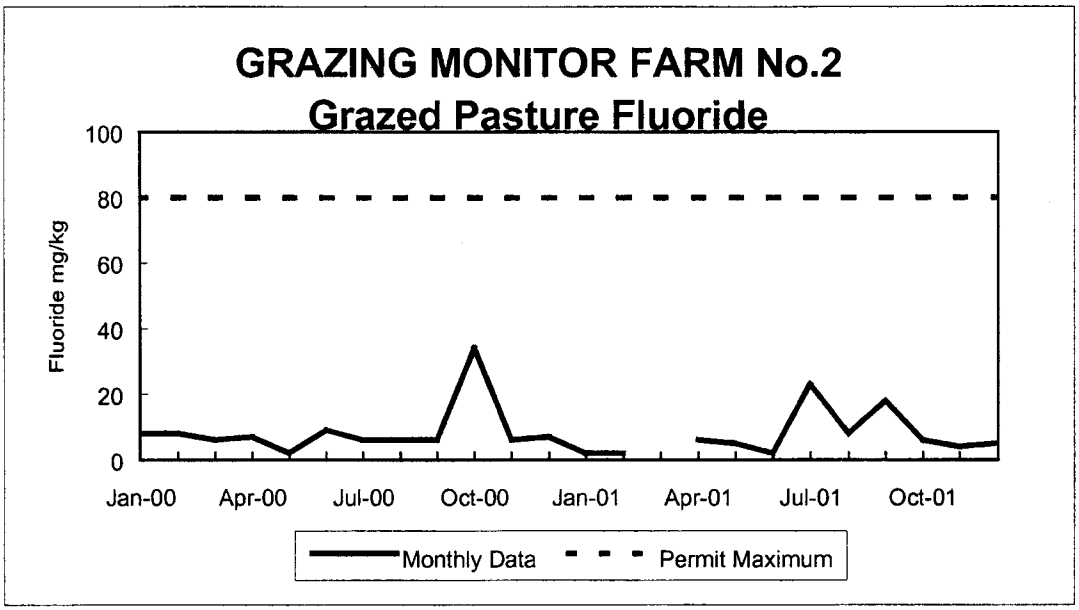
- fluoride in grazed pasture, and
- comments on the monitoring.

Fluoride in grazed pasture

The following table shows the grazed pasture monitoring results for 2001.

	Units	Standard	2001
Monthly sample maximum	mg/kg	80	23
Two monthly average maximum	mg/kg	60	16
Twelve monthly running average maximum	mg/kg	40	10
Annual average	mg/kg		7

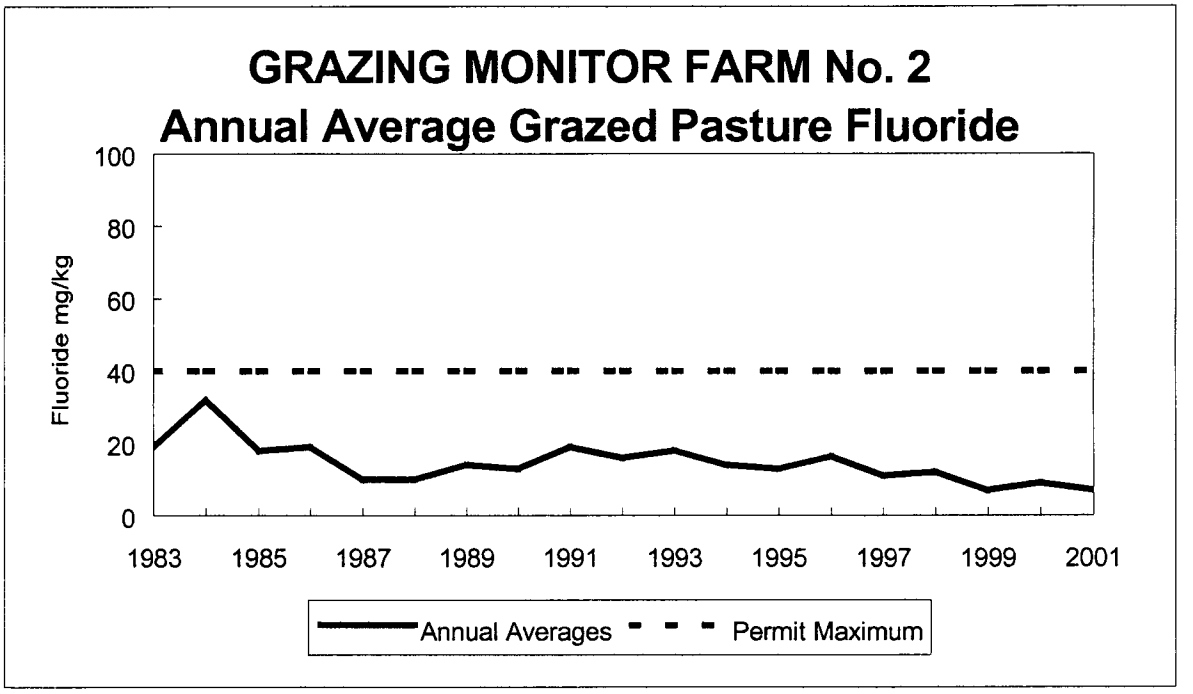
The following graph shows the results of monthly fluoride monitoring of grazed pasture during 2000 and 2001.



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 2001 average grazed pasture fluoride concentration of 7 mg/kg was similar to the average fluoride concentration measured during 2000. There was no sample data for March 2001 as fertilizer has been applied within 20 days of the sample being taken.

Grazing Monitor Farm No. 3

Introduction

The following information is contained in this section:

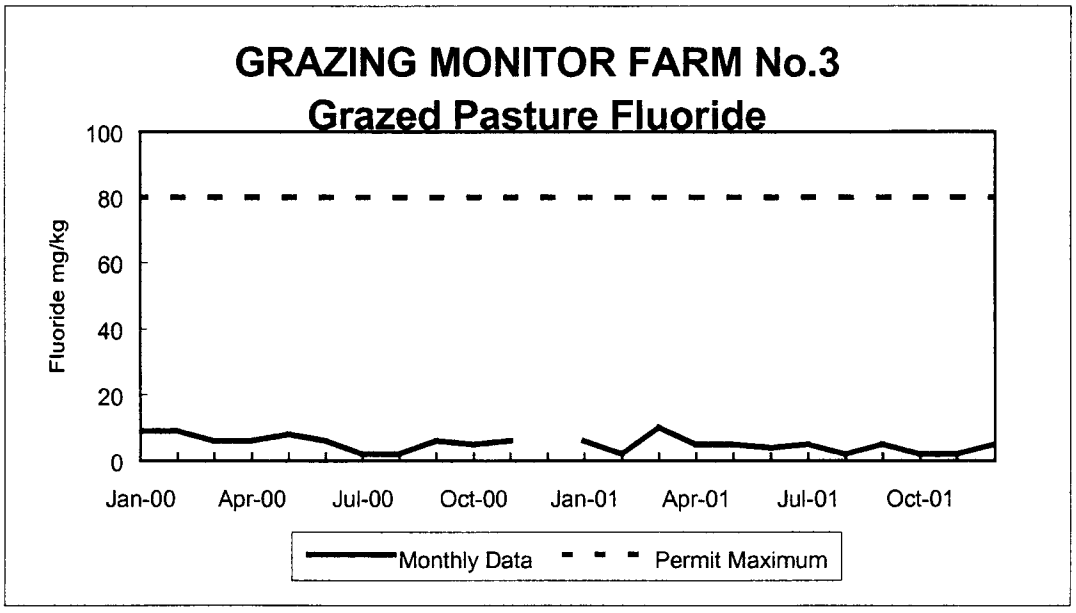
- fluoride in grazed pasture, and
- comments on the monitoring.

Fluoride in grazed pasture

The following table shows the grazed pasture monitoring results for 2001.

	Units	Standard	2001
Monthly sample maximum	mg/kg	80	10
Two monthly average maximum	mg/kg	60	8
Twelve monthly running average maximum	mg/kg	40	6
Annual average	mg/kg		4

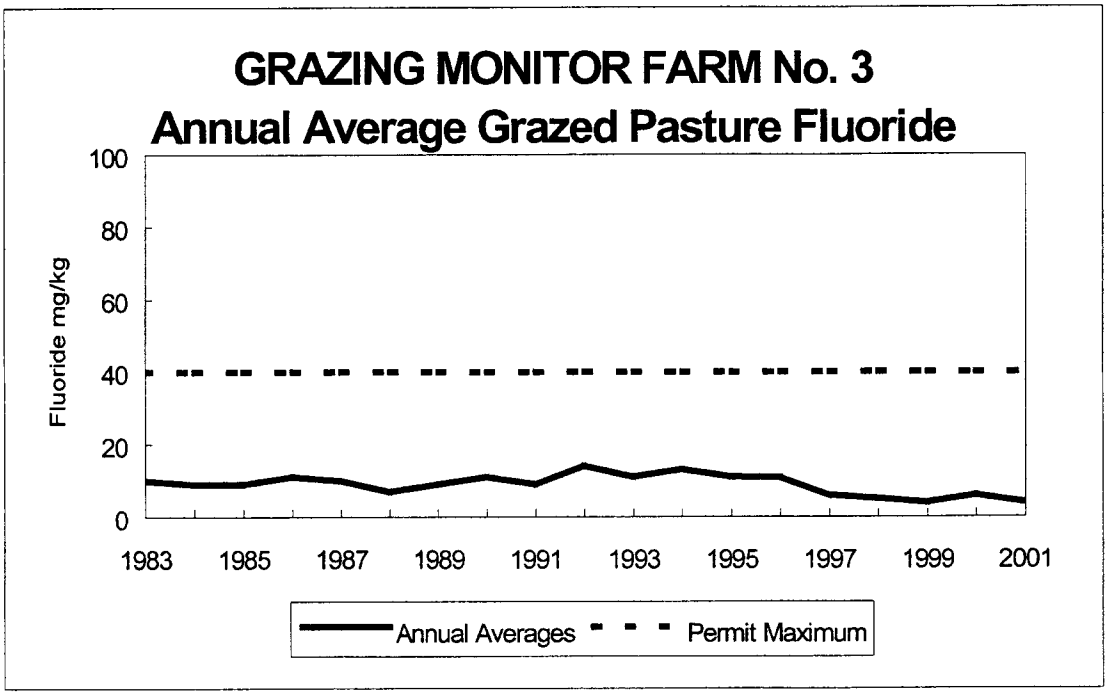
The following graph shows the results of monthly fluoride monitoring of grazed pasture during 2000 and 2001.



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 2001 annual average grazed pasture fluoride concentration of 4 mg/kg was similar to the concentration measured during previous years. There was no sample data for December 2000 as fertilizer had been applied within 20 days of sampling.

Grazing Monitor Farm No. 4

Introduction

The following information is contained in this section:

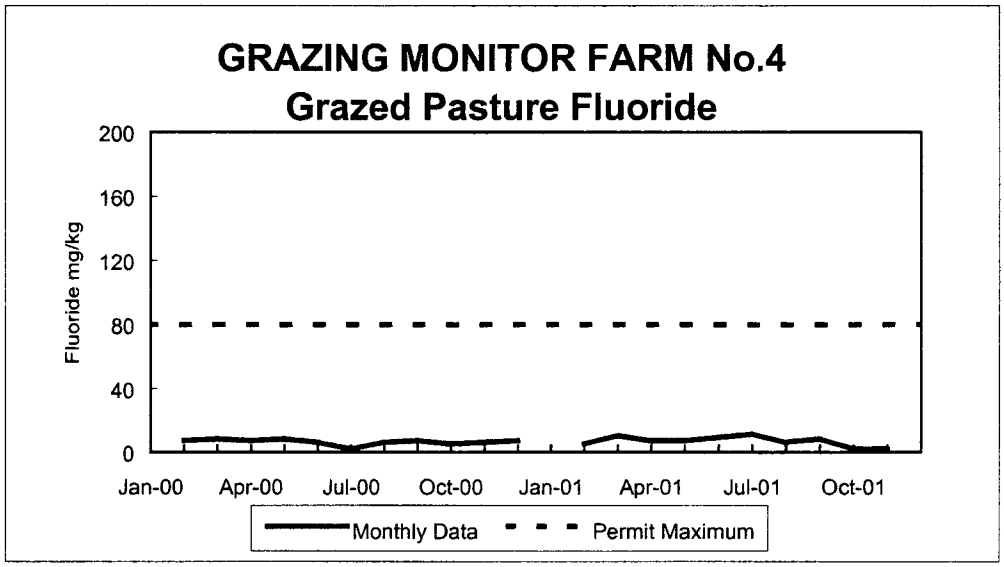
- fluoride in grazed pasture,
- cattle urinary fluoride,
- cattle bone fluoride,
- cattle dental condition, and
- comments on the monitoring.

