RUSAL
AUGHINISH

Aughinish Alumina Ltd

Askeaton, Co. Limerick

IPPC Licence Reg. P0035-04

Annual Environmental Report

2008

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Aughinish Alumina Ltd.

Integrated Pollution Prevention & Control Licence
Register No. P0035-04

Annual Environmental Report 2008

March 2009

Contents

List of Tables

List of Figures

Attachments

1. Introduction

This document comprises the tenth Aughinish Alumina Limited (AAL) Annual Environmental Report (AER).

The report covers the period from the 1st of January 2008 to the 31st of December 2008 and has been prepared in accordance with the Environmental Protection Agency (EPA) 'Guidance Note on the Annual Environmental Report' and other relevant guidance as provided by the EPA on the Agency website (www.epa.ie).

1.1 Description of the Activity

AAL was granted a revised Integrated Pollution Prevention & Control (IPPC) licence in April 2008.This licence grants AAL permission to carry out the following activities:

- The extraction of aluminium oxide from an ore.
- The burning of any fuel in a boiler or furnace with a nominal heat output exceeding 50MW.
- The recovery or disposal of waste in a facility, within the meaning of the Waste Management Act, 1996, which facility is connected or associated with another activity specified in the first schedule of the EPA Act of 1992.

This IPPC Licence (Reg. No. P0035-04) supersedes the installations previous licence (Reg. No. P0035-02), which had been issued in 2004.

The AAL plant extracts alumina from bauxite using the Bayer Process, a chemical method that has been developed and refined over the past century and is used by over 40 alumina extraction plants worldwide.

Approximately 70% of the bauxite processed by AAL comes for Guinea in West Africa with the remainder coming from Brazil. The finished product, alumina, is exported for further processing through smelting to aluminium metal.

The production output of the plant in 2008 was 1,890,200 tonnes of Alumina Hydrate representing an increase of 4.8% over 2007 production levels.

1.2 Management Structures

Since March 2008 AAL has been wholly owned by United Company RUSAL, which is the largest integrated aluminium company worldwide.

AAL has a structured management approach to the operation of the business in terms of product quality, process control, environment, safety, training and analytical capability. Training of personnel is a key function in the successful operation of the plant.

Safety, environmental and quality management systems are audited on an ongoing basis by a combination of internal audit teams and external certification surveillance audits by DNV (UK). In 2004, AAL became the first company outside Denmark to implement a formalised Energy Management System Standard (DS2403).

Table 1 Management Systems at AAL

Year	System	Accreditation Board
1993	International Safety Rating System (ISRS)	Det Norske Veritas (DNV)
1993	Irish Laboratory Accreditation Board (ILAB)	National Accreditation Board (NAB)
1995	ISO 9002 Quality System	Det Norske Veritas (DNV)
1997	Excellence Through people (Training)	FAS
2000	ISO 14001:2004 Environmental Management System	Det Norske Veritas (DNV)
2002	Continuous Professional Development	Institution of Engineers of Ireland (IEI)
2004	Danish Standard 2403 Energy Management System Standard	Det Norske Veritas (DNV)

1.3 Organisational Structure

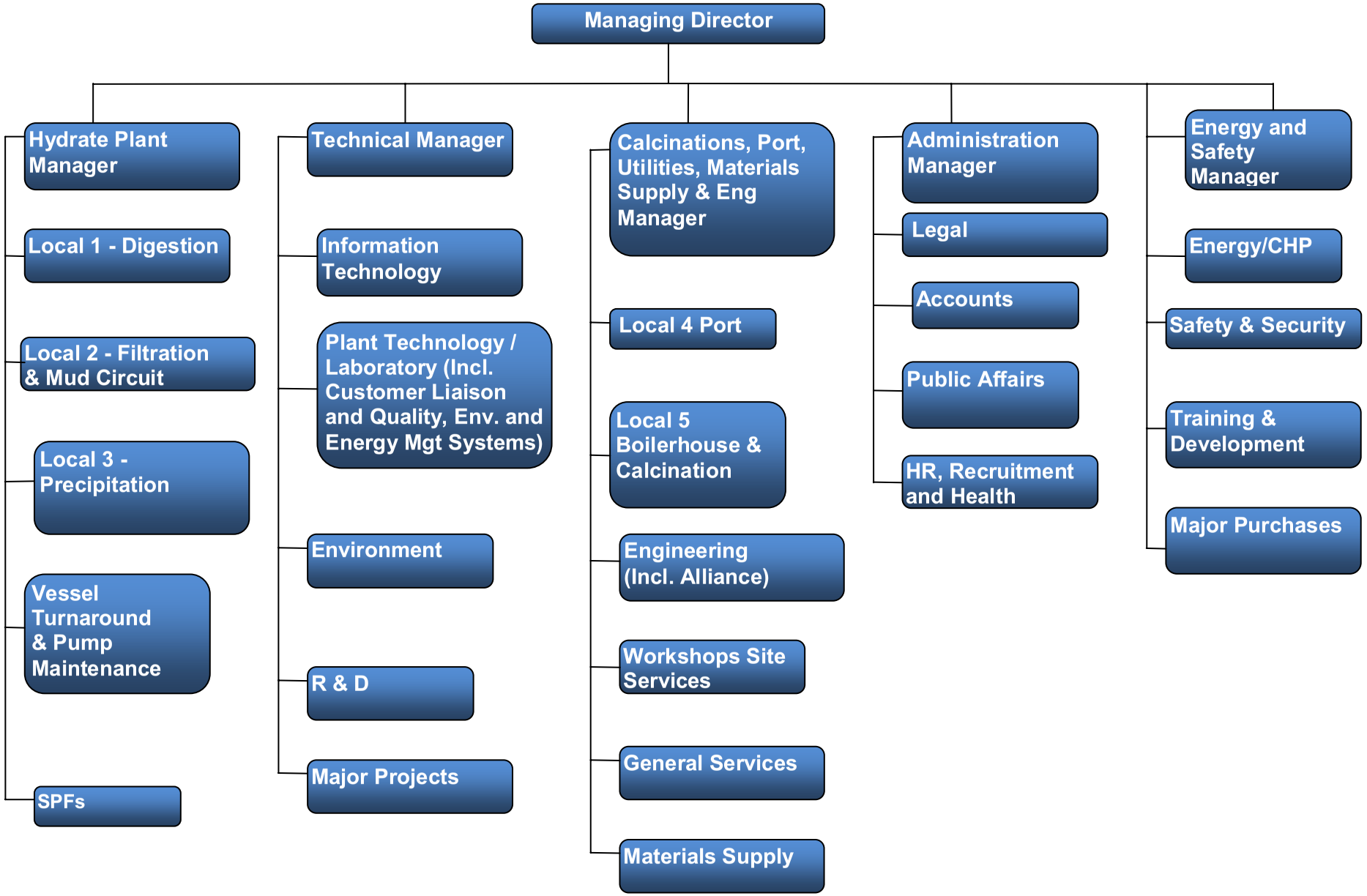
AAL operates a relatively flat management structure with a strong emphasis on team working. The company organogram is set out below and indicates the responsibility for day-to-day management of environmental issues at the plant.

As part of the site training, an Environmental Manual was issued to the on-site Contractor Alliance covering AAL's requirements for Environmental Management and Control.

The Environmental Co-ordinator has overall responsibility for environmental management and reports directly to the Management Team.

The Environmental Co-ordinator is supported in the day-to-day activities by the Environmental Engineer(s), who have responsibility for the maintenance of the Environmental Management System, undertaking specific projects of an environmental nature and evaluating compliance with the IPPC licence.

Environmental Technologists are responsible for monitoring and sampling of all emissions and discharges from the Aughinish site. This work is supported by a Co-op Student from the University of Limerick from January to September each year.


Managing Director
Hydrate Plant Manager
Local 1 - Digestion
Local 2 - Filtration & Mud Circuit
Local 3 - Precipitation
Vessel Turnaround & Pump Maintenance
SPFs
Technical Manager
Information Technology
Plant Technology / Laboratory (Incl. Customer Liaison and Quality, Env. and Energy Mgt Systems)
Environment
R & D
Major Projects
Calcinations, Port, Utilities, Materials Supply & Eng Manager
Local 4 Port
Local 5 Boilerhouse & Calcination
Engineering (Incl. Alliance)
Workshops Site Services
General Services
Materials Supply
Administration Manager
Legal
Accounts
Public Affairs
HR, Recruitment and Health
Energy and Safety Manager
Energy/CHP
Safety & Security
Training & Development
Major Purchases

1.4 Environmental Policy

Environmental Policy Statement

Protection of the environment is a high priority for every employee, contractor and director of Aughinish Alumina Ltd. This objective requires our full co-operation in a continuing effort to improve our products and production processes.

The process we employ at Aughinish, the 'Bayer Process', is the accepted industrial method for the manufacture of alumina worldwide. Our principal product, smelter grade alumina, is used to manufacture aluminium, a metal with many recognised environmental benefits.

Successful integration of our environmental objectives with our health, safety, quality and cost objectives is required to ensure our competitive position. We will continue to:

- Comply with all legal requirements and where appropriate, use more stringent internal standards based on our expertise
- Use world-class practices to ensure that we prevent pollution and meet social, economic and environmental demands.
- Develop opportunities with suppliers and customers to improve our products and to minimise waste and environmental impacts.
- Make effective use of environmental management systems that continually improve our performance consistent with defined goals.
- Review our environmental objectives and targets regularly to ensure that these remain both relevant and appropriate to our operations.
- Communicate with employees, consumers, communities, businesses and government to achieve greater environmental understanding.
- Ensure that Aughinish environmental policy is communicated to all employees and contractors and is made available to the public.

By fulfilling these objectives, we will have due regard to the environmental expectations of our many stakeholders.

Damien Clancy *September 2003*
Managing Director

2. Emissions

Aughinish implements a comprehensive environmental monitoring programme to assess the significance of emissions from site activities. The programme includes air emissions, discharged water, surface water and waste monitoring. An overview of the results of the monitoring conducted in the reporting period is presented in this section.

This section also includes an evaluation of all non-compliances with the conditions and schedules of the IPPC licence, together with a summary of environmental incidents reported to the Agency during 2008. External complaints received by the plant during 2008 are detailed, together with a description of the investigations and corrective actions initiated as a result of those complaints.

Summary information on all emissions and discharges, waste arising and resource use has been compiled on an electronic spreadsheet which has been submitted to the Agency by e-mail to IPPCaer@epa.ie. Monitoring data, summarised in the following sections, shows a high degree of compliance with the IPPC Licence emission limit values.

2.1 Emissions to Atmosphere

There are 16 IPPC licensed air emission points at AAL, 13 of which are monitored. The primary sources of emissions to atmosphere are the Boilers (Emission Point Ref. A1) and Calciners (Emission Point Ref. A2). In 2005, 2 new major emission points (Emission Point Ref. A3-A & A3-B) were added as part of the Combined Heat and Power Plant (CHP) Project.

The remaining emission sources comprise bag house and cyclone exhausts for control of particulate emissions from materials handling operations.

2.1.1 Boiler Emissions

Boiler emissions are one of the major emission sources on the site. Depending on the parameter, monitoring varies from continuous on-line monitors, to quarterly analyses as specified in Schedule C1.1 (Control of Emissions to Atmosphere) of IPPC licence P0035-04. A summary of the annual mass emissions for the licensed parameters is tabulated in Table 2 of this report.

Actual mass emissions of oxides of sulphur (as SO_2), as tabulated below, are generated by calculation, based on the sulphur content of the fuel and the quantity of fuel oil consumed in 2008. Nitrogen oxides mass emissions (as NO_2) are derived from measured NO_2 values, and estimated exhaust gas flow rates. Dust mass emissions from the boilers are calculated from the measured particulate emissions and estimated exhaust gas flow rates. The gas flow rate estimation is based on the quantity of fuel used, as there is a stochiometric relationship between air flow and fuel consumption.

Licensed mass emissions are based on emissions concentration and flow rate at ELV, taking a 366 day operational period.

The actual mass emission of SO_2 from the boilers decreased between 2007 and 2008 by 28% due to reduced Heavy Fuel Oil (HFO) consumption linked to improved process energy efficiency.