Fluoride in grazed pasture

The following table shows the grazed pasture monitoring results for 2001.

	Units	Standard	2001
Monthly sample maximum	mg/kg	80	11
Two monthly average maximum	mg/kg	60	10
Twelve monthly running average maximum	mg/kg	40	7
Annual average	mg/kg		7

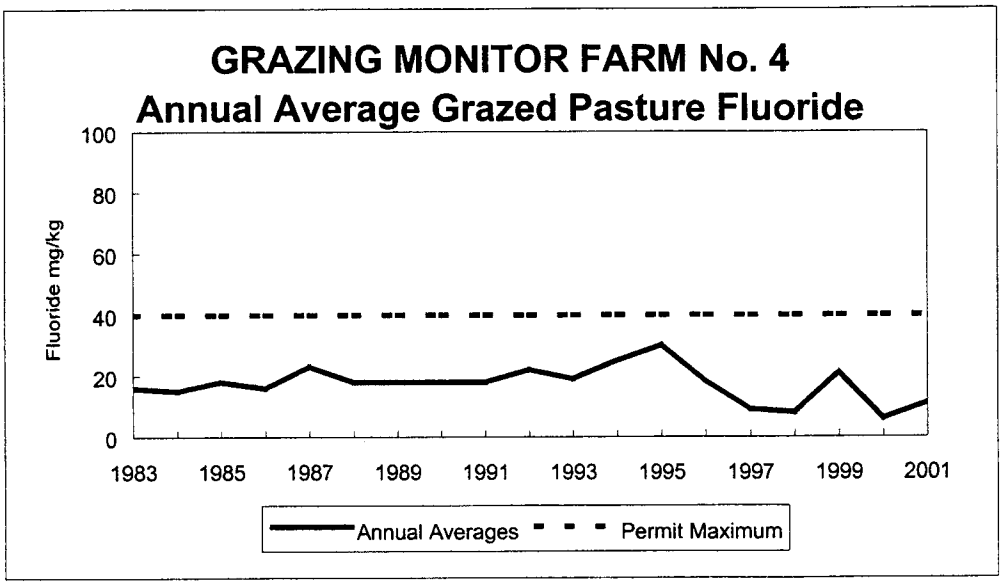
The following graph shows the results of monthly fluoride monitoring of grazed pasture during 2000 and 2001.



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

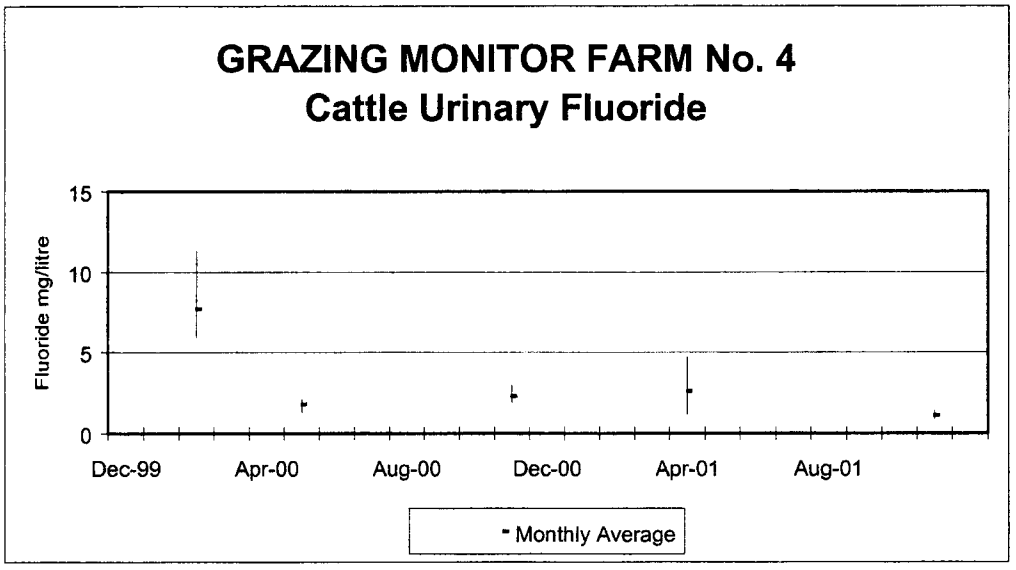
The following table summarises the results of cattle urinary fluoride monitoring during 2001.

	Units	Guideline	2001
Average fluoride concentration	mg/L	-	1.9
Maximum fluoride concentration	mg/L	10	4.7
Minimum fluoride concentration	mg/L	-	0.9
No. of samples	mg/L	-	11

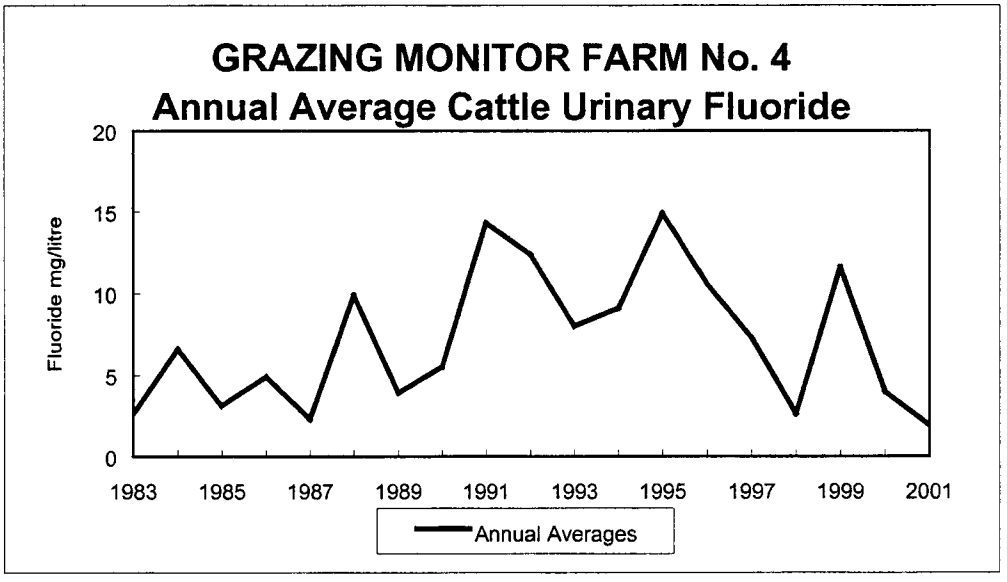
Grazing Monitor Farm No. 4, Continued

Cattle urinary fluoride, continued

The following graph shows the results of urinary fluoride monitoring of cattle during 2000 and 2001. 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.



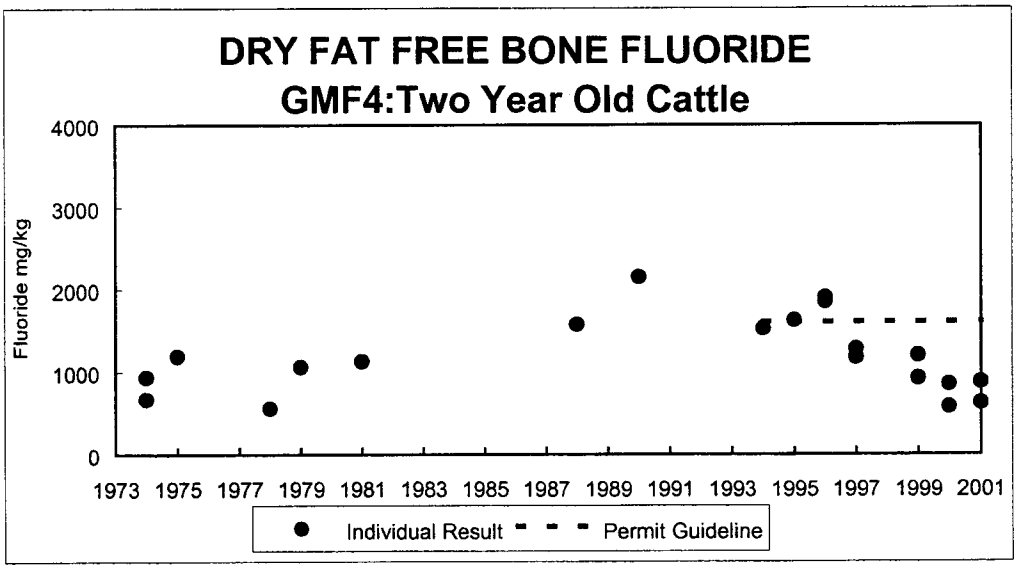
Grazing Monitor Farm No. 4, Continued

Cattle bone fluoride

The following table shows the results of bone fluoride monitoring during 2001.

Identification	Age	Units	Guideline	2001
Red & White Hereford Cross	4	mg/kg	2,379	1900
Black Devon	2	mg/kg	1605	875
Yellow 1	2	mg/kg	1605	650
Brindle	6	mg/kg	2,794	1975

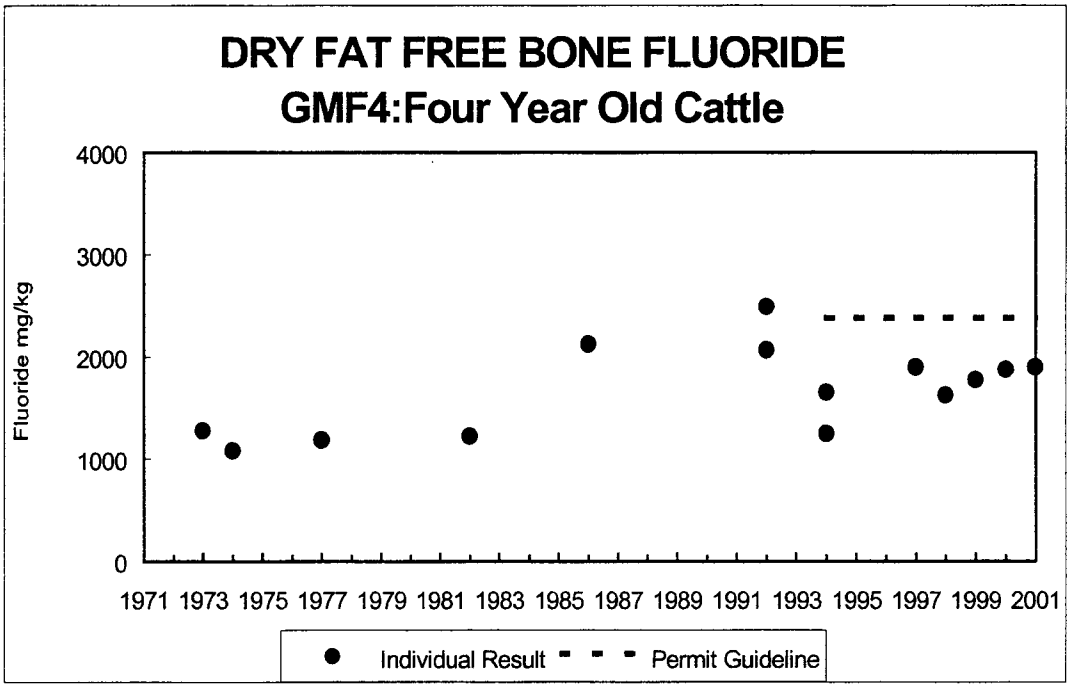
The following graph shows the bone fluoride concentration of individual biopsies collected from two year old cattle since the project began.



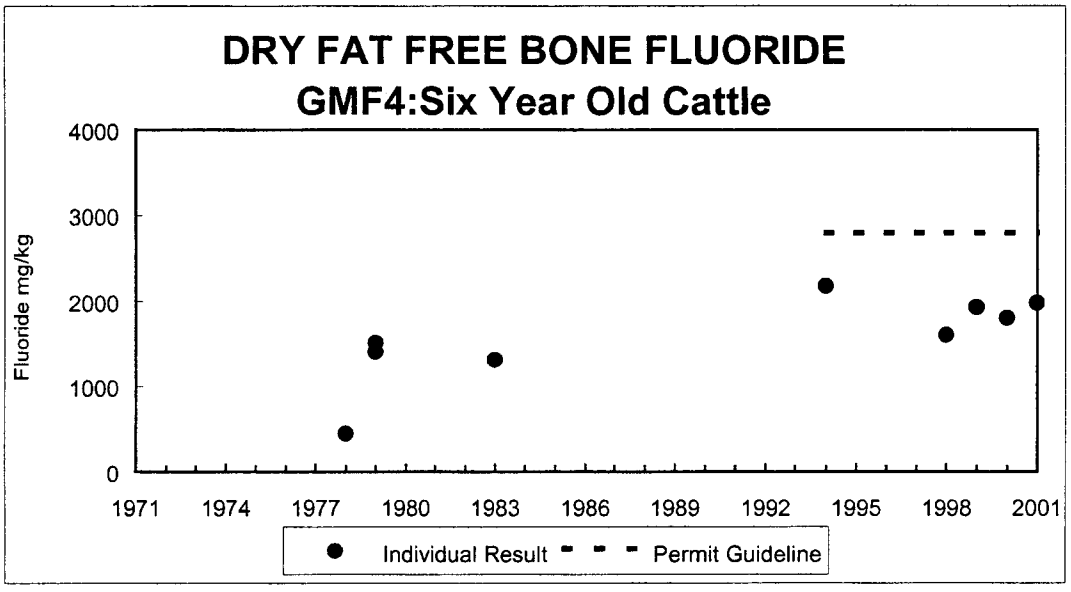
Grazing Monitor Farm No. 4, Continued

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.



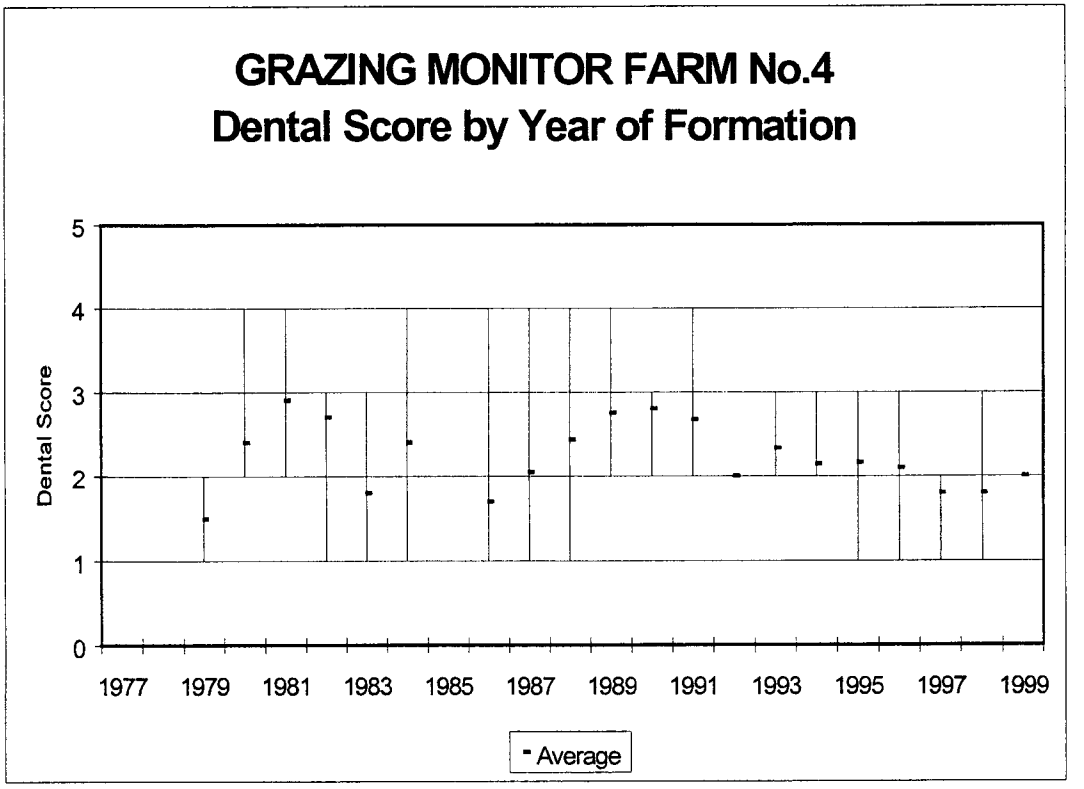
Grazing Monitor Farm No. 4, Continued

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	2.16	2.10	1.8	1.8	2
Maximum tooth score	3	3	2	2	2
Minimum tooth score	1	1	1	1	2
No. of cattle inspected	11	6	4	4	2

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, grazed pasture and cattle urine on GMF4 were within the permit guidelines during 2001.

The 2001 annual average grazed pasture fluoride concentration of 7 mg/kg was similar to that determined during 2000. There is no data for January and December 2001 as fertilizer has been applied within 20 days of sampling.

The annual average urinary fluoride concentration measured during 2001 was 1.9 mg/L compared to 3.9 mg/L measured during 2000. The maximum individual urinary fluoride concentration measured during 2001 was 4.7 mg/L compared with a maximum of 11.3 mg/L measured during 2000.

The average fluoride concentration of bones sampled from cattle during 2001 was similar to those determined in the last four years.

The dental scores in cattle inspected during 2001 were similar to those inspected in 2000. The stability reflects the decrease in the fluoride concentrations measured on this farm since the introduction of the dry scrubbing system at the smelter in 1996.

Grazing Monitor Farm No. 11

Introduction

The following information is contained in this section:

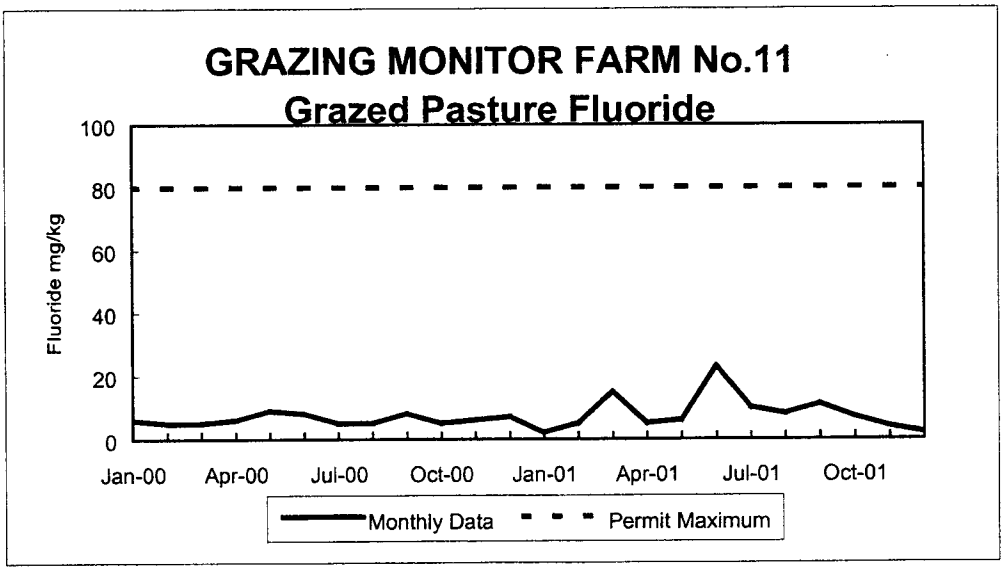
- fluoride in grazed pasture, and
- comments on the monitoring.

Fluoride in grazed pasture

The following table shows the grazed pasture monitoring results for 2001.

	Units	Standard	2001
Monthly sample maximum	mg/kg	80	23
Two monthly average maximum	mg/kg	60	17
Twelve monthly running average maximum	mg/kg	40	9
Annual average	mg/kg		8

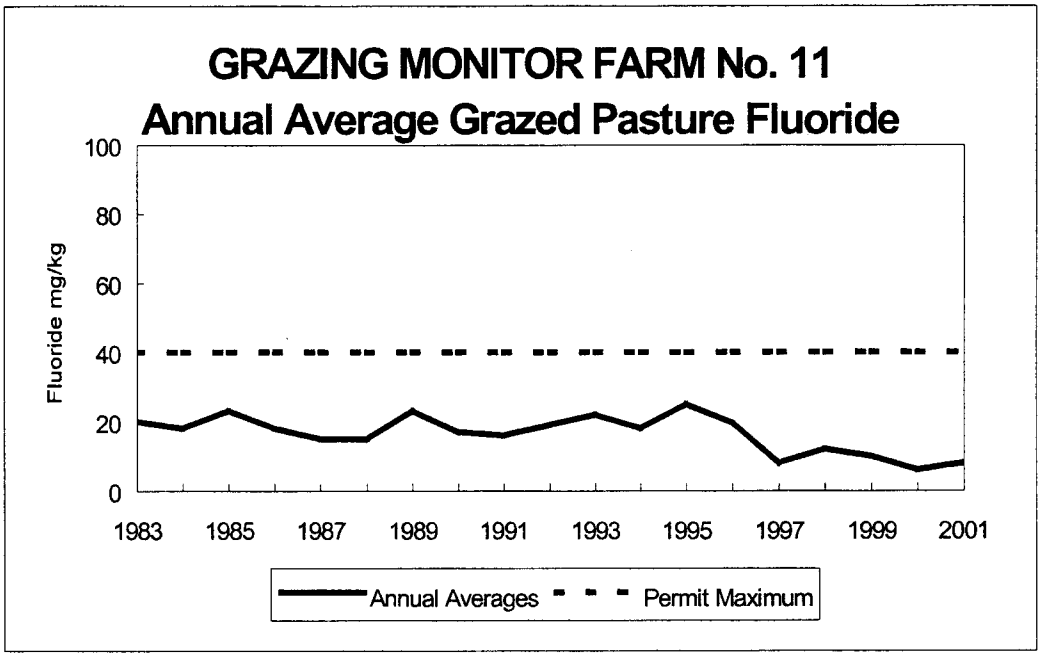
The following graph shows the results of monthly fluoride monitoring of grazed pasture during 2000 and 2001.



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 2001 average grazed pasture fluoride concentration of 8 mg/kg was similar to the average fluoride concentration measured during 2000.

Grazing Monitor Farm No. 12

Introduction

The following information is contained in this section:

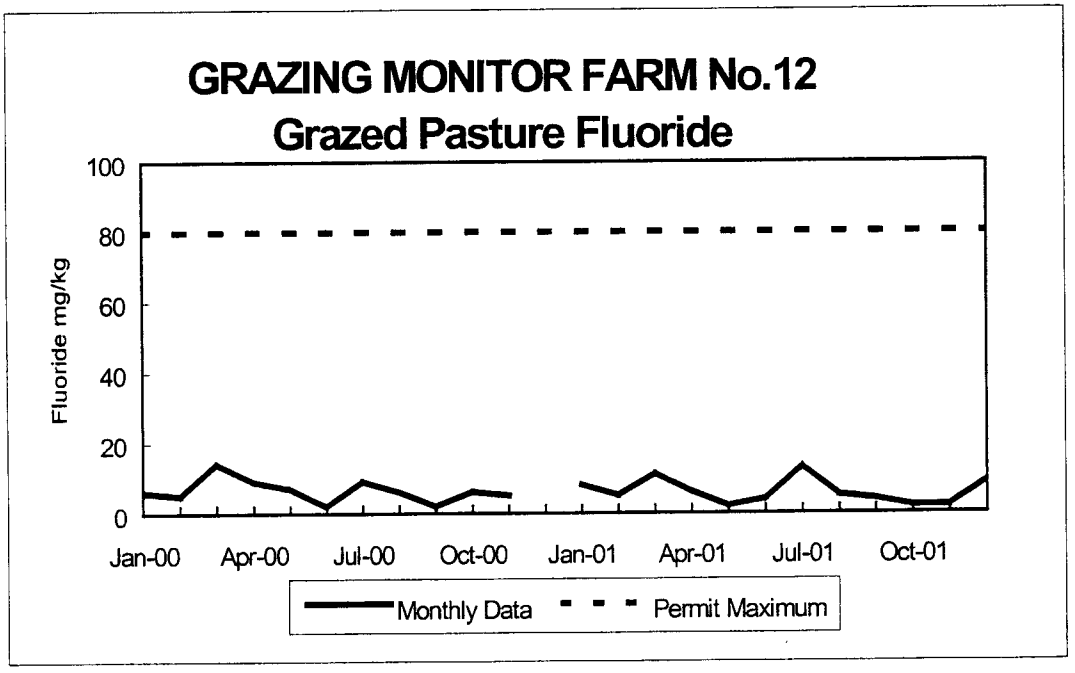
- fluoride in grazed pasture, and
- comments on the monitoring.