Emissions of nitrogen oxides (as NO_2) decreased by 41% during the same period due to reduced HFO consumption and decreased boiler air flow rates which generated reduced thermal nitrogen oxides.

Table 2 Mass emissions to air from the Boilers (Emission point A1)

Emission Point Ref. A1 Boilers	Mass Emission (Kgs) 2007	Mass Emission (Kgs) 2008	Licensed Mass Emissions (Kgs)
Oxides of Sulphur (as SO_2)	2,012,000	1,456,123	5,489,297
Nitrogen Oxide (as NO_2)	882,000	521,847	2,421,749
Dust	N/A	32,257	161,450

Emissions of sulphur dioxide, nitrogen oxides and dust from the main site boilers were significantly below licensed rates for these parameters.

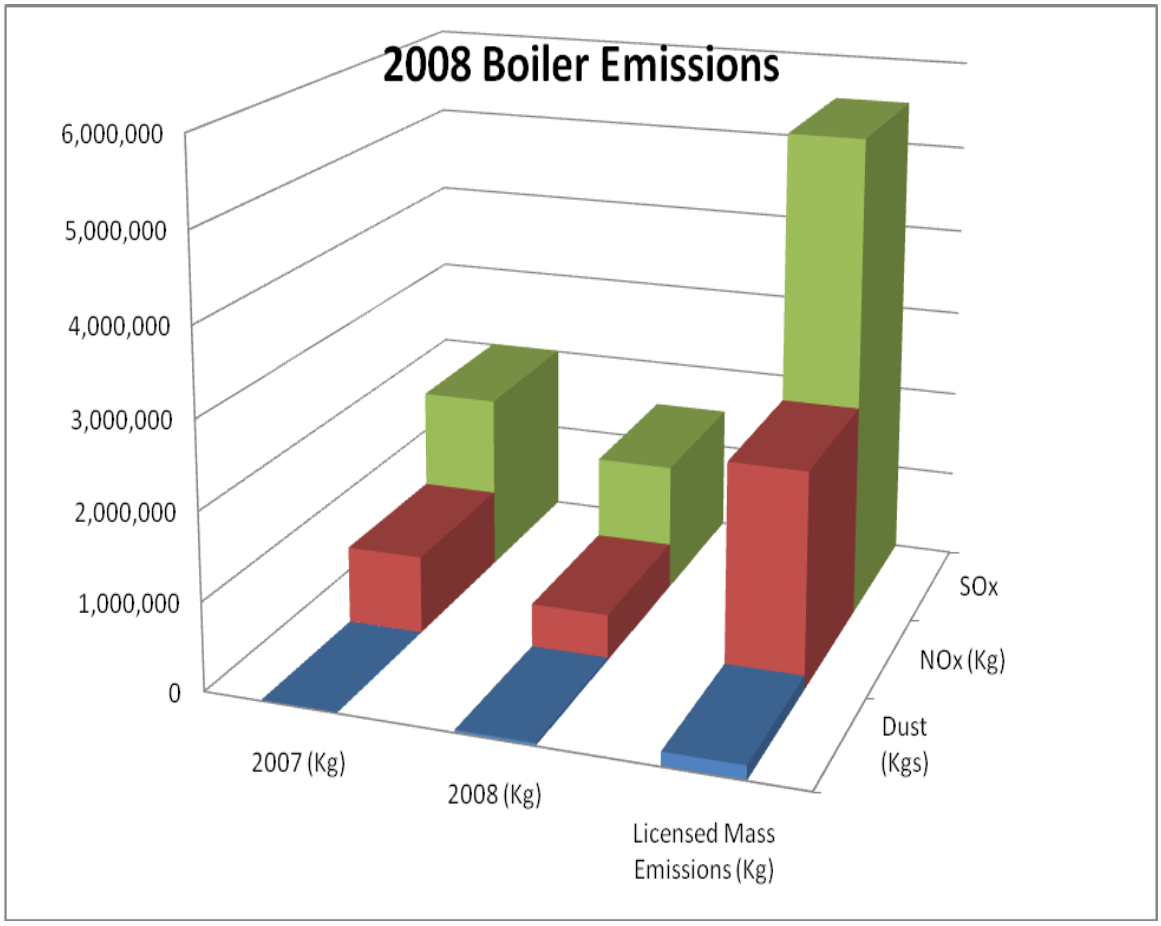


Figure 1. Summary of Boiler Mass Emissions

2.1.2 Calciner Emissions

Emissions from the calciners are summarised in Table 3 as actual annual mass emissions (in Kgs) for the licensed parameters over the 2008 reporting period. Mass emissions of oxides of sulphur are generated by calculation, based on the measured SO_2, as monitored as part of the IPPC requirements, and estimated exhaust gas flow rates. Particulate mass emissions are calculated in a similar fashion.

Mass emissions of oxides of sulphur increased between 2007 and 2008. This is believed to be due to the increased rate of production of alumina coupled with a decreased adsorption of sulphur onto the product over the corresponding period.

Table 3. Mass Emissions to air from the Calciners (Emission Point A2)

Emission Point Ref. A2 – Calciner	Mass Emission (Kgs) 2007	Mass Emission (Kgs) 2008	Licensed Mass Emissions (Kgs)
Oxides of Sulphur (as SO_2)	826,000	1,047,392	6,282,317
Particulates	88,000	88,149	235,704

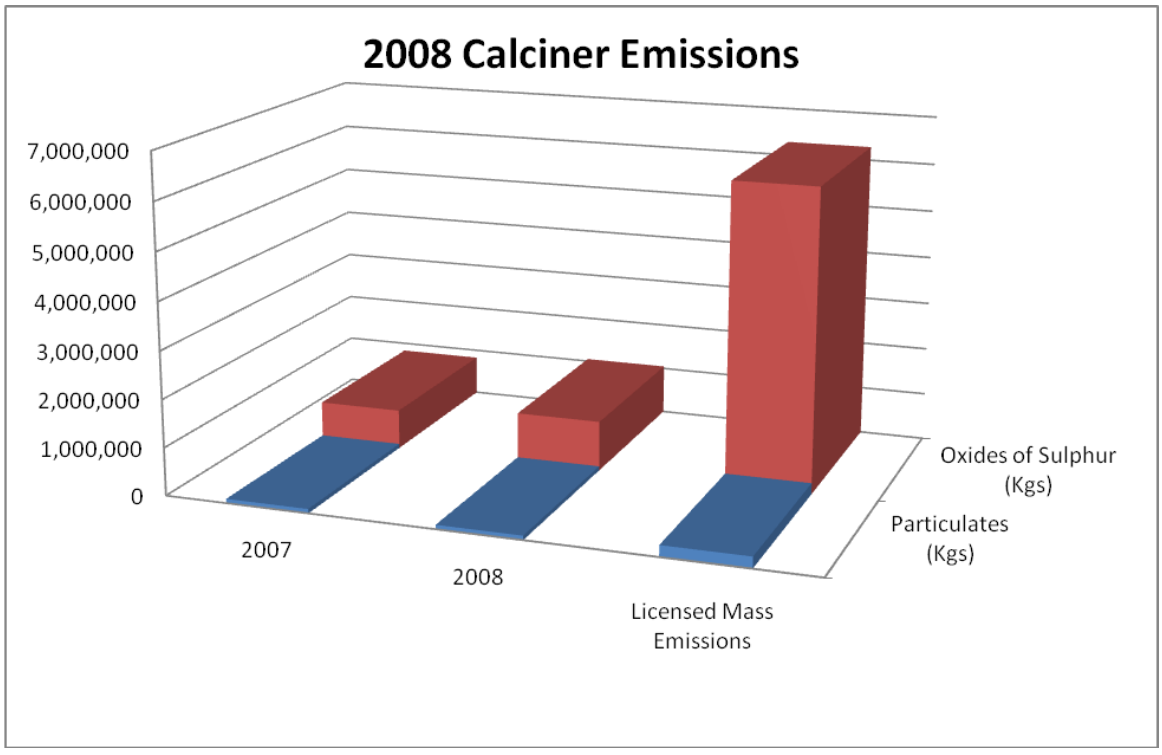


Figure 2. Summary of Mass Emissions from Calcination

2.1.3 CHP Emissions

Condition C1.1 of IPPC licence P0035-04 requires the monitoring of NO_2 for the CHP emissions. The NO_2 monitoring data for 2008 is shown below in Table 4. The emissions are significantly lower than the permitted licensed mass emissions.

Table 4 Mass Emissions to atmosphere from CHP

Emission Point Ref. A3A & A3B CHP	Mass Emission (Kgs) 2007	Mass Emission (Kgs) 2008	Licensed Mass Emissions (Kgs)
Nitrogen Oxides (as NO_2)	202,000	358,716	948,672

The licence requirements for the Gas Turbine heat recovery steam generator stack are as outlined below:

- ❖ No 24-hour value shall exceed the emissions limit value of 75 mg/m^3
- ❖ No hourly value shall exceed twice the emission limit value

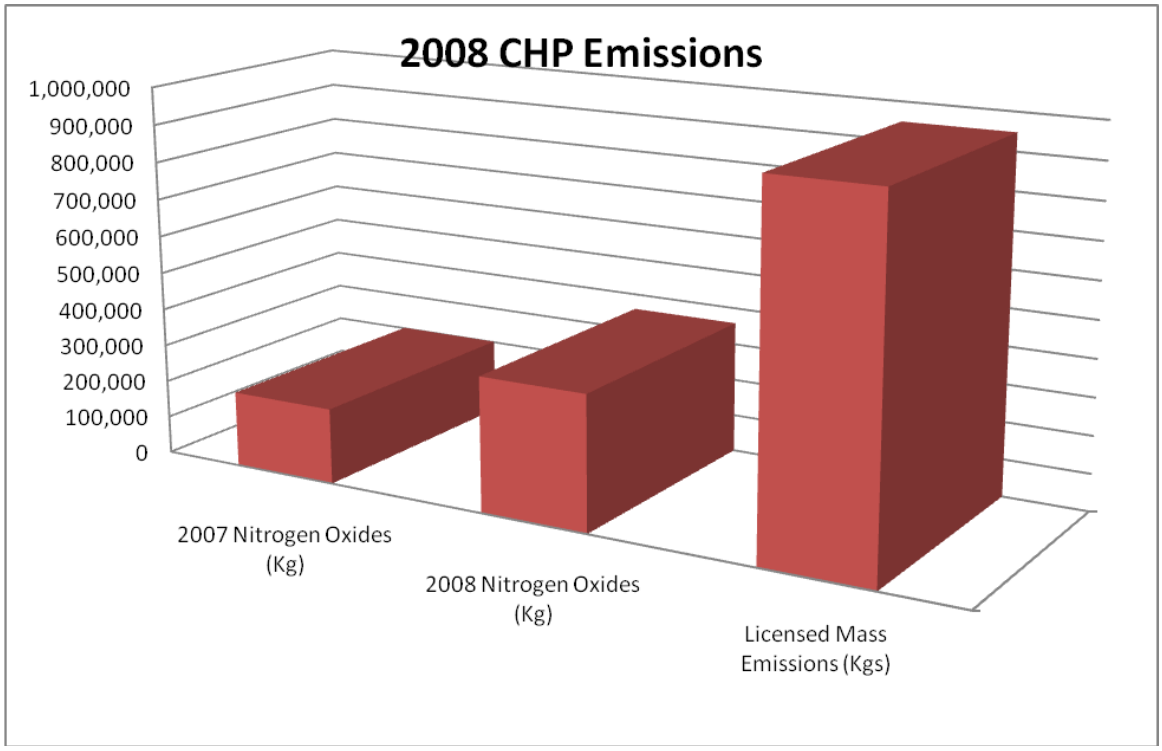


Figure 3. Summary of CHP emissions 2008

There are three unmonitored licensed combustion emission points at the plant. Licensed emission points 13, 14 and 15 are associated with small scale space heating boilers at Area 73, Area 76 and Area 79 respectively. These units are fired on gas oil with less than 0.2% Sulphur. There are no emission limits set for these small boilers and no requirement to monitor emissions.

2.1.4 Other Emission Points (Dust Collection Units)

There are 9 licensed process air emission points. These emissions are from dust collection units (DCU,s) associated with bauxite and alumina handling along with the conveying systems at the plant.