Fluoride in grazed pasture

The following table shows the maximum grazed pasture monitoring results for 2001.

	Units	Standard	2001
Monthly sample maximum	mg/kg	80	13
Two monthly average maximum	mg/kg	60	9
Twelve monthly running average maximum	mg/kg	40	7
Annual average	mg/kg		6

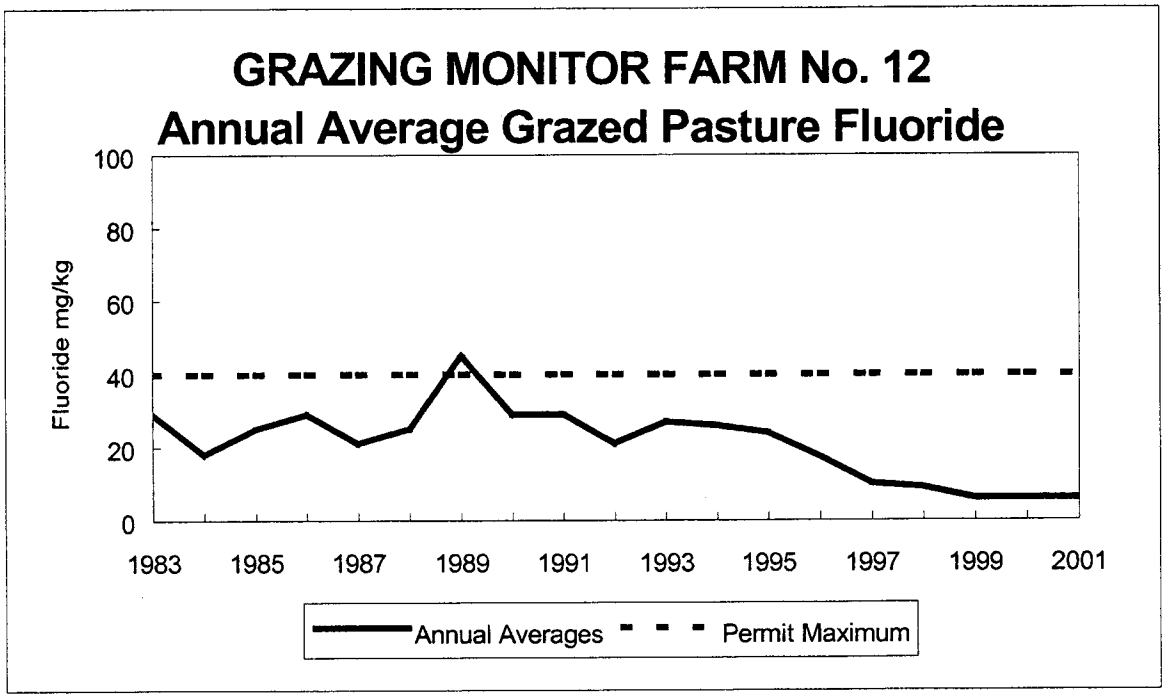
The following graph shows the results of monthly fluoride monitoring of grazed pasture during 2000 and 2001.



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 2001 annual average grazed pasture fluoride concentration of 6 mg/kg was the same as the average concentration measured in 2000. There was no sample data for December 2000 as fertilizer has been applied within 20 days of sampling.

Grazing Monitor Farm No. 14

Introduction

The following information is contained in this section:

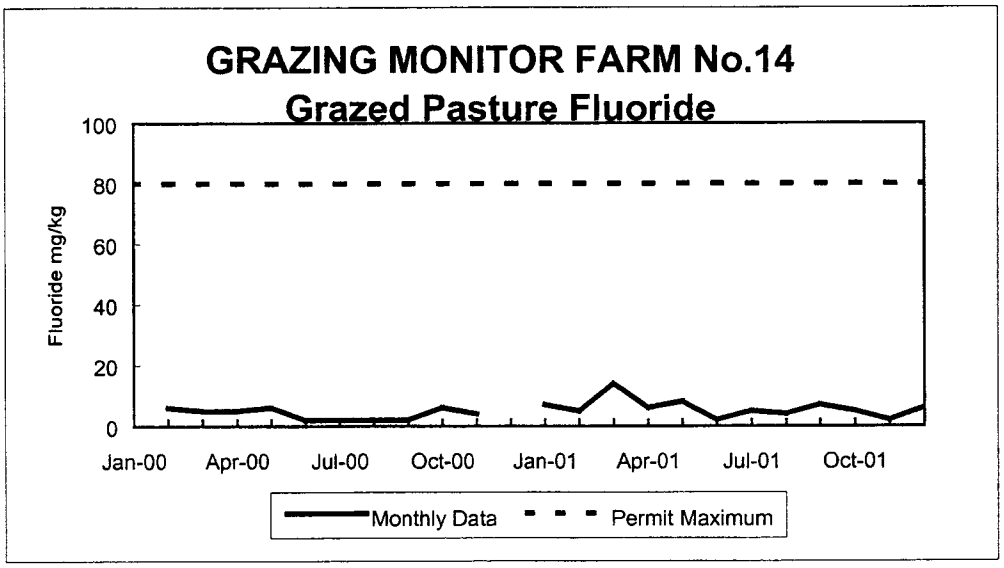
- fluoride in grazed pasture, and
- comments on the monitoring.

Fluoride in grazed pasture

The following table shows the grazed pasture monitoring results for 2001.

	Units	Standard	2001
Monthly sample maximum	mg/kg	80	14
Two monthly average maximum	mg/kg	60	10
Twelve monthly running average maximum	mg/kg	40	6
Annual average	mg/kg		6

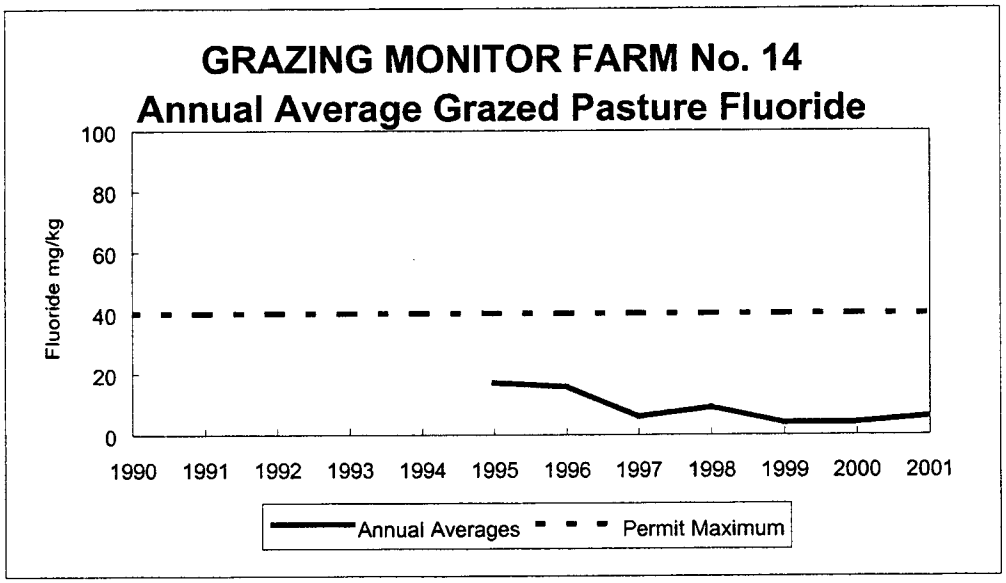
The following graph shows the results of monthly fluoride monitoring of grazed pasture during 2000 and 2001.



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 concentration in grazed pasture was within the permit standards during 2001. The annual average grazed pasture fluoride concentration of 6 mg/kg was similar to the average concentration measured during 2000. There was no sample data for December 2000 as fertilizer had been applied within 20 days of sampling.

Grazing Monitor Farm No. 16

Introduction

The following information is contained in this section:

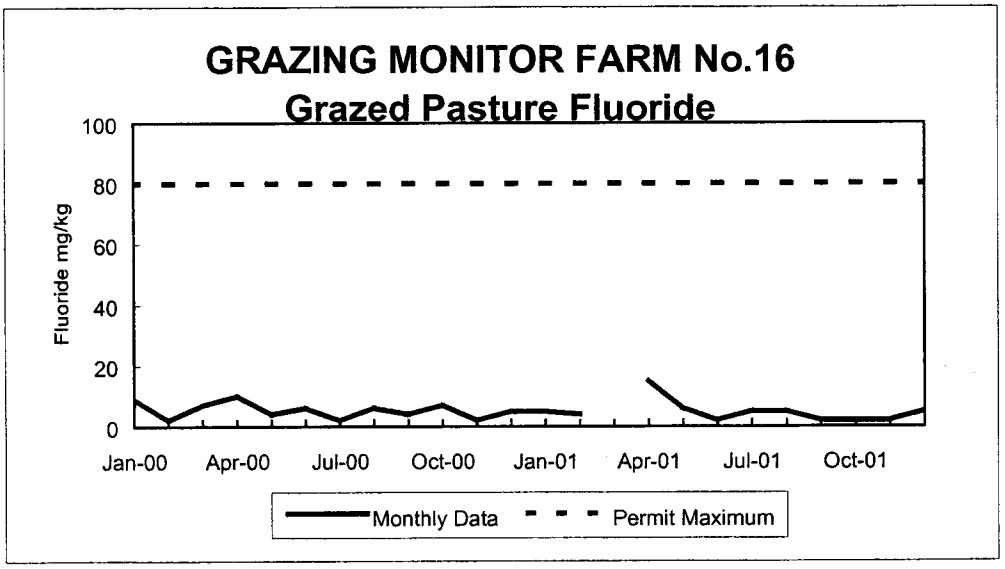
- fluoride in grazed pasture, and
- comments on the monitoring.

Fluoride in grazed pasture

The following table shows the grazed pasture monitoring results for 2001.

	Units	Standard	2001
Monthly sample maximum	mg/kg	80	15
Two monthly average maximum	mg/kg	60	11
Twelve monthly running average maximum	mg/kg	40	6
Annual average	mg/kg		5

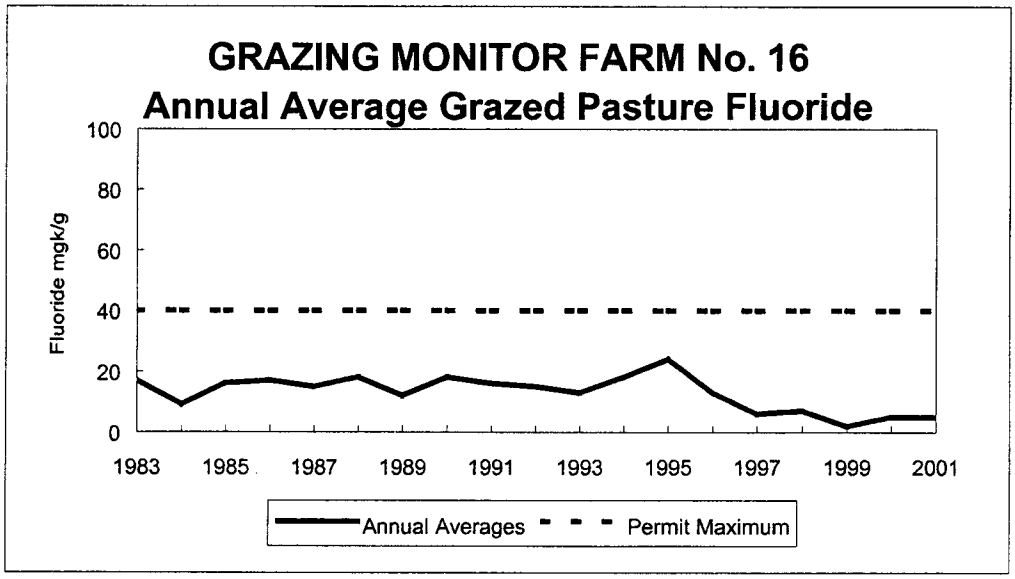
The following graph shows the results of monthly fluoride monitoring of grazed pasture during 2000 and 2001.



Grazing Monitor Farm No. 16

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 2001. The 2001 annual average grazed pasture fluoride concentration of 5 mg/kg was similar to the concentration measured in 2000. There was no sample data for March 2001 as fertilizer had been applied within 20 days of sampling.

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.

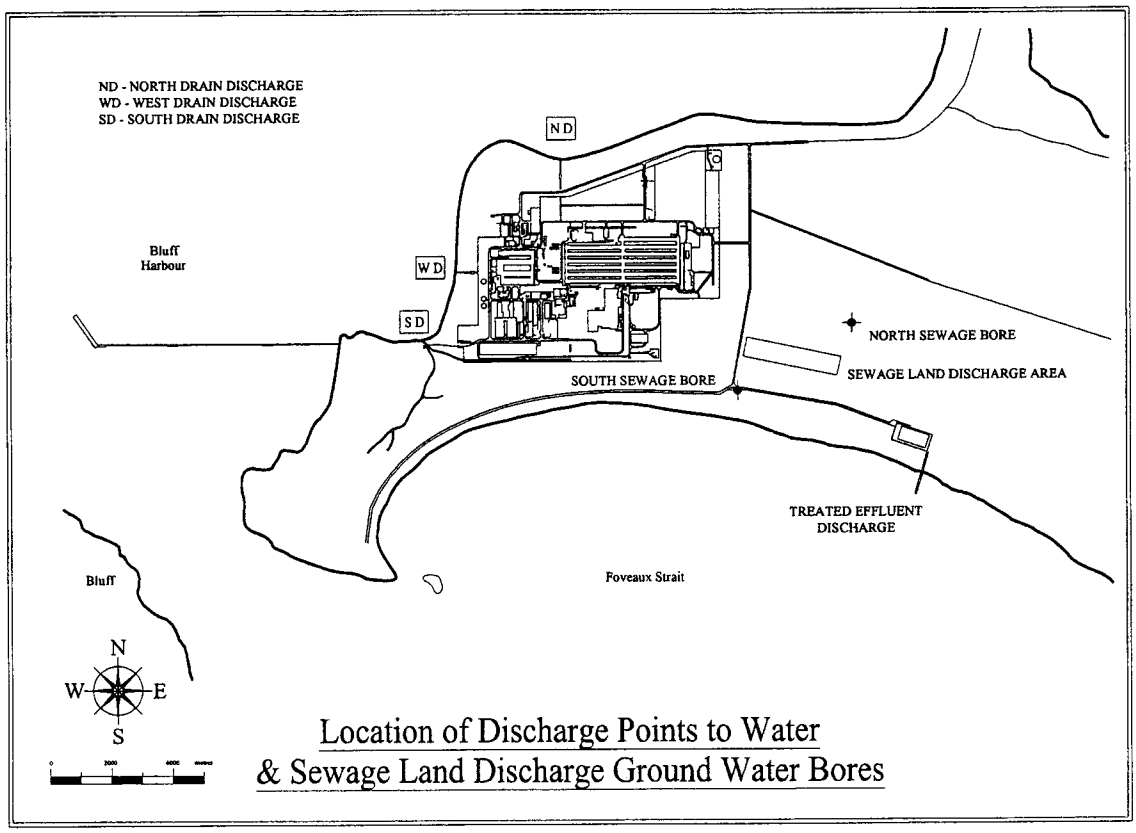
	Units	Limit
North, South, and West Drain		
• Quarterly average total suspended solids	g/m^3	30
Treated effluent		
• Maximum daily discharge	m^3/day	140
• Total suspended solids	g/m^3	100
• Free cyanide	g/m^3	20
Treated sewage		
• Maximum daily flow	m^3/day	295
• Biochemical oxygen demand	g/m^3	18
• Total 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 2001 and shows a comparison with 2000 results.

Parameter	Units	Limit	2000 Result	2001 Result
Total suspended solids				
• Annual average	g/m^3	-	11.5	7.3
• Maximum quarterly average	g/m^3	30	13.6	10.0
• 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 2001 and shows a comparison with 2000 results.

Parameter	Units	Limit	2000 Result	2001 Result
Fluoride				
• Annual average	g/m^3	-	1.4	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	1.7	1.8
• 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 North Drain annual coastal water monitoring results during 2001 and shows a comparison with 2000 results.

Parameter	Units	Limit	2000 Result	2001 Result
Difference in temperature	°C	3.0	0.1	0.1
Minimum dissolved oxygen concentration	mg/litre	5.0	9.1	8.4

Comments

Discharges from the North Drain were within permit limits during 2001.

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 2001 and shows a comparison with 2000 results.

Parameter	Units	Limit	2000 Result	2001 Result
Total suspended solids				
• Annual average	g/m^3	-	3.0	2.0
• Maximum quarterly average	g/m^3	30	3.8	2.5
• 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 2001 and shows a comparison with 2000 results.

Parameter	Units	Limit	2000 Result	2001 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	1.4
• 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 2001 and shows a comparison with 2000 results.

Parameter	Units	Limit	2000 Result	2001 Result
Difference in temperature	°C	3.0	1.4	0.2
Minimum dissolved oxygen concentration	mg/litre	5.0	8.9	8.7

Comments

Discharges from the South Drain were within permit limits during 2001.

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 2001 and shows a comparison with 2000 results.

Parameter	Units	Limit	2000 Result	2001 Result
Total suspended solids				
• Annual average	g/m^3	-	10.6	6.7
• Maximum quarterly average	g/m^3	30	14.8	9.5
• 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 2001 and shows a comparison with 2000 results.

Parameter	Units	Limit	2000 Result	2001 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	0.3	0.1
• No. of times > 0.1		0	1	0
Visible oil				
• No. of times observed		0	0	0

The following table summarises the West Drain annual coastal water monitoring results during 2001 and shows a comparison with 2000 results.

Parameter	Units	Limit	2000 Result	2001 Result
Difference in temperature	°C	3.0	0.7	0.5
Minimum dissolved oxygen concentration	mg/litre	5.0	9.3	8.7

Comments

Discharges from the West Drain were within permit limits during 2001.

Catch pots have been placed in some of the sumps which lead to the west drain. These retain the particulate washed down the drain during heavy rain. It is planned to progressively add catch pots to further sumps. In addition it is also planned to relocate the storage and "breaking up" of reject anodes to under cover, which will minimise the amount of particulate entering the West Drain.

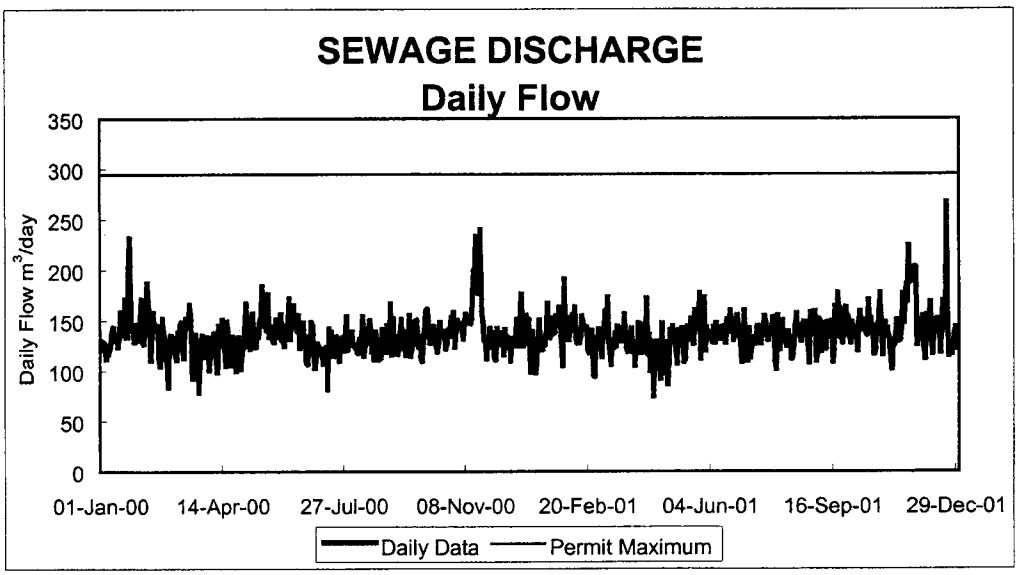
Treated Sewage Discharges

Introduction

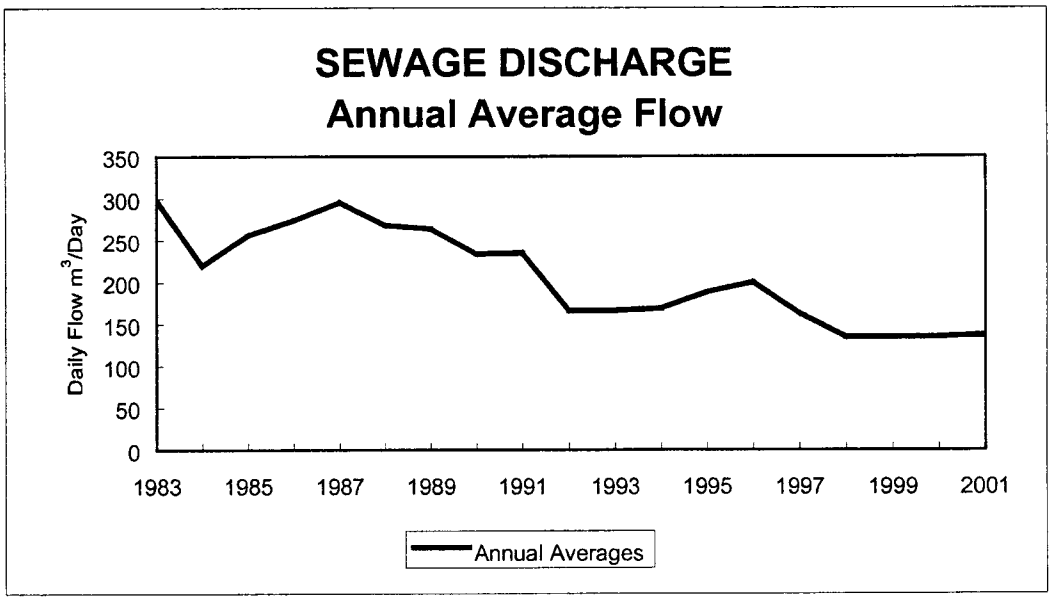
Discharges of treated sewage onto land are covered by Discharge Permit Number 96122, which was granted on 16 October 1996.

Discharge monitoring results

The following graph shows the daily sewage discharge flow during 2000 and 2001. The permit limit for daily flow is 295 m^3/day.



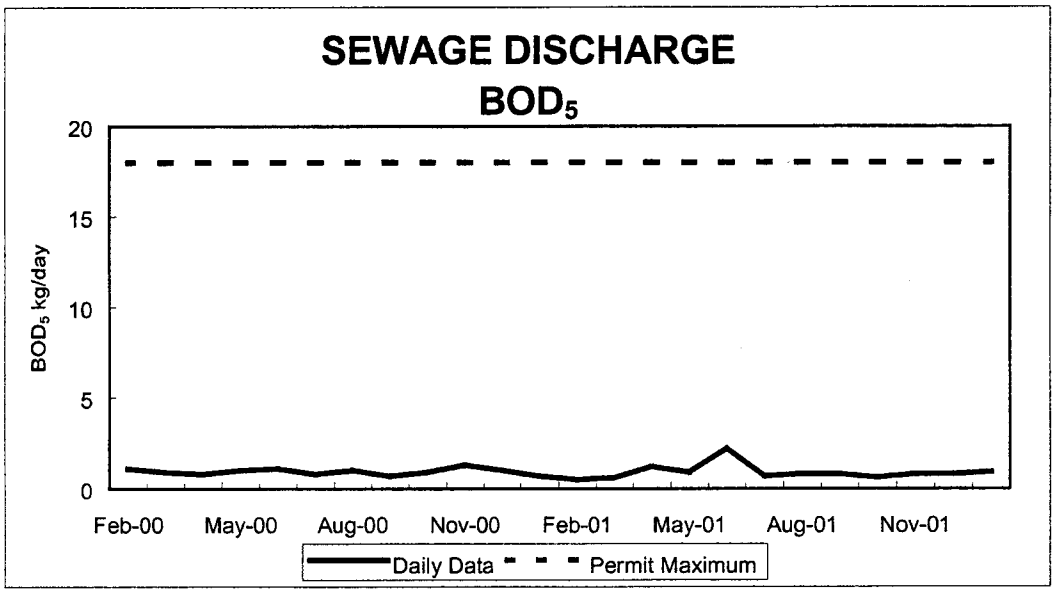
The following graph shows the annual average daily sewage discharge flow.