Actual mass emissions of particulates from each of the operational licensed emission points are tabulated below and are based on average quarterly monitoring results and total hours of operation during 2008.

Licensed mass emissions are based on discharges at the ELV over a 24 hour, 366 day operational period.

The combined actual annual mass emission of particulates from the licensed emission points was 10,198 Kgs in 2008, which is significantly lower than the permitted annual mass emission for the combined sources of 175,045 Kgs.

In addition each individual sample collected during the quarterly monitoring events was significantly below the relevant emission limit value for that source.

Table 5 Summary of particulate emissions from dust collection units

Emission Point Ref./Description		Mass Emission (Kg) 2007	Mass Emission (Kg) 2008	Licensed Emission (Kg)
5	Transfer Tower 4 & 5 exhaust fan	259	1,005	51,899
6	Bauxite crusher Scrubber Exhaust	460	1,111	49,168
8	Transfer Tower 3 Scrubber Exhaust	143	260	21,594
11	Alumina loader fan FA49AL03	1053	212	20,716
12	Alumina Loader dust Fan FA49A	892	2,597	9,708
16	Alumina Silo Dust Collector FA12A017	1905	1,553	6,588
17	Alumina Silo Dust Collector FA12A018	2135	2,194	6,588
18	Alumina Silo Dust Collector FA12A019	701	715	4,392
19	Alumina Silo Dust Collector FA12A020	1243	552	4,392
Total		**8,791**	**10,198**	**175,045**

2.1.5 Compliance Summary

Compliance with the relevant emission limit values (ELV's) for emissions to atmosphere is evaluated in the following sections.

Boiler Emissions

The overall annual level of compliance with emission limit values for continuous monitoring of boiler emissions to atmosphere is tabulated below for the 48-hour and the monthly average compliance requirements of the IPPC Licence. These compliance interpretation requirements are specified in Condition 4 of the IPPC Licence.

The requirements for compliance with both 48-hour and monthly monitoring results are specified in Condition 4.1.4 of the IPPC Licence. The parameters evaluated are sulphur dioxide, nitrogen dioxide and opacity.

The evaluation indicates that boiler emissions were fully compliant with both the 48-hour (Table 6) and monthly average (Table 7) compliance interpretation as specified in condition 4.1.4 of the IPPC Licence.

Table 6 Evaluation of compliance with 48-hour average emissions limits

Parameter	Oxides of Sulphur (as SO2)			Nitrogen Oxides (as NO2)			Opacity		
No. Measurement Intervals	183			183			183		
Boiler Ref.	A	B	C	A	B	C	A	B	C
No. of Periods above ELV	0	0	0	0	0	0	0	0	0
% of 48-hour periods below ELV	100%	100%	100%	100%	100%	100%	100%	100%	100%
Target % below ELV for compliance	97%	97%	97%	95%	95%	95%	97%	97%	97%
Compliant	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**

Table 7 Evaluation of compliance with monthly average emission limits

Parameter	Oxides of Sulphur (as SO2)			Nitrogen Oxides (as NO2)			Opacity		
# Measurement Intervals	12			12			12		
Boiler Ref.	A	B	C	A	B	C	A	B	C
No. of Periods above ELV	0	0	0	0	0	0	0	0	0
% of monthly periods below ELV	100%	100%	100%	100%	100%	100%	100%	100%	100%
Target % monthly periods below ELV for compliance	100%	100%	100%	100%	100%	100%	100%	100%	100%
Compliant	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**

Calciner Emissions

The licence requirements for Calciner particulate emissions as outlined in the revised IPPC licence are as follows:

- No daily average value shall exceed the ELV (50mg/m^3)
- No hourly average shall exceed twice the ELV

A summary of on-line data for 2008 is included in Table 8.

Table 8 Evaluation of Compliance 2008 – Calciners

Parameter	IPPC ELV (mg/m3)	Actual 2008 (mg/m3)	Comment
Average Particulates per Day	50	100%<50 (Average = 12)	Compliant
Average Particulates per Hour	100	100% <100 (Average = 13)	Compliant

In addition, all iso-kinetic stack gas monitoring results from quarterly sampling was fully compliant with the relevant ELV's for calciner emissions.

CHP Emissions

A summary of all data for CHP emissions is included in Table 9. In all cases the emissions were compliant with the relevant ELVs.

Table 9 Evaluation of Compliance - CHP 2008

Parameter	IPPC ELV (mg/m3)	Actual 2008 (mg/m3)	Comment
A3-A (GT1) Average NO_X per Day	100%< 75	100% <75 (Average = 27)	Compliant
A3-A (GT1) Average NO_X per hour	100%< 150	100% <150 (Average = 40)	Compliant
A3-B (GT2) Average NO_X per Day	100%< 75	100% <75 (Average = 30)	Compliant
A3-B (GT2) Average NO_X per hour	100%< 150	100% <150 (Average = 45)	Compliant

Dust Collection Units

Other particulate emissions are required to be sampled on a quarterly basis.

All quarterly monitoring results for each of the emission points were fully compliant with the specified emission limit values set out in the IPPC licence.

2.2 Emissions to Water

Aughinish Alumina Ltd. (AAL) has two licensed discharges of treated effluent to the Shannon Estuary as follows:

Table 10 Licensed Discharges to Water

Licence Reference	Receiving Water	Characteristics
W1-1	Shannon Estuary	Treated Industrial Wastewater
Sanitary Effluent	Shannon Estuary	Treated Sanitary Wastewater

Discharges of treated industrial and sanitary wastewaters to the Shannon Estuary are made at an outfall point close to the AAL Marine Terminal. Both discharges are sampled continuously for both flow and pH, and for other parameters at weekly, monthly, quarterly and six monthly frequencies, as specified in Schedules C.2.1 (Control of Emissions to Water) and C.2.2 (Monitoring of Emissions to Water) of the IPPC Licence.

2.2.1 Process Wastewater (W1-1)

Treated process wastewater is discharged to the Shannon Estuary at emission point W1-1. Summary monitoring results for 2008 are tabulated below in Table 11. Toxicity testing, VOC and heavy metal screening for process wastewater are detailed in Sections 2.2.2, 2.2.3 and 2.2.4 respectively.

The data reported on Table 11 below is for the 12 months of 2008. Figures for 2007 are included by way of comparison. It is noted that annual mass emissions during the reporting period were within licensed mass limit values in all cases.

Table 11 Process Wastewater Mass Emissions (W1-1)

Parameters	Mass Emissions (kg) 2007	Mass Emissions (kg) 2008	Licensed Emissions (kg)
Volume (m^3)	3,735,977	4,381,238	7,905,600
BOD	407,921	316,307	863,760
Suspended Solids	49,142	53,062	395,280
OFG	4,023	15,334	118,584

While hourly and daily flow values occasionally approach up to the relevant limit, annual volumetric emissions from W1-1 are significantly below the permitted ELV. While it is noted that there was an increase in the reported levels of Oils, Fats and Greases (OFG) in 2008 versus the 2007 data, this increased figure was still less than 13% of the permissible licensed mass emissions. AAL will continue to monitor the OFG levels in wastewater emissions to ensure continued compliance with the relevant ELVs.

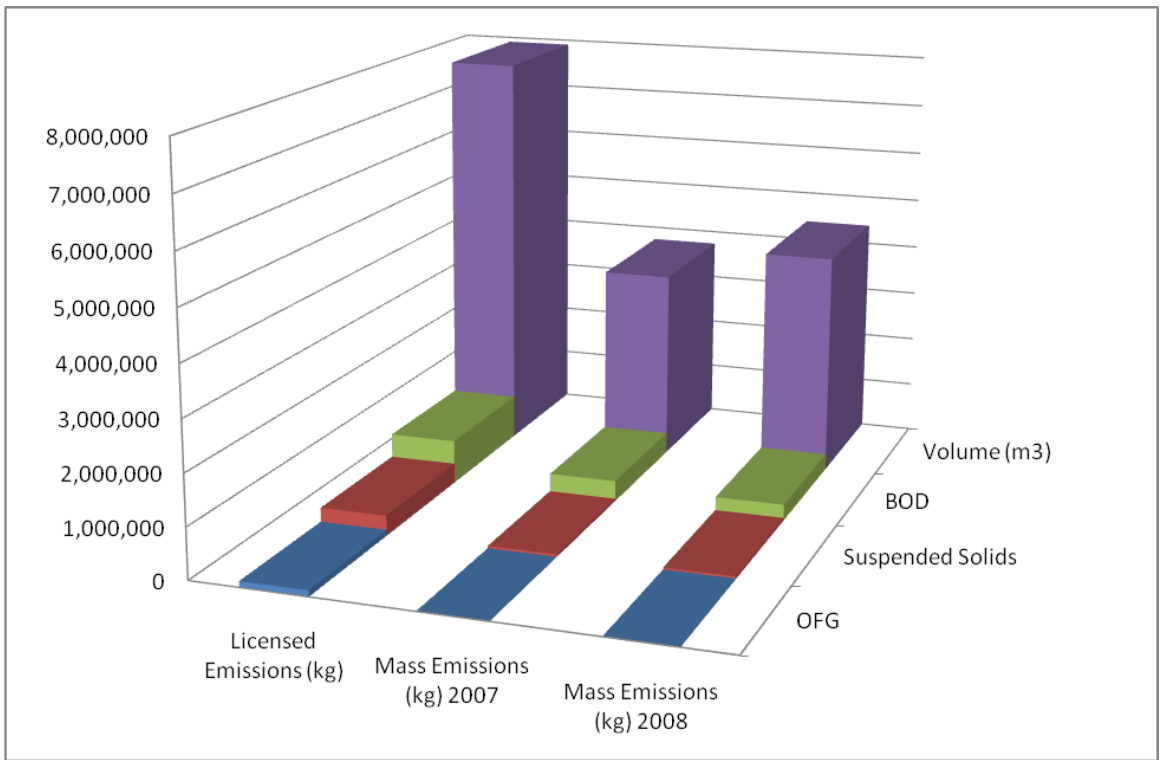


Figure 4 Treated wastewater mass emissions (2007 & 2008)

2.2.2 Toxicity Testing

Schedules B.2 (Emissions to Water) and C.2.2 (Monitoring of Emissions to Water) of the IPPC Licence require toxicity testing of the treated wastewater via Bi-Annual monitoring. The ELV for toxicity is 5 Toxic Units (TU).

2 samples of treated effluent (each consisting of 24 hour flow proportional composite samples) were collected and dispatched to the Shannon Aquatic Toxicity Laboratory (SATL) of Enterprise Ireland. These samples were collected in March and November of 2008. The November analysis was contracted to Euro Environmental Ltd who sub-contracted SATL to carry out the testing.

The acute toxicity of treated industrial wastewater was analysed on suitable sensitive aquatic indicator species i.e. *Tisbe battagliai, Crustacae Copepoda* and *Vibrio fischereri*.

The results of toxicity testing (Table 12) show that the effluent was compliant against the ELV for toxicity. The toxicity testing reports are appended as Attachment 1 of this report.

Table 12 Results of toxicity testing (2008)

Test Parameter	March 2008 Results (TU)	November 2008 Results (TU)	ELV (TU)
48h LC_{50} to *Tisbe battagliai*	3.2	-	5
48h LC_{50} to *Copepoda, Crustacae*	-	< 3.1	5
5 min EC_{50} to *Vibrio fischereri*	< 2.2	< 2.2	5
*1*5 min EC_{50} to *Vibrio fischereri*	< 2.2	2.3	5

Note: values denoted less than (<) are below the relevant threshold or limit of detection for that test.

2.2.3 Heavy Metal, Aluminium and Soda Analysis

AAL is required to analyse the treated wastewater for heavy metals, aluminium and soda under IPPC Licence Schedule C.2.2 Monitoring of Emissions to Water

Heavy metals

Euro Environmental Ltd were contracted to undertake heavy metal analysis on the effluent discharged from emission point W1-1 on a quarterly basis. Results of analysis for 2008 are shown in Table 13.