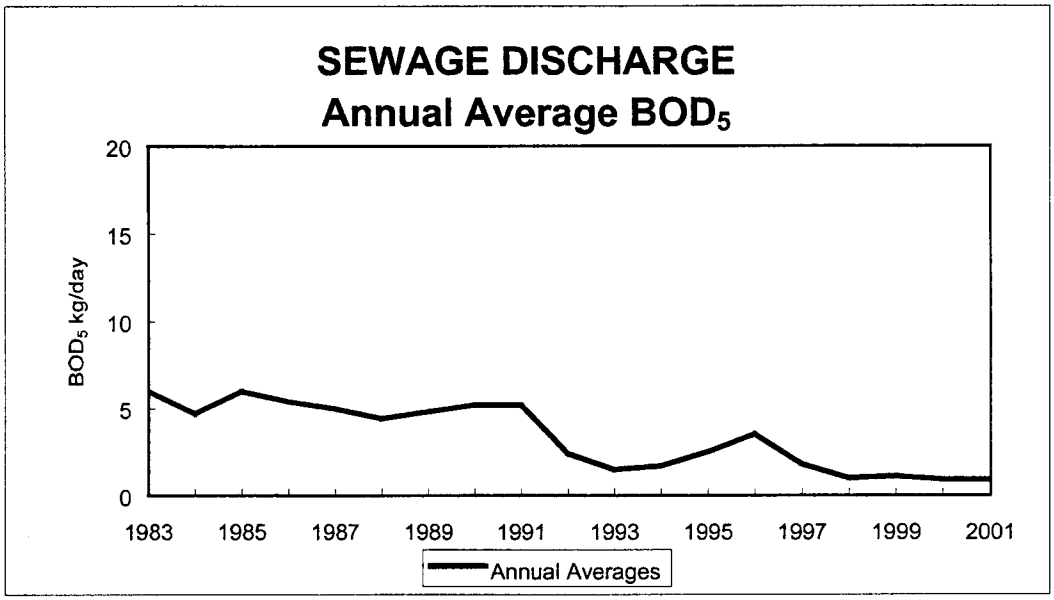
Treated Sewage Discharges, Continued

Discharge monitoring results, continued

The following graph shows the monthly biochemical oxygen demand (BOD_5) discharge from the sewage treatment plant during 2000 and 2001. The permit limit for BOD_5 is 18kg/day.



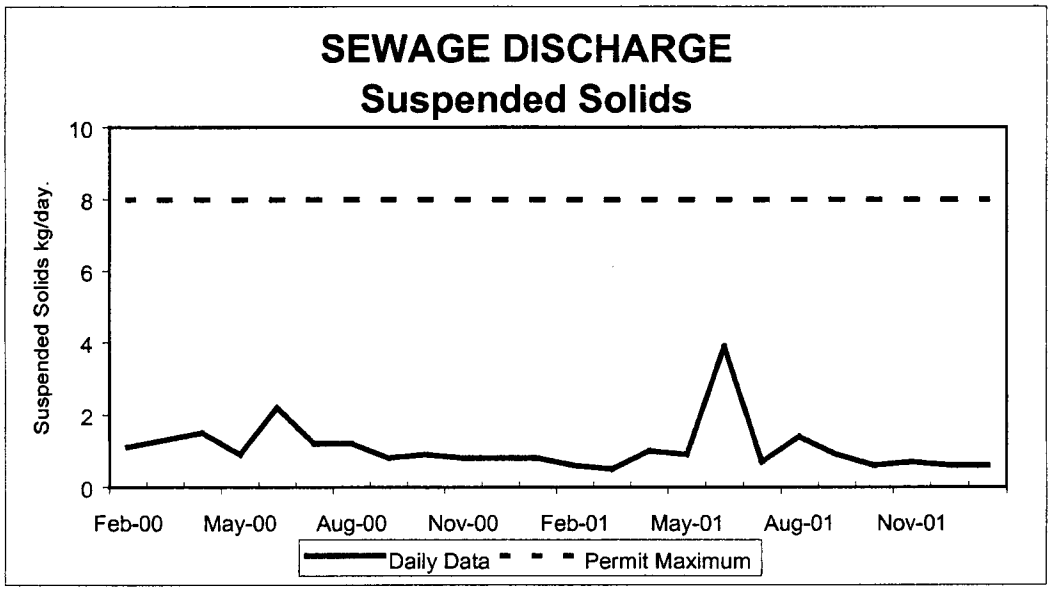
The following graph shows the annual average BOD_5 discharge from the sewage treatment plant.



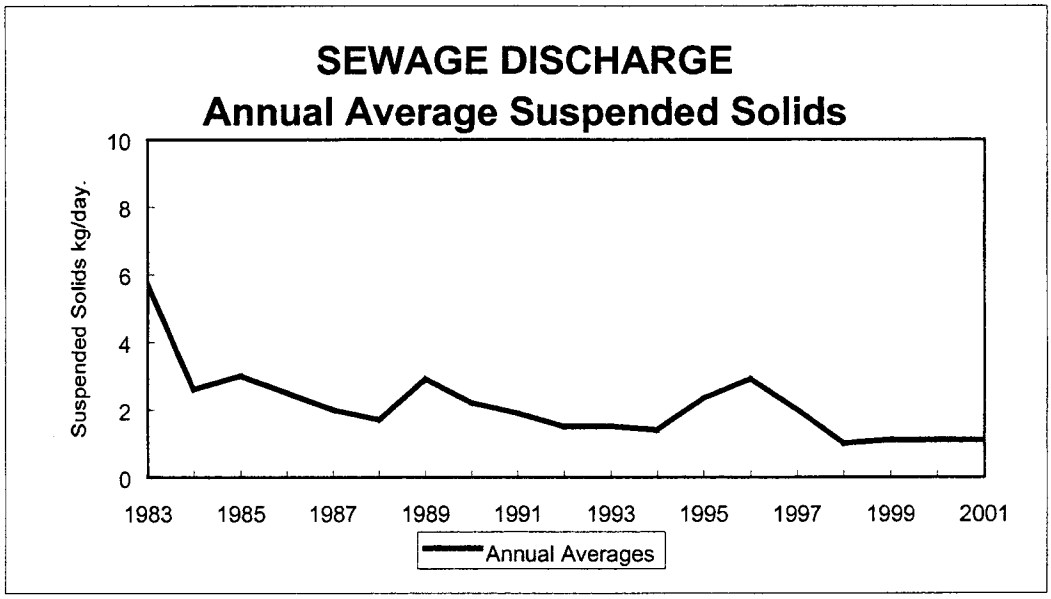
Treated Sewage Discharges, Continued

Discharge monitoring results, continued.

The following graph shows the monthly suspended solids discharge from the sewage treatment plant during 2000 and 2001. 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	2000 Average	2001 Average	Previous Range (post commission)
North Bore (Upstream)				
Faecal coliforms	MPN/100 ml	<2	<2	< 2
Total phosphorus	g/m^3	0.09	0.08	0.07 - 0.15
Total ammoniacal-N	g/m^3	0.01	0.03	0.01 - 0.03
Nitrate-N	g/m^3	0.010	0.004	< 0.01 - 0.06
Total Nitrogen	g/m^3	0.14	0.10	0.08 - 0.2
pH		7.9	7.8	7.8 - 8.1
Conductivity	µS/cm	312	327	309 - 332
Chlorinated Aliphatic HC	g/m^3	B.L.		B.L.
South Bore (Downstream)				
Faecal coliforms	MPN/100 ml	<2	<2	< 2 - 23
Total phosphorus	g/m^3	0.02	0.01	0.01 - 0.04
Total ammoniacal-N	g/m^3	<0.01	<0.01	0.01 - 0.02
Nitrate-N	g/m^3	0.169	0.091	0.02 - 0.35
Total Nitrogen	g/m^3	0.39	0.26	0.23 - 0.62
pH		7.8	7.7	7.4 - 7.9
Conductivity	µS/cm	413	401	252 - 415
Chlorinated Aliphatic HC	g/m^3	B.L.	B.L.	B.L.

HC = Hydrocarbons

B.L. = Below limit of detection for each of the 23 compounds determined.

Comments

The discharges of treated sewage onto land during 2001 were within permit limits.

Groundwater monitoring results are similar or lower to those reported in 2000.

Treated Effluent Discharges

Introduction

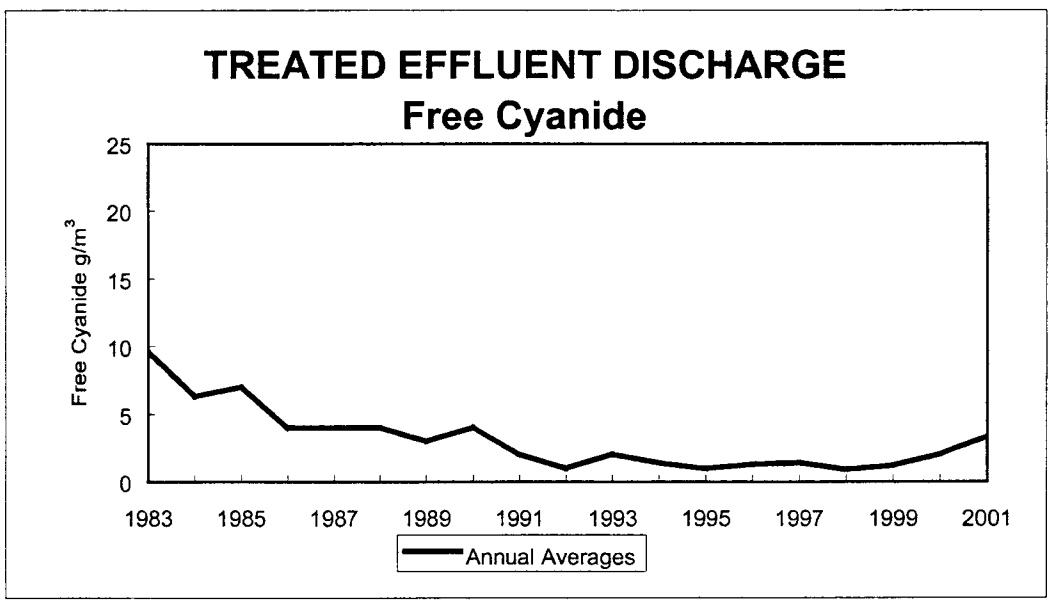
Discharges of treated effluent into Foveaux Strait are covered by Coastal Permit Number 94488 which commenced on 11 October 1996.

Discharge monitoring results

The following table summarises the results of treated effluent discharge monitoring during 2001 and shows a comparison with the 2000 results.

Parameter	Units	Limits	2000 Result	2001 Result
Maximum daily discharge	m^3/day	140	80	80
Suspended Solids				
Maximum Concentration			58	15
Average Concentration	g/m^3	100	11.1	4.3
No.> 100 g/m^3		0	0	0
Free Cyanide				
Maximum Concentration	g/m^3	20	8.7	13.7
Average Concentration			2.0	3.3
No.> 20 g/m^3		0	0	0

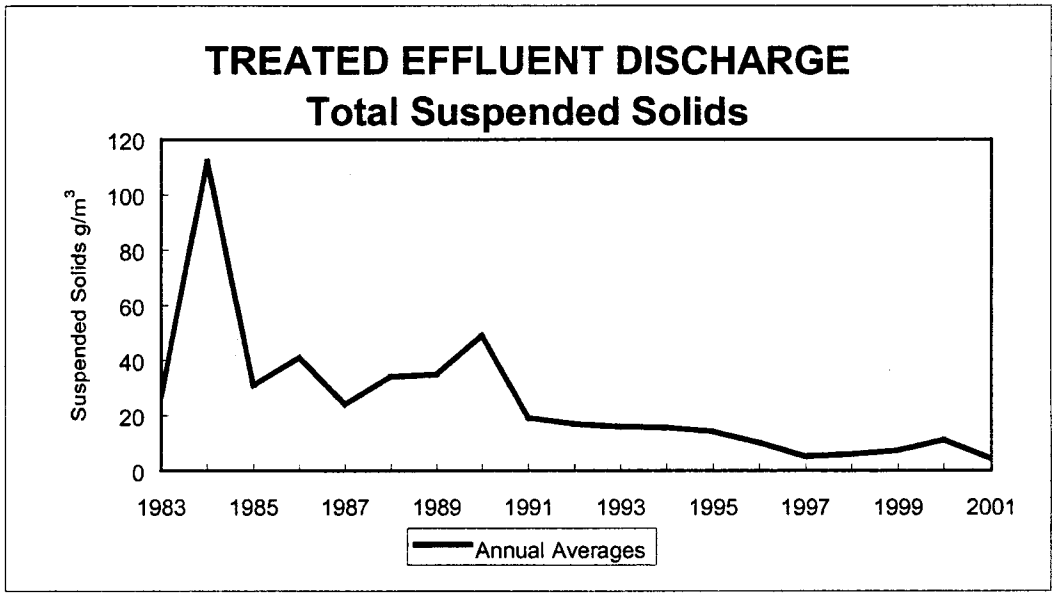
The following graph shows the annual average free cyanide concentration of treated effluent discharged.



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 2001 and shows a comparison with 2000 results.

Parameter	Units	Limit	2000 Result	2001 Result
Change to temperature	°C	3.0	0.0	0.3
Change to pH		0.1	0.0	0.0
Dissolved oxygen	mg/L	>= 5.0	8.5	8.8
No of times visible oil observed		0	0.0	0

Comments

All discharges of treated effluent were within permit limits during 2001. The increase in free cyanide may be due to an increase in the number of cells relined from Line 4.

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.

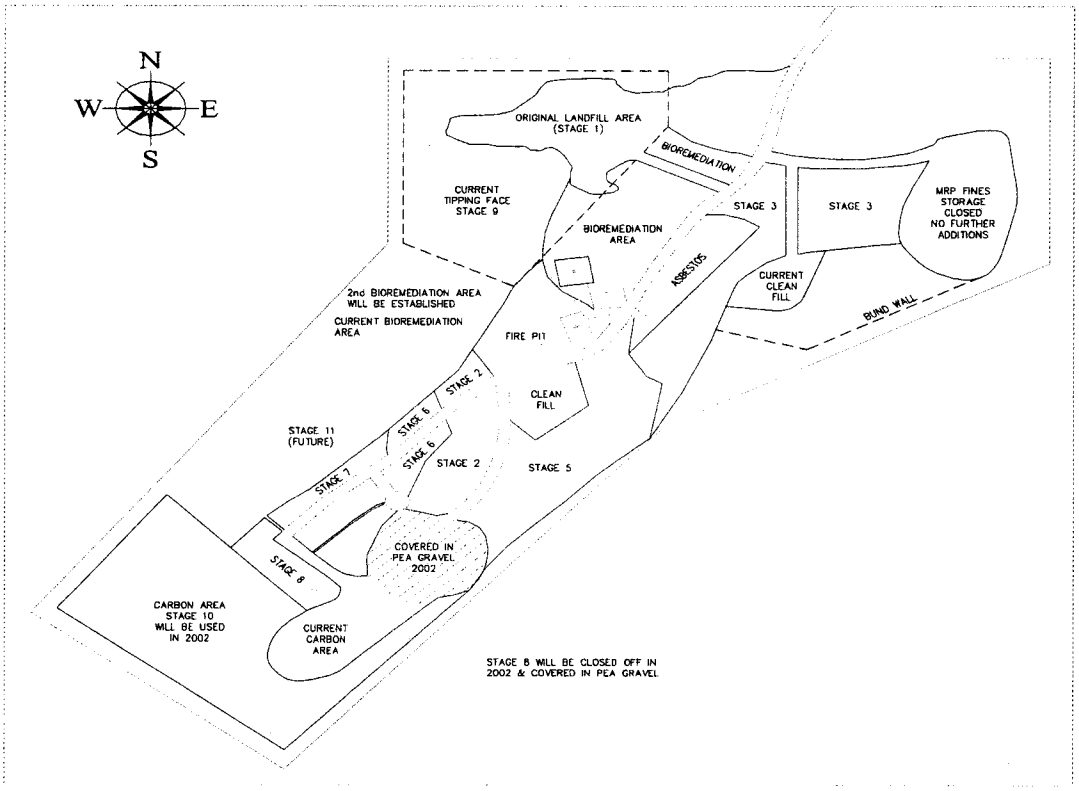
Proposed Operation For 2002

Introduction

The proposed operation of the landfill for 2002 is outlined in the NZAS Landfill Management Plan. Additional details on the proposed operations during 2002 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 2002, Continued

Landfill areas being developed or extended, continued

Stage 8 will be closed off in 2002 and covered in pea gravel.

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

The current MRP fines area has been closed – there will be no further additions.

The current clean fill area will continue but with reduced deposition – the landfill will be sold off site.

The current carbon area will be covered in pea gravel in 2002 and stage 10 will come into use.

A 2nd bioremediation are will be established to the north west of the current bioremediation area.

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

Existing native plantings in the path of new tipping areas will be relocated to closed off areas.

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 2 December 2001 to 20 January 2002.

- Each truck load of waste was weighed before and after deposition at the landfill to obtain an accurate weight
- Non – classified skips were studied in more detail this survey to further investigate site segregation standards
- 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.

Estimate for 2002.

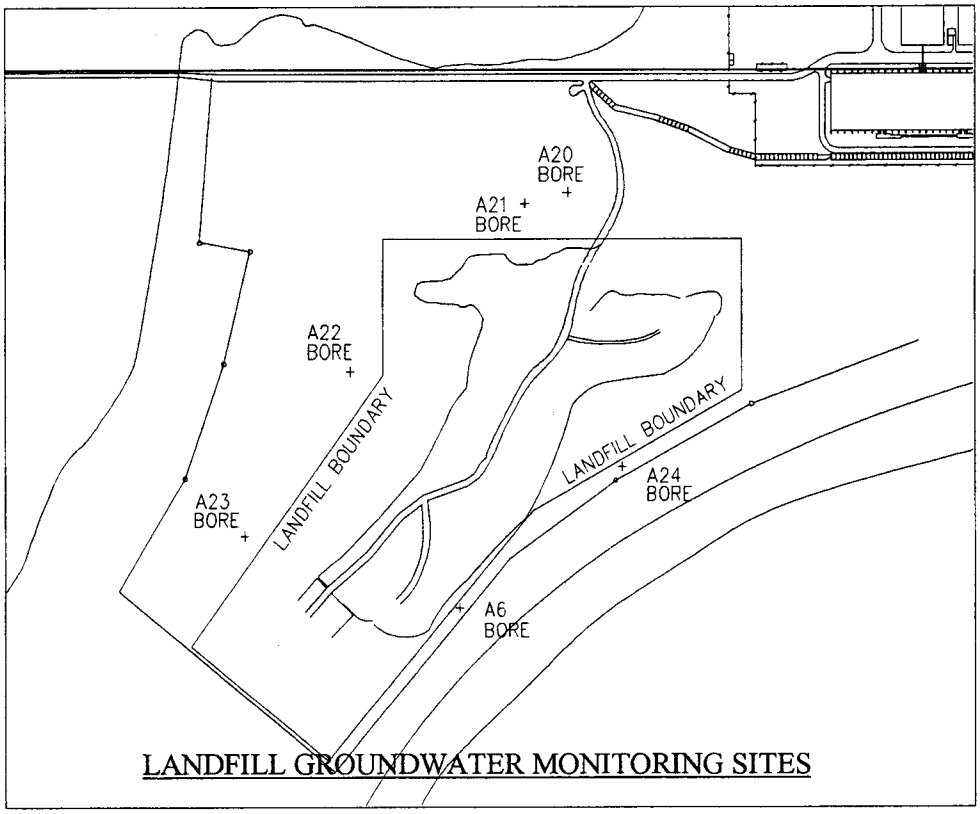
The following table shows the estimated amount of waste deposited at the Tiwai Point Landfill during 2001 and 2002.

Type of Waste	2002 Yearly Estimate	2001 Yearly Estimate
	(tonnes)	(tonnes)
Bath (Reject)	175	316
Bricks	334	596
Carbon Material	3199	2981
Concrete and Rubble	101	207
D/C Filter Bags	6	2
Furnace Slag	247	226
Furnace Elements	5	7
Organic	3	0
Metal Dust	42	153
MRP	0	1348
Non-Classified Waste	772	528
Paper + Cardboard	28	19
Plastic	22	11
Resistor Coke	110	67
Timber	94	39
Rubber	20	
Textiles	14	
Asbestos	< 1	
Floor Sweepings	26	
TOTALS	**5198**	**6293**

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 SITES

Landfill Groundwater Monitoring, Continued

Bore A20 monitoring results

The table below shows a summary of results from samples collected from bore A20 during 2000 and 2001. Bore A20 is located north of the landfill (upstream).

Analyte	Units	2000 Average	2001 Average	Range (since Commissioning)
Temperature	^0C	10.4	11.1	7.5 - 13.4
pH		6.1	5.7	5.4 - 7.2
Conductivity	µS/cm	838	805	676 - 845
Alkalinity	g/m^3	49	23	8 - 146
Carbonaceous BOD5	g/m^3	1.8	2.2	1 - 6
Total Nitrogen	g/m^3	0.38	0.58	0.1 - 1.3
Total Ammoniacal Nitrogen	g/m^3	0.07	0.06	0.04 - 0.16
Fluoride	g/m^3	0.17	0.21	0.03 - 0.25
Sulphate	g/m^3	37	33	27 - 47
Total Iron	g/m^3	8.39	6.06	0.7 - 13.5
Total Petroleum Hydrocarbons	g/m^3	1	2.5	0.3 - 11.6
Total Kjeldahl Nitrogen	g/m^3	N.D.	0.5	0.4 - 0.5
Nitrate Nitrogen	g/m^3	N.D.	0.4	0.003 - 14
Nitrite Nitrogen	g/m^3	N.D.	0.001	0.001 - 0.014
Weak Acid Dissociable Cyanide	g/m^3	N.D.	0.001	0.001 - 0.1
Boron	g/m^3	N.D.	0.04	0.038 - 0.067
Manganese	g/m^3	N.D.	0.29	0.115 - 0.394
Nickel	g/m^3	N.D.	0.007	0.002 - 0.01
Potassium	g/m^3	N.D.	3.6	3.3 - 4.1
Vanadium	g/m^3	N.D.	0.001	0.001 - 0.003

N.D: Not analysed.

Landfill Groundwater Monitoring, Continued

Bore A21 monitoring results

The table below shows a summary of results from samples collected from bore A21 during 2000 and 2001. Bore A21 is located north of the landfill (upstream).