Table 13 Results of heavy metal analysis 2008 (W1-1)

Parameter	Conc. (mg/l) Q1	Conc. (mg/l) Q2	Conc. (mg/l) Q3	Conc. (mg/l) Q4	Limit of Detection (mg/l)
As	0.034	0.026	0.032	0.027	**0.005**
Cd	0.000	0.001	0.001	0.0003	**0.0006**
Cr	0.014	0.004	0.001	0.008	**0.014**
Cu	0.017	0.008	0.003	0.011	**0.003**
Hg	0.005	0.005	0.007	0.006	**0.0001**
Ni	0.016	0.008	0.007	0.008	**0.025**
Pb	0.001	0.002	< 0.0004	0.0004	**0.01**
Zn	0.012	0.006	0.005	0.006	**0.003**

The results of the analyses for Aluminium and Soda determination are detailed in Table 14. The figure provided for each parameter is the average result for the 2007 and 2008 monitoring intervals.

Table 14 Results of soda and aluminium analysis (W1-1)

Parameter	Annual Mean 2007	Annual Mean 2008	ELV
Aluminium (as mg/l Al)	1.48	1.99	Not specified
Soda (as g/l Na_2O)	3.18	2.61	Not specified

2.2.4 Wastewater Screen (VOC)

VOC screening of industrial wastewater (W1-1) is carried out on a biannual basis. Analysis was undertaken by Euro Environmental Laboratories Ltd using a modified version of the US EPA Method 524.2, as approved by the Agency (Ref. M35/AP/12).

In all cases, target analytes were below the limits of detection for the parameters tested. Results are shown in Table 15. The VOC Screening Report is appended to this document in Attachment 2.

Table 15 Results of VOC Screen 2008 (W1-1)

Date	Test	Method	Result
10/04/08	VOC	USEPA 542.2	< 1 .0µg/l
10/09/08	VOC	USEPA 542.2	< 1 .0µg/l

Note: values denoted less than (<) are below the relevant threshold or limit of detection for that test. LOD for all VOC parameters <1.0 µg/l.

2.2.5 Sanitary Effluent

Treatment of sanitary effluent is provided for by a proprietary biological effluent treatment plant, which comprises an activated sludge stage and a settlement/clarification stage, prior to discharge. The system discharges to the industrial wastewater emission line at a point upstream of the final discharge at W1-1.

An acid dosing system is in place at the sanitary effluent treatment plant to control the aeration basin pH at between 7.0 and 7.5. In the event that ingress of high pH effluent results in pH, BOD or suspended solids levels after treatment, which are higher than the IPPC ELV's, the treated effluent is re-circulated within the system and not discharged i.e. potentially non-compliant effluent is returned for re-treatment to ensure compliance. Annual mass emissions for treated sanitary wastewater discharges are tabulated on Table 16 below.

Table 16 Sanitary effluent mass emissions 2008

Parameters	Mass Emissions (kg) 2007	Mass Emissions (kg) 2008	Licenced Emissions (kg)
Volume (m^3)	29,810	23,235	87,840
BOD	194	127	2,196
Suspended Solids	133	236	3,074

The annual volumetric discharge mass emissions for all parameters was significantly below permitted levels for those discharges.

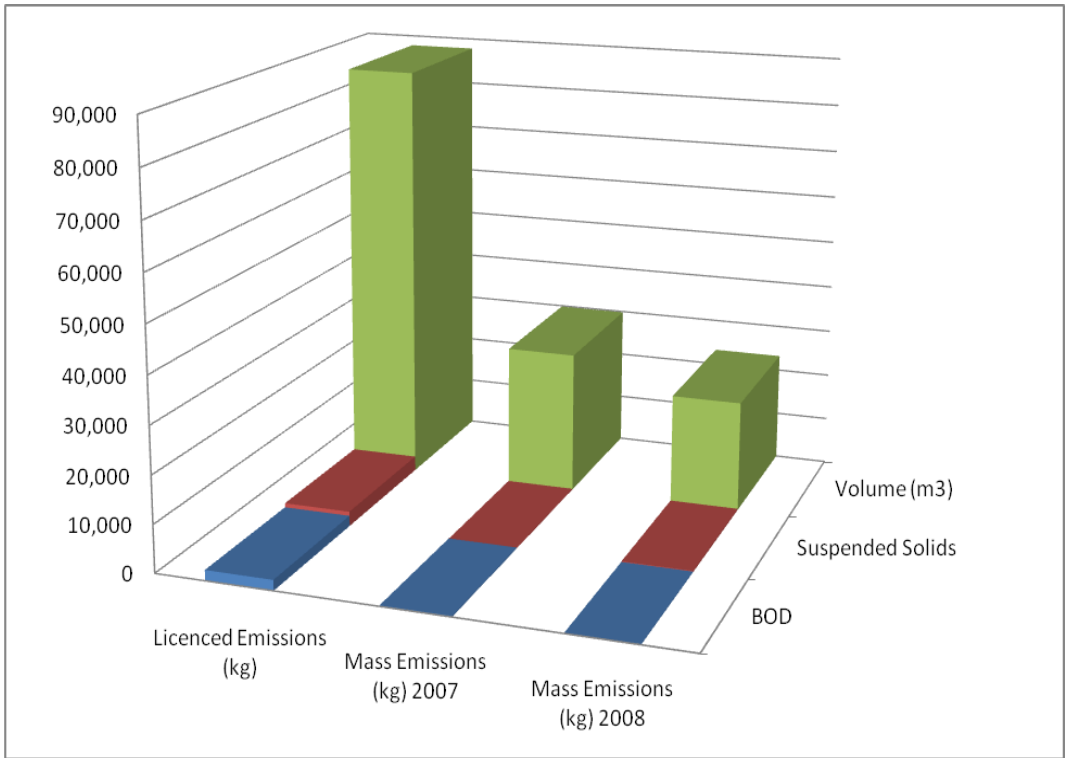


Figure 5 Sanitary effluent mass emissions (2007 & 2008)

2.2.6 Surface Water Monitoring

Monitoring of surface water run-off from the site is undertaken at five discharge locations referred to as Surface Streams (SS).

Monitoring results for each emission point are summarised in Table 17 as the average value for the monitoring period.

Table 17 Results of surface water discharge monitoring 2008

Emission Point Reference	pH	Conductivity (µS/cm)	Na_2O (g/l)
Frequency	**Weekly**	**Weekly**	**Monthly**
SS 1	8.3	129	0.010
SS 2	8.3	177	0.009
SS 3	8.3	275	0.028
SS 4	8.5	154	0.015
SS 5	8.3	361	0.037

(Note: Results are numerical average of 2008 data)

2.2.7 Surface Water Monitoring at the BRDA

Monitoring of surface water runoff in the area of the BRDA is undertaken at three locations. Results for each emission point are detailed in Table 18 and show the average value over the monitoring period. As the surface water in the area is subject to saline intrusion, the soda values are subject to sodium interference owing to the presence of sodium salts in the brackish water.

Table 18 Surface water monitoring results in the BRDA 2008

Description	pH	Conductivity µS/cm	Soda (Na_2O) g/l
Mangan's Lough	7.05	985	0.20
OPW Channel	7.90	2774	0.57
South Mud Stack Drain	7.27	869	0.06

(Note: Results are numerical average of 2008 data)

2.2.8 Discharges to Water Compliance Summary

All discharges of treated process wastewater and sanitary effluent complied fully with the relevant emission limit values set out in the IPPC licence.

3 Waste Management Record

The national waste database table, providing a summary of waste arising at the AAL facility has been compiled for the calendar year 2008. This information is tabulated on Tables 19 and 20.

3.1 National Waste Database (2008)

Table 19 Summary Information on Waste Arising

Waste	**2005**	**2006**	**2007**	**2008**
Total quantity of waste produced in calendar year(Tonnes)	1,225,864	1,219,119	1,224,504	1,242,451
total quantity of waste disposed of on-site	1,224,053	1,217,252	1,221,929	1,240,695
total quantity of waste disposed of off-site	424	296	274	273.9
total quantity of waste recovered on-site	14	13	0	0
total quantity of waste recovered off-site	1,373	1,558	2301.5	1482
	2005	**2006**	**2007**	**2008**
Quantity of non-hazardous waste produced in calendar year (Tonnes)	1,216,538	1,205,104	1,209,594	1,265,311
quantity of non-hazardous waste disposed of on-site	1,207,766	1,203,504	1,207,980	1,263,666
quantity of non-hazardous waste disposed of off-site	412	280	265	256
quantity of non-hazardous waste recovered on-site	0	0	0	0
quantity of non-hazardous waste recovered off-site	1,360	1,367	1,348	1389
	2005	**2006**	**2007**	**2008**
Quantity of hazardous waste produced in calendar year (Tonnes)	16,326	13,958	14,910	12,669
quantity of hazardous waste disposed of on-site	16,287	13,748	13,949	12,558
quantity of hazardous waste disposed of off-site	12	16	8	18
quantity of hazardous waste recovered on-site	14	13	0	0
quantity of hazardous waste recovered off-site	13	190	953	93

The quantities of waste disposed of at the plant Bauxite Residue Disposal Area (BRDA) are largely estimated based on the number of containers multiplied by typical container net weight. As such, the degree of accuracy is of the order of ± 10% on these figures. The volume of red mud residue is recorded. There were no rejected waste consignments during the 2008 reporting period. Results of waste analysis carried out by AAL during 2008 are appended as Attachment 3.

There was an overall 18,332 tonnes increase in the quantity of waste generated on site when compared to figures for 2007 and this was associated with the increase in production from 1.8 million tonnes of alumina hydrate in 2007 to 1.89 million tonnes of alumina hydrate in 2008.

Table 20 Information on Individual Waste Streams

European Waste Catalogue Code	Hazardous (Yes/No)	Description of Waste	Hazardous Waste Tag	Quantity (t/year)	Disposal/ Recovery Code	Location of Disposal/ Recovery	Name of Waste Disposal Recovery Contractor	Licence / Permit Reference for Treatment Facility
17 06 01	Yes	Asbestos	23 Asbestos	9	D1 Deposit on, in or under land.	(c) Off-site Abroad	Sita Environmental Ltd Greenogue Industrial Rathcoole Co. Dublin	W0035-01
16 06 01	Yes	Lead Acid batteries	27 Lead Acid Batteries	0.01	R4 Recycling/reclamation of metals and metal compounds	(b) Off-site Ireland	Returnbatt Ltd., Unit A Old Mill Ind Estate, Old Milltown, Kill Co Kildare.	EPA Waste Licence Reg No 105-1
20 01 21	Yes	Fluorescent and discharge tubes	26 Fluorescent Tubes	0.162	R4 Recycling/reclamation of metals and metal compounds	(c) Off-site Abroad	Irish Lamp Recycling Ltd., Kilkenny Road, Athy, Co Kildare.	Kildare County Council 02/2000A
15 02 02	Yes	Oil rags/Oil dry	18 Waste Oils	9.4	D1 Deposit on, in or under land.	Off-site Ireland	Sita Environmental Ltd Greenogue Industrial Rathcoole Co. Dublin	W0035-01
13 02 06	Yes	Oil (heavy gear)	18 waste oils	93.06	R9 Used oil re-refining or other reuses of previously used oils	Off-site Ireland	Atlas Environmental Ireland Ltd., Clonminam Ind Estate, Portlaoise, Co Laois.	EPA Waste Licence Reg No 184-1
16 07 08	Yes	Empty oil drums	18 Waste Oils	3.396	R4 Recycling/reclamation of metals and metal compounds	Off-site Ireland	Atlas Environmental Ireland Ltd, Clonminam Ind Estate, Portlaoise Co Laois	EPA Waste Licence Reg No 184 -1
01 03 07	Yes	Salt cake (process residue)	28 Saltcake/Salts	12,558	D1 Deposit on, in or under land.	(a) On-site	Aughinish Alumina Ltd.	IPPC Licence Reg No P0035-4

European Waste Catalogue Code	Hazardous (Yes/No)	Description of Waste	Hazardous Waste Tag	Quantity (t/year)	Disposal/ Recovery Code	Location of Disposal/ Recovery	Name of Waste Disposal Recovery Contractor	Licence / Permit Reference for Treatment Facility
16 01 99	No	Conveyor Belting	-	39.5	R11 Uses of residual materials obtained from any of the operations numbered R1-R10	(b) Off-site Ireland	M Walshe, Cray St, Glin, Co Limerick	WCP/LK/083/02b
20 03 99	No	General Refuse	-	207.4	D1 Deposit on, in or under land.	(b) Off-site Ireland	Veolia, Dock Road, Limerick.	EPA Waste Licence Reg No 82-2
01 03 99	No	Lime grits	-	7509	D1 Deposit on, in or under land.	(a) On-site	Aughinish Alumina Ltd.	IPPC Licence Reg No P0035-4
20 01 39	No	Plastic containers (empty)	-	50.65	R11 Uses of residual materials obtained from any of the operations numbered R1-R10	(b) Off-site Ireland	Rilta Environmental Ltd. Greenogue Business Park, Rathcoole, Co. Dublin	WO192-03
01 03 99	No	Process waste (scales, sand etc)	-	71,750	D1 Deposit on, in or under land.	(a) On-site	Aughinish Alumina Ltd.	IPPC Licence Reg No P0035-4
01 03 09	No	Red mud	-	1,148,738	D1 Deposit on, in or under land.	(a) On-site	Aughinish Alumina Ltd.	IPPC Licence Reg No P0035-4
10 01 99	No	Refractory	-	110	D1 Deposit on, in or under land.	(a) On-site	Aughinish Alumina Ltd.	IPPC Licence Reg No P0035-4
19 08 05	No	Sanitary effluent sludge	-	580	D1 Deposit on, in or under land.	(a) On-site	Aughinish Alumina Ltd.	IPPC Licence Reg No P0035-4
17 04 07	No	Scrap metal	-	1176	R4 Recycling/reclamation of metals and metal compounds	(c) Off-site Abroad	Hegarty metals Recycling, Ballysimon Road, Limerick	Limerick County Council WP05-04
16 01 03	No	Tyres (used)	-	1.38	R11 Uses of residual materials obtained from any of the operations numbered R1-R10	(b) Off-site Ireland	R Quinn Clarina Co Limerick	WCP/LK/255/05b

European Waste Catalogue Code	Hazardous (Yes/No)	Description of Waste	Hazardous Waste Tag	Quantity (t/year)	Disposal/ Recovery Code	Location of Disposal/ Recovery	Name of Waste Disposal Recovery Contractor	Licence / Permit Reference for Treatment Facility
20 01 38	No	Wood	-	64.7	R3 Recycling/reclamation of organic substances which are not used as solvents	(b) Off-site Ireland	Veolia, Dock Road, Limerick.	EPA Waste Licence Reg No 82-2
20 01 37	No	Wood	-	53.8	D1 Deposit on, in or under land.	(b) Off-site Ireland	Veolia, Dock Road, Limerick.	EPA Waste Licence Reg No 82-2
20 01 99	No	Used hosing	-	48.4	R11 Uses of residual materials obtained from any of the operations numbered R1-R10	(b) Off-site Ireland	Veolia, Dock Road, Limerick.	EPA Waste Licence Reg No 82-2
15 01 10	No	Used IBC	-	38.8	R11 Uses of residual materials obtained from any of the operations numbered R1-R10	(b) Off-site Ireland	Silver Lining, Unit 61 Cookstown Ind Estate Tallaght , Dublin 24	EPA Waste Licence Reg No W 0122-01
16 02 00	No	Electrical/ electronic waste	-	3.2	R4 Recycling/reclamation of metals & other metal compounds	(b) Off-site Ireland	Rilta Environmental Ltd. Greenogue Business Park, Rathcoole, Co. Dublin	WO192-03
20 01 01	No	Paper & documents (shredding)	-	12.56	R5 Recycling/reclamation of other inorganic materials	(b) Off-site Ireland	DGD Papers Ltd., Raheen Business Park, Limerick	WFP/LK/2008/09C
20 01 01	No	Cardboard	-	12.5	R5 Recycling/reclamation of other inorganic materials	b) Off-site Ireland	Veolia, Dock Road Limerick	EPA Waste Licence Reg No 82-2
20 01 23	Yes	Aerosols	-	1.07	R4 Recycling/reclamation of metals & other metal compounds	(c) Off-site Abroad	Rilta Environmental Ltd. Greenogue Business Park, Rathcoole, Co. Dublin	WO192-03

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4 Monitoring and Enforcement

4.1 Monitoring

The EPA made 4 separate monitoring visits during 2008. On 3 occasions, Agency personnel collected samples of treated process effluent and sanitary effluent. One monitoring visit was carried out by Alcontrol on behalf of the EPA during which emissions to air from the calciner stack (emission point A2) were monitored. Results for all samples collected by the Agency were compliant with the relevant schedules and conditions of the IPPC licence.

Summarised data on Agency site monitoring visits is tabulated in Table 21 and Agency monitoring results are summarised in Tables 22, 23 and 24

Table 21 Number of EPA site visits

No. of monitoring visits	4	No. Exceedences	Compliance Rate (%)
Total No. of Analyses	271	0	100%
Emissions to Water Analysis	270	0	100%
Emissions to Air	1	0	100%

Table 22 EPA Industrial Effluent results (Emission point W1-1)

Parameter	Max EPA Result	IPPCL ELV
pH	8.33	6 – 9
Solids(mg/l)	42	50
BOD (mg/l)	56	2360 (kg/day)

In all cases process effluent results were compliant with the emission limit values as stated in Schedule B.2 of the IPPC Licence.

Table 23 EPA Sanitary Effluent Results

Parameter	Max EPA Result	IPPCL ELV
pH	8.69	6 – 9
Solids(mg/l)	4.8	35
BOD (mg/l)	5.3	25

In all cases, sanitary effluent results were compliant with the relevant ELV's.

Table 24 EPA Emissions to air results

Parameter	Max EPA Result	IPPCL ELV
Particulates	19.6 mg/m3	50 mg/m3

4.2 Third Party Inspections

AAL obtained certification to the international environmental management system (EMS) standard, ISO14001, in 2000.

Det Norske Veritas Quality Assurance (DNV-QA) carried out a full re-certification audit in November 2008. No significant non-conformances were raised during this audit.

It is noted that AAL operates a rigorous internal audit schedule in order to ensure conformance with plant operating systems (production, quality, safety, environmental) and to facilitate the process of continual improvement in those systems.

5. Energy Consumption

Owing to the nature of the Bayer process used at AAL for alumina manufacturing and post extraction processing, energy represents the most economically significant impact to the process.

For this reason, Aughinish was designed with energy efficiency in mind. Heat recovery and power efficiency are two of the key process efficiency targets that receive close scrutiny. AAL is the first process plant certified to DS 2403 Management System Standard outside of Denmark and the only alumina refinery to receive independent 3rd party certification for energy management.

Data for 2008 shows a decrease in energy consumption over 2007. This decrease is due to improvements in process efficiencies implemented in 2008 in the digestion area of the plant.

Table 25 Summary energy data for 2005 to 2008

Source	2005 (MW)	2006 (MW)	2007 (MW)	2008 (MW)
Heavy Fuel Oil	454.6	320.8	291.9	258.8
Power (Electrical)	41	41.7	41.8	42.1
Diesel	1.8	5.3	1.9	2.8
Natural Gas	0.0001	294.1	392.7	392.7
Total	**497.4**	**661.9**	**728.3**	**696.4**

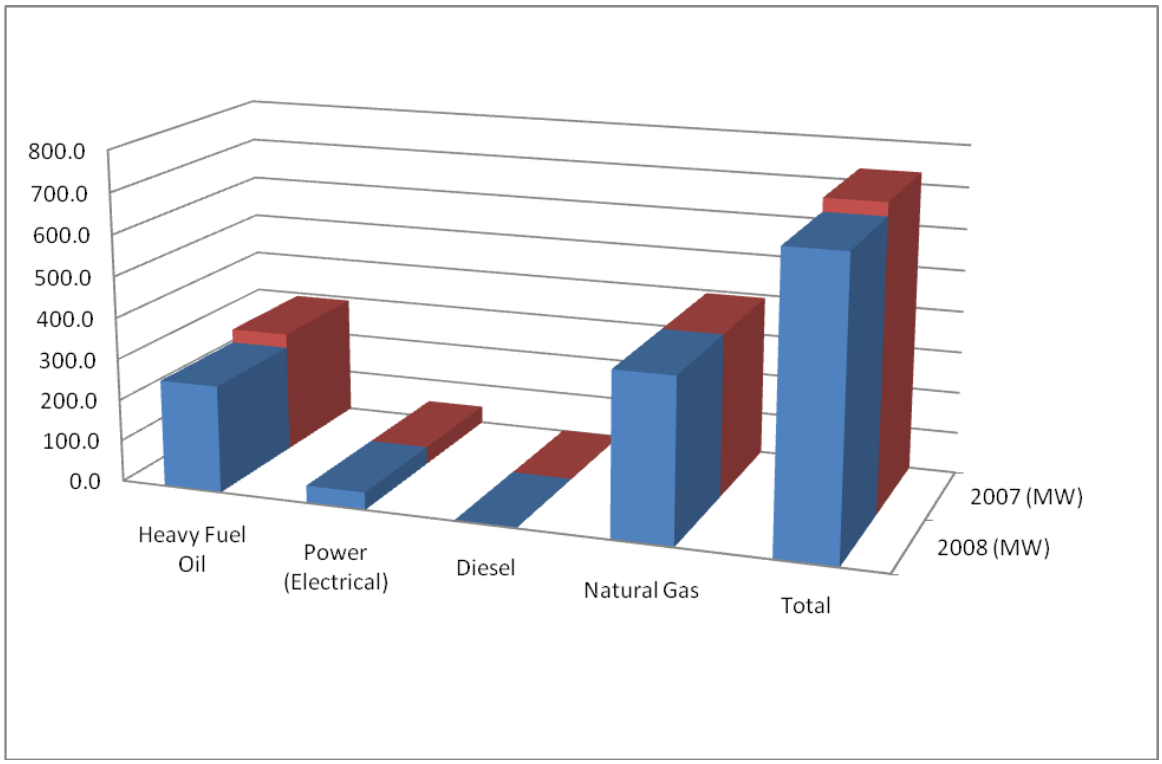

Figure 6 Energy Use 2007 & 2008

5.1 Water Consumption

AAL receives potable water from Limerick County Council for process and domestic uses.

The bulk of the potable water is demineralised in the AAL treatment plant for use in boiler steam generation. The balance of the potable water is used for process make-up, where process condensate (re-condensed water from the process) supply is not available, and also as domestic water. AAL strives each year to reduce its relative water consumption as measured as M^3 of water per tonne of product.

Aughinish does not abstract any groundwater for process or domestic purposes.

The overall volume of water used at the plant decreased by 4% between 2007 and 2008 (Table 26). This reduction in consumption resulted from reduced steam usage in the Digestion chain due to heat recovery and the use of condensate to replace potable water in some process applications.

Table 26 Summary water consumption data for 2005 to 2008

Year	Total (m^3)	Relative Consumption (m^3/tonne product)
2008	5,359,462	2.84
2007	5,584,421	3.09
2006	5,706,177	3.14
2005	5,630,941	3.30

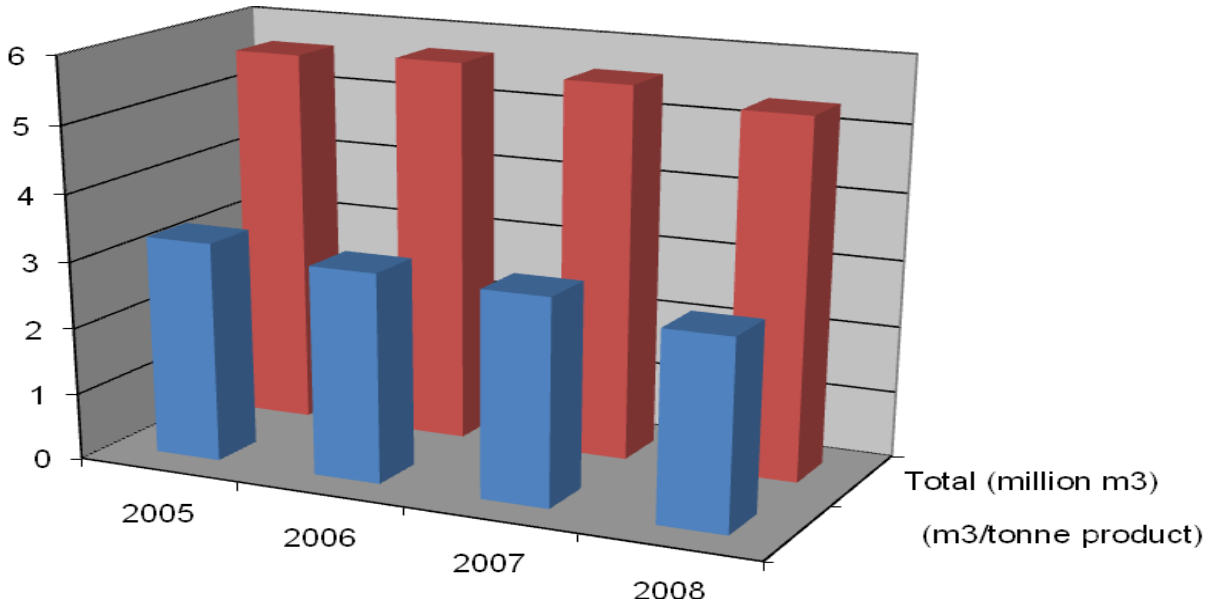

Figure 7 Plant Water Consumption

6. Environmental Incidents and Complaints

In the event of an environmental incident occurring, AAL informs the EPA and where appropriate, Limerick County Council and the Shannon Fisheries Board. Copies of all notification correspondence are forwarded to the installation auditors, DNV QA.