Analyte	Units	2000 Average	2001 Average	Range (since Commissioning)
Temperature	°C	10.4	11.4	6.5 - 13.7
pH		5.6	5.4	5.1 - 6.3
Conductivity	µS/cm	932	983	683 - 1723
Alkalinity	g/m3	18	10	9 - 160
Carbonaceous BOD5	g/m3	1.4	1.7	1 - 16
Total Nitrogen	g/m3	1.0	0.8	0.9 - 8
Total Ammoniacal Nitrogen	g/m3	0.20	0.20	0.1 - 4.6
Fluoride	g/m3	0.35	0.37	0.19 - 0.83
Sulphate	g/m3	57	58	29 - 101
Total Iron	g/m3	8.6	4.3	2.2 - 94.6
Naphthalene	mg/m3	0.010	0.005	0.003 - 0.1
Anthracene	mg/m3	0.011	0.004	0.002 - 0.03
Phenanthrene	mg/m3	0.005	0.009	0.002 - 0.02
Fluoranthene	mg/m3	0.004	0.002	0.002 - 0.01
Total Petroleum Hydrocarbons	g/m3	1.00	2.50	0.3 - 7.3
Total Kjeldahl Nitrogen	g/m3	N.D.	0.9	0.9 - 6.5
Nitrate Nitrogen	g/m3	N.D.	0.02	0.01 - 29
Nitrite Nitrogen	g/m3	N.D.	0.001	0.001 - 0.028
Weak Acid Dissociable Cyanide	g/m3	N.D.	0.001	0.001 - 0.1
Boron	g/m3	N.D.	0.109	0.077 - 0.154
Manganese	g/m3	N.D.	0.1	0.1 - 0.473
Nickel	g/m3	N.D.	0.003	0.003 - 0.007
Potassium	g/m3	N.D.	5.4	5.4 - 11.3
Vanadium	g/m3	N.D.	0.005	0.001 - 0.043

N.D: Not analysed.

Landfill Groundwater Monitoring, Continued

Bore A22 monitoring results

The table below shows the averages of results from samples collected from bore A22 during 2000 and 2001. Bore A22 is located west of the landfill.

Analyte	Units	2000 Average	2001 Average	Range (since Commissioning)
Temperature	°C	10.3	10.5	8.6 - 12.1
pH		4.7	4.3	4.2 - 7.3
Conductivity	µS/cm	608	636	450 - 1204
Alkalinity	g/m3	3.75	0.50	0.5 - 294
Carbonaceous BOD5	g/m3	1.3	1.9	1 - 12
Total Nitrogen	g/m3	1.9	2.05	0.4 - 2.8
Total Ammoniacal Nitrogen	g/m3	0.08	0.10	0.05 - 0.47
Fluoride	g/m3	1.99	1.95	0.4 - 2.3
Sulphate	g/m3	21	29.50	10 - 44
Total Iron	g/m3	2.11	0.80	0.6 - 3.5
Total Petroleum Hydrocarbons	g/m3	1	2.50	0.3 - 10.7
Total Kjeldahl Nitrogen	g/m3	N.D.	1.90	0.9 - 1.9
Nitrate Nitrogen	g/m3	N.D.	0.010	0.01 - 0.2
Nitrite Nitrogen	g/m3	N.D.	0.004	0 - 0.042
Weak Acid Dissociable Cyanide	g/m3	N.D.	0.002	0.001 - 0.1
Boron	g/m3	N.D.	0.059	0.006 - 0.066
Manganese	g/m3	N.D.	0.025	0.005 - 0.394
Nickel	g/m3	N.D.	0.010	0.001 - 0.01
Potassium	g/m3	N.D.	2.60	2.1 - 4.1
Vanadium	g/m3	N.D.	0.008	0.002 - 0.022

N.D: Not analysed.

Landfill Groundwater Monitoring, Continued

Bore A23 monitoring results

The table below shows a summary of results from samples collected from bore A23 during 2000 and 2001. Bore A23 is located west of the landfill.

Analyte	Units	2000 Average	2001 Average	Range (since Commissioning)
Temperature	°C	10.6	10.4	9 - 12.5
pH		5.8	6.0	5.4 - 6.1
Conductivity	µS/cm	563	531	516 - 745
Alkalinity	g/m3	42	36	33 - 60
Carbonaceous BOD5	g/m3	1.7	1	0.5 - 5
Total Nitrogen	g/m3	2	2.1	0.9 - 2.7
Total Ammoniacal Nitrogen	g/m3	1.0	1.0	0.05 - 1.4
Fluoride	g/m3	0.16	0.20	0.03 - 0.36
Sulphate	g/m3	2	3.0	0.5 - 30
Total Iron	g/m3	8.5	6.5	5.2 - 13
Total Petroleum Hydrocarbons	g/m3	1	2.5	0.3 - 7.2
Total Kjeldahl Nitrogen	g/m3	N.D.	2.3	1.8 - 2.3
Nitrate Nitrogen	g/m3	N.D.	0.01	0.01 - 0.05
Nitrite Nitrogen	g/m3	N.D.	0.003	0.001 - 0.019
Weak Acid Dissociable Cyanide	g/m3	N.D.	0.002	0 - 0.1
Boron	g/m3	N.D.	0.045	0.038 - 0.05
Manganese	g/m3	N.D.	0.055	0.055 - 0.118
Nickel	g/m3	N.D.	0.002	0 - 0.002
Potassium	g/m3	N.D.	4.4	4 - 5
Vanadium	g/m3	N.D.	0.015	0.013 - 0.021

N.D: Not analysed.

Landfill Groundwater Monitoring, Continued

Bore A24 monitoring results

The table below shows a summary of results from samples collected from bore A24 during 2000 and 2001. Bore A24 is located south east of the landfill.

Analyte	Units	2000 Average	2001 Average	Range (since Commissioning)
Temperature	°C	11	10.7	9.4 - 12.8
pH		7.3	7.6	6.9 - 7.6
Conductivity	µS/cm	2875	2930	2110 - 4410
Alkalinity	g/m3	798	890	565 - 1182
Carbonaceous BOD5	g/m3	9	9	2 - 17
Total Nitrogen	g/m3	86	99	16.8 - 152
Total Ammoniacal Nitrogen	g/m3	69	80	44 - 146
Fluoride	g/m3	8.8	9.4	0.5 - 21
Sulphate	g/m3	21	21	5 - 312
Total Iron	g/m3	21	26	13 - 29.5
Naphthalene	mg/m3	0.46	25.05	0.1 - 82
Anthracene	mg/m3	0.067	0.199	0.005 - 0.32
Phenanthrene	mg/m3	0.047	0.105	0.003 - 0.18
Fluoranthene	mg/m3	0.021	0.036	0.003 - 0.06
Total Petroleum Hydrocarbons	g/m3	1	2.5	0.3 - 18.6
Total Kjeldahl Nitrogen	g/m3	N.D.	83.8	67 - 83.8
Nitrate Nitrogen	g/m3	N.D.	1.23	0.05 - 1.23
Nitrite Nitrogen	g/m3	N.D.	0.632	0.01 - 0.632
Weak Acid Dissociable Cyanide	g/m3	N.D.	0.008	0.005 - 0.1
Boron	g/m3	N.D.	5	4 - 5
Manganese	g/m3	N.D.	0.13	0.11 - 0.13
Nickel	g/m3	N.D.	0.01	0 - 0.01
Potassium	g/m3	N.D.	31.7	11.1 - 31.7
Vanadium	g/m3	N.D.	0.4	0.3 - 0.4

N.D: Not analysed.

Landfill Groundwater Monitoring, Continued

Bore A6 monitoring results

The table below shows a summary of results from samples collected from bore A6 during 2000 and 2001. Bore A6 is located south east of the landfill.

Analyte	Units	2000 Average	2001 Average	Range (since Commissioning)
Temperature	°C	12.1	12.1	10.3 - 13.5
pH		6.7	7	6.4 - 7
Conductivity	µS/cm	3545	2865	158 - 5689
Alkalinity	g/m^3	652	484	478 - 851
Carbonaceous BOD5	g/m^3	1.6	3	1 - 6
Total Nitrogen	g/m^3	27	23	9.7 - 44
Total Ammoniacal Nitrogen	g/m^3	13.5	3.2	1.3 - 31.5
Fluoride	g/m^3	27	72	1.5 - 104
Sulphate	g/m^3	901	792	674 - 2050
Total Iron	g/m^3	13.4	11	9.9 - 22.6
Naphthalene	mg/m^3	0.012	0.010	0.003 - 0.05
Anthracene	mg/m^3	0.516	0.372	0.05 - 0.72
Phenanthrene	mg/m^3	0.043	0.011	0.005 - 0.075
Fluoranthene	mg/m^3	0.0160	0.005	0.003 - 0.09
Total Petroleum Hydrocarbons	g/m^3	1	2.5	0.3 - 9.2
Total Kjeldahl Nitrogen	g/m^3	N.D.	14.2	14.2 - 23.4
Nitrate Nitrogen	g/m^3	N.D.	8.58	0 - 14
Nitrite Nitrogen	g/m^3	N.D.	0.034	0.004 - 0.17
Weak Acid Dissociable Cyanide	g/m^3	N.D.	0.013	0.013 - 0.1
Boron	g/m^3	N.D.	0.9	0.9 - 2.5
Manganese	g/m^3	N.D.	1.5	0.2 - 1.9
Nickel	g/m^3	N.D.	0.022	0.005 - 0.022
Potassium	g/m^3	N.D.	17.60	17.6 - 37
Vanadium	g/m^3	N.D.	0.07	0.05 - 0.22

N.D: Not analysed.

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 2001.

Samples collected from Bore A24 and A6 in 2001 showed increasing levels of fluoride. The increased concentrations are unlikely to have an impact on the receiving seawater in Foveaux Strait. Bore A24 in quarter four also showed an elevated level ($30.1 mg.m^{-3}$) of Naphthalene but previous surveys have showed levels varying between 8 and $82 mg.m^{-3}$.

The increase in analyte concentrations at Bores A24 and A6 most likely indicate the proximity of the bore to the MRP fines storage area. MRP fines are no longer being deposited at the landfill. Deposition of MRP fines stopped during quarter three 2001.

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 for a period of three years, no annual report is available. A "snapshot" study due to be undertaken 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. The monitoring in 2001 indicated no leakage.

Diesel Bioremediation.

As with the Spent Cathode Pad Leachate monitoring, Environment Southland recommended that monitoring cease for three years, followed by "snapshot" monitoring with future monitoring contingent on the "snapshot" results. "Snapshot" monitoring is due in 2002 with another full survey due in 2006.

Spent Cell Lining Storage Shed

Monitoring of the membranes under the Spent Cell Lining storage shed continued during 2001. An increased volume of liquid was detected during quarter four. This liquid contained elevated concentrations of cyanide and fluoride and was identified as coming from sludge generated in the cell reconstruction wash down area. The sludge was being disposed of in the shed. The spill was mostly contained within the leak detection and prevention system of the shed, but it appears that the floor of the shed may have been compromised. An investigation is under way on an alternative disposal system so that this type of waste is longer disposed of in the Spent Cathode Lining shed.

Waituna Wetlands Water Quality and Vegetation Health Assessment.

Introduction

This chapter covers the impact of Smelter operations upon water quality in the Waituna Wetlands and the health of vegetation in the vicinity of the smelter.

The assessments are periodic and are required under Air Discharge Permit 93566.

Waituna Wetlands Water Quality

The survey was carried out by NIWA during September and November 2001, report NZA02202. Authors: Greg Olsen, Jim Cooke, & Andrew Willsmen.

Report Executive Summary

The data collected in 2001 indicates the aerial emissions from the smelter are still having an influence on fluoride in the Waituna Wetland ponds. However, the levels have significantly decreased since the last sampling period (1994 & 1996) and they are less than those recommended in the water quality guidelines for drinking water for livestock ($2g/m^3$) and irrigation water ($1mg/m^3$). Fluoride is anticipated to have a limited adverse effect on freshwater aquatic life in the Waituna Wetland ponds.

Smelter emissions appear to have a negligible affect on pH and aluminium in the Waituna Wetland ponds. However, the low pH's recorded at both Waituna Wetland ponds (4.5-5.0) represent the lower range of pH data presented for natural wetland waters. This acidic environment is expected to be the main factor, which restricts the diversity and abundance of aquatic life in the Wetland ponds in this area.

Vegetation Health Assessment

The vegetation health survey was carried out in December 2001 by Professor Davis Doley, Department of Botany, The University of Queensland, Brisbane, Queensland, Australia.

The conclusion of the survey states that the condition of the vegetation in the vicinity of the smelter on Tiwai Point was influenced more by normal environmental stresses, particularly salt-laden winds than by smelter emissions.

Effects of smelter emissions, presumed to be fluoride, on native species were observed up to 1km downwind of the smelter. The extent of injury to the east of the smelter was about one quarter of that recorded in 1997.

There was no visible evidence that plant species in the Awarua and Waituna areas, and particularly the Waituna Wetland, were affected adversely by smelter emissions. There was no evidence of fluoride injury to plant species in the Bluff and Greenhills areas, although there was ample evidence of wind injury.