As part of the requirements of the IPPC licence, AAL operates, through the plant Environmental Management System, a procedure for logging and responding to complaints received from the Public.

There were 4 minor environmental incidents during 2008. 7 complaints were received over the year.

6.1 Significant Environmental Incidents

There were no significant environmental incidents during 2008.

6.2 Recordable Incidents

There were 3 minor recordable incidents during 2008. These incidents were reported to the Agency on a precautionary or informative basis as part of AAL's environmental reporting procedure. In addition, the EPA also requested that AAL carry out an incident investigate into atypical arsenic levels which had been periodically detected in a number of the groundwater observation wells surrounding the existing bauxite residue disposal area (BRDA). A summary of the incidents is shown in table 27.

Table 27: Internal Recordable Incident Summaries 2008

Date	Incident description	Actions taken	Authorities contacted
11/03/08	A leak on a fuel line for a mobile compressor being used to drive an air driven pump resulted in 25 litres of diesel being spilled to ground and an adjacent internal drain	EPA notified. Clean up of ground and adjacent drain carried out. All diesel was recovered. Mobile compressors and pumps are now required to have spill protection in place when located outside bunded areas	EPA
23/04/08	Approximately $5m^3$ of caustic liquor overflowed a drainage trench due to a restriction in the trench. This liquor pooled on an adjacent graded area.	EPA notified. The liquor which overflowed the trench was recovered using mobile pumps. The affected area was covered with alumina hydrate to soak up any liquor. This hydrate was disposed of to the BRDA and the area re-graded.	EPA
10/09/08	A restriction on feed chute for a bauxite grinding mill resulted in approximately $5m^3$ of caustic liquor being spilled to ground. The majority of this spill pooled on an adjacent roadway with a small amount flowing onto a grassed area.	EPA notified. The pooled liquor was recovered using mobile pumps. The surface of affected grass areas was removed and disposed of to the BRDA. All surfaces were washed with potable water and the washings recovered. Soil pH checks were carried out to confirm the success of the cleanup.	EPA
24/09/08	EPA requested that AAL investigate the atypical arsenic levels as seen periodically within the data as submitted as part of the phase 2 BRDA application process	The investigation of the arsenic levels by AAL identified that the atypical results were generated by an analytical error in the off-site laboratories contracted to carry out this work. Correspondence detailing the findings was sent to the EPA 24/02/09	EPA

6.3 Complaints

In 2008 there were 7 complaints received and these are summarised by category in Table 28. Table 29 details AAL's response to the individual complaints.

Table 28 Summary of Complaints by Category during 2008

Cat.	Air	Odour	Noise	Water	Procedural	Misc.	Total
Jan	3						**3**
Feb	3						**3**
Mar							
Apr							
May							
Jun							
Jul							
Aug	1						**1**
Sept							
Oct							
Nov							
Dec							
Total	**7**						**7**

A description of the complaints and investigations taken by AAL are listed below. It should be noted that a significant number (6 out of 7) of the complaints received related to alleged atmospheric emissions at a single receptor location.

Table 29: Complaints Summary

Date	Cat.	Complaint	Investigation Outcome	Follow up
11/01/08	Emissions to Air	Pollution from Aughinish.	Investigation undertaken by AAL. No unusual plant operating conditions which could give rise to complaint. All emissions to air were within IPPC licence ELVs.	Letter sent to EPA
16/01/08	Emissions to Air	Pollution from Aughinish. Burning to face and eyes	Investigation undertaken by AAL. No unusual plant operating conditions which could give rise to complaint. All emissions to air were within IPPC licence ELVs.	Letter sent to EPA
21/01/08	Emissions to Air	Pollution from Aughinish. Difficulty breathing.	Investigation undertaken by AAL. No unusual plant operating conditions which could give rise to complaint. All emissions to air were within IPPC licence ELVs.	Letter sent to EPA
04/02/08	Emissions to Air	Pollution from Aughinish.	Investigation undertaken by AAL. No unusual plant operating conditions which could give rise to complaint. All emissions to air were within IPPC licence ELVs.	Letter sent to EPA
08/02/08	Emissions to Air	Smell of chemicals & Pollution from Aughinish.	Investigation undertaken by AAL. No unusual plant operating conditions which could give rise to complaint. All emissions to air were within IPPC licence ELVs.	Letter sent to EPA
12/02/08	Emissions to Air	Pollution from Aughinish. Burning to face and eyes	Investigation undertaken by AAL. No unusual plant operating conditions which could give rise to complaint. All emissions to air were within IPPC licence ELVs.	Letter sent to EPA
01/01/08	Emissions to Air	'White Smoke' emitted from calciner stack reported to AAL by EPA.	Investigation of calciner operations for period of complaint indentified no unusual conditions or emissions from the calciner stack	Investigation by AAL

7. Environmental Management

Section 7 of this AER contains summary information on the AAL Environmental Management Programme (EMP).

A revised Schedule of Objectives and Targets for 2009 is presented in Section 7.2 for Agency approval.

Both the EMP and Schedule of Objectives and Targets fall under the site ISO 14001 Environmental Management System. Accordingly, they are included within a structured system of management review and periodic auditing by both internal auditors and independent 3rd party auditors (DNV-QA).

The Pollution Release and Transfer Register, which is a requirement of Condition 6.14 of the IPPCL, has been updated to reflect emissions during the 2008 monitoring period.

7.1 Environmental Management Programme Report for 2008

The AAL Environmental Management Programme (EMP) is a continuously updated plan showing the status of key programmes within the plant and is reviewed as part of the ISO14001 Environmental Management System (EMS).

Progress in achieving planned objectives and targets during 2008 is summarised in this section. This sets out the AAL environmental objective, associated targets and a comment on progress in meeting those targets.

During 2008, significant progress was achieved in a number of key areas related to reduced emissions to air, control of fugitive dust emissions at the BRDA, improvement in groundwater quality and monitoring of emissions to atmosphere.

In addition, it is noted that significant work is undertaken on an ongoing or recurring basis at the plant in order to continuously maintain and update AAL plant environmental performance.

A summary of the progress in meeting a number of the plant targets during 2008 is provided below.

A detailed breakdown of all plant environmental objectives and targets, together with the EMP for implementation and achievement of these targets is contained in the Environmental Management Programme (EMP), which is appended to this document as Attachment 4.

Table 30 EMP 2008 Report

No.	Objective	Target	Comment
1	Improve energy efficiency	Implement Max HT in digestion	Completed
2	Improve effluent quality	Implement BOD reduction solution & achieve better than 30% reduction currently being achieved	Ongoing
3	Groundwater Protection	Continue asset care programme at Interstage A , blow off and PRT area	Completed
		Assess integrity of certified bunding structures	Ongoing
		Develop proposal on petrol tank decommissioning	Ongoing
		Repair of sewer system	Completed
		Implement revised groundwater protection programme	Completed
4	Improve air quality	Implement boiler NOX reduction programme	Ongoing – C boiler upgrade completed
5	Improve Stack & Ambient Air Monitoring	Install sampling enclosure for Calciner 1 New AMS (NOx, SOx and Particulates) on boilers	Completed
6	Monitor noise emissions from AAL operations	Ensure that noise levels during Phase 2 BRDA construction are within IPPC licence limits Continue reporting survey via AER	Ongoing
7	Operate the landfill to best practice	All ongoing landfill operations to be to best practice standard	Ongoing
8	Improve visual appearance of AAL	Continue with 5 year landscaping plan	Ongoing
9	Emergency planning	Continue with revised emergency response plan.	Ongoing
10	Environmental Management System	Review calibration frequency of all ISO Environmental Instruments	Completed Completed
11	GHG Permit	Achieve compliance with Monitoring and Reporting guidelines at GHG Audit end of 2008	Compliance achieved in 2008
12	Implement NERP monitoring Plan	Achieve compliance with NERP targets for SOx, NOx and Particulates during 2008	Compliance achieved in 2008

7.2 Environmental Objectives and Targets for 2009

AAL reviews the plant Environmental Management System on an ongoing basis with the aim of updating and refining the Environmental Management Programme (EMP) to take account of progress in meeting objectives and targets.

In addition, new targets are added on the basis of achievement of existing targets and where issues have been identified as requiring a formal and structured EMP approach to drive their implementation.

New targets, which have been added for 2009 are summarised below in Table 31. This list highlights only those targets added to the EMP and excludes the significant work involved in ongoing programmes and projects to achieve existing targets, the detail of which is set out in the EMP for 2009.

Accordingly, the primary focus of the EMP in achieving significant environmental objectives during 2009 will be the continued improvement of air emission quality, together with the development of a suitable methodology for the neutralisation of bauxite residue.

Table 31 Objectives and Targets 2009

No.	Objective	Target
1	Improve air quality	Implement NO_X reduction programme
2	Operate the on-site landfill to best practice	All ongoing landfill operations to be to best practice standard
3	Improve visual appearance of AAL	Continue with 5 year landscaping plan
4	Elimination of sources of groundwater contamination	Integrity testing & repairs of bunds, tanks & other structures to be completed as scheduled in 3 year integrity testing plan
5	Caustic Mass Balance	Unaccounted for caustic balance to be reduced
6	Reduction in BOD	Continue to achieve BOD discharge of levels of not more than 1500kg/day
7	Reduction in CO_2 emissions from site	CO_2 emissions in 2009 to be reduced by decreased use of boilers
8	Neutralisation step for bauxite residue prior to deposition to BRDA	Neutralisation method to be agreed with Agency in 2009
9	Implementation of recommendations of Golders Associates report	Risk reduction assessment to be completed
10	Implementation of recommendations of closure plan as per Residues Solutions report	Closure revegetation trial cell grassing to be completed.
11	Review of sampling & analysis methods for compliance with EPA guidelines	Review of all relevant procedures during 2009
12	Fugitive emissions programme	Initiate Fugitive emissions monitoring programme

7.3 Pollutant Release and Transfer Register

7.3.1 Pollutant Release and Transfer Register 2008

The Pollutant Release and Transfer Register (PRTR) has been updated to provide further data for the calendar year 2008. Based upon the emissions arising from the boilers and calciners, and also emissions which currently appear on the European Pollutant Emission Register (EPER), the following substances are included in the PER for 2008;

- Sulphur dioxide (SO_2)
- Oxides of nitrogen (as NO_2)
- Particulate matter
- Carbon dioxide
- Arsenic
- Cadmium
- Chromium
- Copper
- Nickel
- Zinc
- Mercury
- Lead
- Caustic (Sodium Hydroxide)

Sulphur dioxide mass emissions are based on measured mass concentrations and calculated volumetric flow rates.

Nitrogen dioxide and particulate mass emissions have been calculated based on results of direct measurement.

Carbon Dioxide and Heavy metal emissions have been calculated based on fuel consumption multiplied by appropriate emission factor.

Emission factors used for calculations Hg, Cr and Cu are based on Ireland specific emission factors for oil fired power plant. All other emission calculations are based on UK NAEI dataset for fuel oil fire power stations

Table 32 PRTR for 2008

Emissions to Air (tonnes)					
Source / **Pollutant Name**	**CHP**	**Calciner**	**Boiler**	**Total (Tonnes)**	**Method of Measurement***
Oxides of Sulphur (as SO_2)	10	1,047	1,456	**2,514**	E & M
Nitrogen oxides(as NO_2)	359	632	522	**1,512**	E & M
Particulates	N/A	88	32	**120**	E & M
Carbon Dioxide**	750,706	448,214	259,079	**1,457,999**	M
Arsenic	N/A	0.017	0.010	**0.026**	C
Cadmium	N/A	0.018	0.010	**0.028**	C
Chromium	N/A	0.022	0.013	**0.035**	C
Copper	N/A	0.022	0.013	**0.035**	C
Mercury	N/A	0.003	0.002	**0.004**	C
Nickel	N/A	0.789	0.455	**1.245**	C
Lead	N/A	0.044	0.026	**0.070**	C
Zinc	N/A	0.064	0.037	**0.101**	C

*Method of Measurement (*Direct Measurement - M; Engineering Estimates – E; Calculations - C)*
*** Includes emissions from propane (canteen and laboratories) & diesel (space heating & CHP)*

7.3.2 Caustic Mass Balance

AAL have continued to undertake a detailed evaluation of caustic flows within the process during 2008. This work has continued on previous mass balance exercises undertaken at the plant over the past few years in order to further close out the quantity of caustic which are unaccounted for.

The mass balance undertaken during 2008, and tabulated below, has closed off the input-output cycle and resolved caustic consumption at the plant to approximately 1.19kg caustic (Sodium Hydroxide) per tonne of Hydrate produced. This is likely to be due to margins of error in sampling and measurement of caustic concentrations of minor streams which are based on periodic grab samples.

A detailed methodology for preparation of Caustic Mass Balance is appended in Attachment 5.

Table 33 Results of Caustic Mass Balance

Element	Units (kg/tH)
Input	
Total Caustic Consumption	62.27
Outputs	
Caustic in Mud	49.59
Caustic in Alumina	4.13
Caustic in Alumina Hydrate Ships	0.12
Caustic in Sand to BRDA	0.91
Caustic in Saltcake to BRDA	2.30
Caustic in process scale from Tank Turnarounds shipped to BRDA	0.56
Caustic in West pond disposal to the BRDA (Storm Water Pond)	1.53
Caustic in treated (neutralized & clarified) industrial effluents to the river	3.29
Caustic recovery to process from the BRDA	-1.35
Total Output	**61.08**
Unaccounted	1.19

7.3.3 Proposed PRTR for 2009

Based upon emissions arising from the boilers and calciners, and also the emissions which appear on the European Pollutant Emission Register (EPER), AAL proposes that the following substances are included in the PRTR for 2009;

- Sulphur dioxide (SO_2)
- Oxides of nitrogen (as NO_2)
- Particulate matter
- Carbon dioxide
- Arsenic
- Cadmium
- Chromium
- Copper
- Nickel
- Zinc
- Mercury
- Lead
- Caustic (Sodium Hydroxide)

8. Other Reports

This section contains details of other once off projects and reports required under the various conditions of the IPPCL.

Monitoring data from annual surveys (noise) together with results from ambient air quality, dust deposition and groundwater monitoring are summarised.

The financial provisions of the plant decommissioning and closure programme along with environmental insurance requirements are updated to reflect recent changes at the plant.

The landfill status report is a recurring requirement of the IPPCL and has been updated to reflect quantities of waste deposited and development works undertaken during the 2008 calendar year.

Generally, where documentation has already been submitted to the Agency, summarised information is provided. Otherwise, full text reports are included as attachments where relevant.

8.1 Noise Monitoring Programme

Aughinish Alumina Limited is required to carry out an annual noise survey (IPPC Licence Condition 6.13). The relevant noise limits at off-site noise sensitive locations (NSL) are:

- Day: 55 dB (A) L_{eq}
- Night: 45 dB (A) L_{eq}

A survey of noise levels at a series of perimeter and off site noise sensitive locations was undertaken by AWN consulting between 16/06/08 and 17/06/08.

At each monitoring point, day and night-time measurements were made for the following measurement parameters: LA_{eq}, $LA_{max,}$ $LA_{min,}$ LA_{90} and LA_{10}.

The results of monitoring are summarised on Table 34 and 35.

Table 34 Noise Survey Results – Noise Sensitive Locations dB(A)

Location	Day time			Night-Time		
	LA_{eq}	LA_{90}	LA_{10}	LA_{eq}	LA_{90}	LA_{10}
NSL 1	50	48	51	43	39	49
NSL 2	48	41	48	39	31	41
NSL 3	46	42	48	45	39	48
NSL 4	41	34	44	39	33	41
NSL 5	59	37	53	52	34	43

Noise levels measured at sensitive receptor locations during day-time periods ranged from L_{Aeq} 41 dB (A) to 59 dB (A) with corresponding LA_{90} values ranging from 34dB(A) to 48 db(A).

The night-time LA_{eq} values recorded ranged from 39dB (A) to 52dB (A) with corresponding LA_{90} values ranging from 31dB (A) to 39dB (A).

The measured day and night-time levels at NSL 5 of 59 and 52dB L_{Aeq} respectively exceed the criteria. These L_{Aeq} levels were dominated by vehicle movements along the site access road. This is evidenced by the LA_{10} values of 53dB and 43 dB during day and night respectively. Noise from AAL was inaudible at this location.

During both survey periods the noise climate at all off-site noise sensitive receptors was dominated by road traffic on the N69 and wind generated noise. The AAL facility was inaudible.

Noise results for the seven perimeter locations are tabulated on Table 35.

Table 35 Noise Survey Results – Perimeter Locations dB (A)

Location	Day time			Night-Time		
	LA_{eq}	LA_{90}	LA_{10}	LA_{eq}	LA_{90}	LA_{10}
B1	61	54	61	57	54	58
B2	61	58	62	61	59	62
B3	56	41	45	48	24	36
B4	57	44	54	55	35	27
B5	43	40	46	40	33	41
B6	51	48	52	50	48	52
B7	46	36	47	35	29	34

Note: Results are presented as a range where more than one data set of measurement results was obtained.

The noise survey concluded that noise emissions from the AAL facility are generally continuous in nature and without clearly audible toned or impulsive characteristics at the noise sensitive locations. The report notes that noise levels at all noise sensitive noise receptor locations fall below LA_{eq} 55 dB (A) during day time periods and 45db(A) for night-time periods for NSL1, NSL2, NSL3 and NSL4. There was a measured noise level exceeded at position NSL5. The exceedence was due to heavy goods vehicles and other vehicular traffic movement along the road to and from the Rusal Aughinish plant and within the vicinity of the measurement position. The AAL facility was not audible at this location during the measurement period.

The full text of the noise survey report is appended in Attachment 6.

8.2 Groundwater Monitoring

The groundwater-monitoring regime at AAL comprise of three elements as follows:
(i) Foreshore springs, referred to as estuarine streams (ES), on the foreshore of the AAL site
(ii) plant observation wells (POW), and;
(iii) Observation wells around the BRDA (OW).

Monitoring of groundwater quality receives extensive attention at AAL. Overall, some 76 groundwater monitoring points have been established and are routinely monitored.

8.2.1 Foreshore Springs

Foreshore springs are locations where the water table level intersects ground level to allow groundwater to directly discharge to the surface. These are referred to as estuarine streams (ES) in the IPPC Licence. Table 36 contains a summary of analyses undertaken on those streams for the 2008 reporting period. Reporting is as per Schedule C.7 of the IPPC Licence.
It should be noted that there is no direct discharge to the estuary from ES 1, ES 7/12 and ES16 as these streams are intercepted and pumped to the effluent plant for treatment.
Appended to this report as Attachment 9 are graphs trending pH and Soda for the Estuarine Streams

Table 36 Summary of foreshore spring monitoring data 2008

Emission Point Reference	pH**	Conductivity (µS/cm)	Soda (g/l)
ES 1*	11.6	3,850	1.1
ES 2	7.9	22,476	6.3
ES 3	8.0	9,966	2.4
ES 5	8.3	534	0.1
ES 6	No flow	No flow	No flow
ES 8	9.6	5,343	1.4
ES 9	8.2	10,755	2.6
ES 10	7.7	1,213	0.2
ES 11	7.8	1,501	0.3
ES 7/12*	12.1	6,266	1.5
ES 13	9.3	512	0.1
ES 14	8.9	926	0.2
ES 15	8.3	569	0.1
ES 16*	9.3	1,098	0.3

* *No direct discharge to estuary*
** *pH refers to the numerical average of the data for the period*

8.2.2 Plant observation wells (POW)

Table 37 contains a summary of analyses undertaken on all groundwater-monitoring locations within the AAL facility. The table also includes data on those wells located around the north pond (NPW) and the south pond (SPW). Information on the status of these wells is provided on a quarterly basis. The values reported are the average of analytical results returned during the 2008 monitoring period.

Table 37 Summary of POW monitoring results 2008

Reference	pH	Conductivity µS/cm	Total Alkalinity mg/l CaCO3	Chloride mg/l	Fluoride mg/l	Soda g/l
POW 1	13.0	36168	11651	177.5	12.4	7.9
POW 2	11.9	3634	668	121.0	0.8	0.9
POW 3	10.5	3151	290	148.2	0.7	0.9
POW 5	10.9	4156	1705	48.1	2.5	1.3
POW 6	9.5	224	55	14.6	0.5	0.0
POW 7	9.3	346	105	22.1	0.5	0.1
POW 8	9.0	703	256	32.6	0.7	0.2
POW 9	8.4	561	232	24.1	0.7	0.1
POW 10	10.1	2785	1018	21.0	1.2	0.6
POW 11	12.2	5631	2201	32.6	2.2	1.4
POW 12	11.2	3516	1446	29.8	1.3	0.9
POW 13	9.0	1220	580	32.2	0.7	0.3
POW 14	7.8	1157	543	50.6	0.5	0.3
POW 15	8.9	1516	764	50.1	0.7	0.5
POW 16	11.1	14253	5969	52.4	9.1	3.8
POW 17	12.6	28815	11968	51.7	13.4	7.3
POW 18	12.4	7043	2774	35.4	2.5	1.7
POW 19	12.4	7793	3044	30.9	2.6	1.9
POW 20	10.3	3397	1311	36.9	1.3	0.8
POW 21	8.6	417	131	33.2	0.5	0.1
POW 22	8.6	295	88	21.3	0.5	0.0
POW 23	9.4	477	169	17.1	0.5	0.1
POW 24	9.0	583	202	33.5	0.5	0.1
POW 25	9.5	561	185	31.6	0.5	0.1
POW 28	8.9	657	273	22.8	0.5	0.1
POW 29	8.5	791	345	29.4	0.5	0.2
POW 30	8.3	782	320	33.5	0.6	0.2
POW 31	9.7	1481	694	26.6	2.5	0.4
POW 32	9.6	1332	569	36.2	2.5	0.4
POW 33	8.4	705	313	31.8	0.6	0.2
SPW 1	9.7	1481	694	26.6	2.5	0.2
SPW 2	9.6	1332	569	36.2	2.5	0.3
SPW 3	8.4	705	313	31.8	0.6	0.0
SPW 4	9.2	789	318	23.0	1.3	0.3
SPW 5	9.2	1148	325	31.1	1.3	0.3
SPW 6	8.1	342	120	21.2	0.5	0.0
NPW 1	9.4	1025	400	29.1	0.6	0.5
NPW 2	8.9	1019	277	31.5	0.6	0.3
NPW 3	8.2	320	98	24.8	0.5	0.0

8.2.3 BRDA observation wells

Table 38 contains a summary of analyses undertaken on all BRDA Observation Wells (OWs) as per Schedule C.7 of the IPPC Licence. The IPPC Licence does not set out limit values for groundwater quality. In April 1997, OWs 3, 4, 5 & 6 were capped as part of the BRDA extension. OWs 9, 10, 11 &12 are subject to

saline intrusion and accordingly, the measured soda values are subject to interference.

An evaluation of elevated soda and pH levels in BRDA observation wells OW1 and OW2 was undertaken by Golders Associates UK in 2005. Recommendations of this evaluation involved installation of a pump and return system for OW1/OW2. Additional boreholes where installed in this area in 2007 to facilitate pump back to the plant for treatment and monitor the rate of remediation. A recovery pump adjacent to OW1 & OW2 abstracts groundwater and pumps it to the Storm Water Pond (SWP) for subsequent neutralisation and clarification followed by disposal. The liner of the SWP was replaced in 2008 and this is expected to improve the quality of the groundwater in the area. Since the re-lining of the SWP there has been a marked improvement in pH and conductivity of both wells versus 2007 data (average pH 2008 was 10.1, in 2007 average pH was 12.0 and average conductivity has decreased from 11,296 to 3,215 μs/cm).

Table 38 Summary of BRDA observation wells monitoring results 2008

OW Ref	Analytical Parameter																	
	pH	Conductivity µS/cm	Chloride mg/l	Fluoride mg/l	Soda g/l	Total Alkalinity mg/l $CaCO_3$	Al µg/l	As µg/l	Cd µg/l	Cr µg/l	Cu µg/l	Fe µg/l	Hg µg/l	Ni µg/l	Pb µg/l	Zn µg/l	Mg mg/l	SO_4 mg/l
OW 1	10.1	2,980	284.1	8.04	1.0	1127	149.5	25.6	0.09	0.9	1.2	11	0.38	6.5	1.0	1.8	274.9	10
OW 2	10.1	3,450	226.6	4.01	1.1	1224	233.9	16.6	0.09	1.1	1.5	171	0.32	8.5	1.2	56.9	167.1	94
OW 7	7.1	9,055	2582.3	0.98	2.1	822	7.5	10.9	0.09	2.3	6.4	3550	0.32	102.7	0.8	11.2	335.0	224
OW 8	7.5	14,695	4625.7	0.77	3.8	880	23.8	9.1	0.09	1.5	2.1	1783	0.32	195.4	0.5	199	555.8	246
OW 9	7.1	13,338	4405.3	0.91	3.2	589	74.3	13.5	0.09	3.1	1.5	2104	0.32	179.3	3.5	13.6	412.6	154
OW 10	7.3	29,840	11215.5	0.93	6.9	566	13.8	1.5	0.09	1.0	11.8	191	0.32	640.2	0.5	79.5	728.3	241
OW 11	7.1	30,967	11068.8	0.58	8.4	1825	88.4	33.3	0.09	3.3	14.2	211	0.32	478.2	0.5	16.0	486.2	134
OW 12	7.2	25,093	8985.2	0.54	6.8	1301	133	26.2	0.09	6.2	13.1	285	1.09	541.6	0.5	20.6	492.3	151
OW 13	7.5	556	25.0	0.50	0.0	208	10.4	1.0	0.09	1.0	1.1	83	0.92	6.7	0.8	2.1	10.7	10.3
OW 14	7.4	618	32.7	0.50	0.0	240	55.5	1.1	0.09	1.6	1.3	96	0.53	6.4	0.5	2.8	12.1	11.7
OW 15	7.2	720	33.5	0.50	0.0	307	7.4	1.0	0.09	0.9	1.4	19	0.32	5.9	0.5	3.9	8.9	9.3
OW 16	7.1	1,045	83.9	0.50	0.1	359	9.7	1.6	0.09	1.8	1.1	89	0.32	13.6	0.5	3.6	34.9	19.3
OW 17	7.1	915	66.8	0.50	0.1	346	7.4	1.8	0.09	1.0	2.4	105	0.32	12.3	1.1	3.9	25.7	16.3
OW 18	7.3	638	18.3	0.50	0.0	280	7.5	1.0	0.09	1.0	1.2	76	0.32	6.9	0.5	4.2	10.3	9.0
OW 19	7.3	1,069	156.5	0.65	0.1	337	35.9	1.0	0.09	1.0	0.9	32	0.32	7.9	0.5	2.8	8.2	9.0
OW 20	7.4	6,716	2261.0	0.97	1.6	817	16.0	10.0	0.09	1.1	7.1	237	0.32	36.9	0.8	18.8	106.7	69.3
OW 21	7.1	23,277	8138.6	0.53	5.9	1893	13.6	24.1	0.09	3.1	12.4	205	0.32	513.2	0.8	4.1	316.6	22.3
OW 22	6.9	4,028	1134.3	0.62	0.6	508	97.8	6.5	0.09	1.3	2.4	69	0.66	42.2	0.5	17.4	126.4	69.7
OW 23	7.1	1,880	252.6	0.55	0.3	595	7.6	6.8	0.09	2.3	2.6	565	0.32	33.2	2.5	12.9	87.0	43.7

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8.3 Leak Detection Monitoring System

Under Condition 6.17 of the IPPC Licence, AAL is required to undertake biannual sampling from four monitoring boreholes located around the former fuel storage area at the Mobile Pool. The fuel storage area at the Mobile Pool comprised three steel underground storage tanks (UST's), 2 of which were used for diesel and 1 for petrol. The two diesel UST's were decommissioned after Agency approval in 2005.

The results of biannual water testing during 2008 are tabulated on Table 39 and 40 below.

Table 39 Results of first round borehole monitoring (April 2008)

Borehole Ref.	DRO* μg/l)	PRO*(μg/l)
BH 1	<1	<1
BH 2	<1	<1
BH 3	<1	<1
BH 4	<1	<1

**Note: DRO – Diesel range Organics; PRO – Petroleum range organics.*

Table 40 Results of second round borehole monitoring (December 2008)

Borehole Ref.	DRO (μg/l)	PRO (μg/l)
BH 1	<1	<1
BH 2	<1	<1
BH 3	<1	<1
BH 4	<1	<1

Results of analysis of decommissioning of the diesel UST confirm significant improvement in ground water quality and a reduction in levels in diesel contaminants.
The results from headspace testing during 2008 are tabulated Table 41 and 42 below and confirm that the area is now fully remediated.

Table 41 Results of first round headspace analysis (April 2008).

Borehole Ref.	DRO (μg per tube)	PRO (μg per tube)
BH 1	<1	<1
BH 2	<1	<1
BH 3	<1	<1
BH 4	<1	<1

Table 42 Results of second round headspace analysis (Dec 2008).

Borehole Ref.	DRO (μg per tube)	PRO (μg per tube)
BH 1	<1	<1
BH 2	<1	<1
BH 3	<1	<1
BH 4	<1	<1

In all cases, results of headspace analysis for petroleum related compounds – both diesel and petrol related organic compounds – were below the limits of detection.

8.4 Fugitive Emissions in the AAL Plant Area

AAL undertakes monitoring for fugitive dust emissions at twenty eight locations within the site perimeter.

The dust-deposition gauges (labelled D.G. 1 – 28) measure deposited particulate material, collected over a 30-day period in accordance with guidelines VDI 2119. The dust-deposition gauges 20 – 28 were installed in September 2008 around the Phase 2 BRDA. In total, there are 19 deposition gauges located around the BRDA to monitor dusting from the landfill area (DG 4 – 13, 20 - 28).

Dust deposition measures the daily quantity of dust settling over a specified area (m^2) and is expressed as milligrams per square metre per day ($mg/m^2/day$).

Deposition rates were generally low and mean results for 2008 are summarised in Table 43. Results are presented as mean annual rates for each location, together with the range of monthly data recorded throughout the year.

It is noted that D.G. 1, D.G. 18 and D.G. 19 monitoring points are located within the plant near the hydrate storage pad and bauxite sheds and are unlikely to cause nuisance to areas outside the plant. D.G. 6 & D.G. 19 reported higher than normal levels of deposited dust during 2008 and in both instances extraneous contamination of the bottle during sampling were deemed to be the cause.

The level of dust deposited (annual average = 36 $mg/m^2/day$) is well below the rate predicted to cause nuisance.

Enterprise Ireland suggests that average levels between 30 – 100 $mg/m^2/day$ are typical of small towns and light industrial areas and as such are ‘hardly noticeable’.

Table 43 Dust deposition rates (mg/m^2/day) in 2008

Deposition Gauges	Average Deposition Rate (mg/m2/day)	Range mg/m^2/d
D.G. 1	39	16- 79
D.G. 2	75	11 - 223
D.G. 3	38	6 - 120
D.G. 4	21	6 - 64
D.G. 5	18	5 - 35
D.G. 6	26	6 - 92
D.G. 7	35	7 - 140
D.G. 8	51	7- 148
D.G. 9	35	4- 100
D.G. 10	27	9 - 84
D.G. 11	69	11 - 268
D.G. 12	28	4 - 60
D.G. 13	26	8 - 68
D.G. 14	15	2 - 44
D.G. 15	51	10 -107
D.G. 16	19	0 - 95
D.G. 17	36	14 -78
D.G. 18	73	23 - 158
D.G. 19	161	26- 303
D.G. 20	12	7 - 17
D.G. 21	18	5 - 32
D.G. 22	48	1 - 173
D.G. 23	4	2 - 6
D.G. 24	11	3 - 20
D.G. 25	27	4 - 41
D.G. 26	11	7 - 19
D.G. 27	8	5 - 10
D.G. 28	31	20 -41

8.5 Ambient Air Quality Monitoring

A programme of off-site ambient air quality monitoring is carried out by AAL in accordance with Conditions 5.8 and 6.15 of the IPPC Licence.

The parameters measured are sulphur dioxide, suspended dust, deposited dust and particulate matter below 10μm (PM_{10}). The monitoring is undertaken at off-site locations by OES Consulting on a contract basis to AAL. The OES report covering the 2008 monitoring programme is appended to this report as Attachment 7.

A summary of the ambient sulphur dioxide findings are tabulated below in table 44. The data tabulated relates to the 2008 monitoring period (January to December 2008).
Tables 45 – 47 show a summary of the remaining data gathered for the ambient air monitoring programme carried out on AAL's behalf.

The results of monitoring indicate that ambient air quality in the area is generally good with the various annual and percentile values for ambient SO_2 falling well within relevant National Air Quality Standards (NAQS) for those parameters.

Table 44 Ambient Air Sulphur Dioxide Concentrations (μg/m^3)

Monitoring Location	Annual Mean (μg/m^3)	Min Result (μg/m^3)	Max Result (μg/m^3)	NAQS* (μg/m^3)
Kenricks House (Site 1)	2.2	0.63	6.8	<50
Kenricks House (1A)	2.1	0.6	6.3	<50
Raw Water Intake (2)	2.2	0.7	8.2	<50
Keane's House (3)	6.4	0.8	20.9	<50
Water Works (4)	3.0	0.5	9.5	<50
Foynes (5)	4.7	1.6	16.6	<50
Moran's House (6)	3.0	0.4	11.0	<50
Fitzsimon's House (7)	3.5	0.8	10.7	<50
Aughinish (8)	5.0	1.0	14.3	<50
Foynes Reservoir (9)	6.0	1.5	32.2	<50
Foynes Reservoir(9A)	3.2	1.7	11.6	<50

*NAQS shown is lower assessment threshold for SO_2 (40% of 24-hour limit value)

Table 45 Ambient Air Mean Particulate Deposition Rates ($mg/m^2/day$)

Site No.	Location	Deposition Rate ($mg/m^2/day$)	Range ($mg/m^2/day$)	NAQS* (mg/m^3)
3	Keane's House	32	6 - 99	350
7	Fitzsimons House	29	10 – 81	350

*NAQS derived from TA Luft Technical Instructions on Air Quality Control 1997

Table 46 Ambient Air Mean Sodium and PM_{10} – Annual Average & Range.

Site No.	Location	Sodium (µg/m3)	PM10 (µg/m3)	NAQS*	Percent Run time**
1	Kenrick's House	1.24 (0 – 6.3)	4.7 (0.0 – 55.7)	20	98.8
8	NE of Alumina Plant	1.5 (0 – 6.4)	17.9 (0.0 - 109)	20	96.9
9	Foynes	1.3 (0 – 6.0)	17.2 (0.3 – 41.5)	20	97.5

*NAQS shown is the lower assessment threshold for PM_{10} (40% of 24-hr limit)
**Percentage run shown is for ambient Partisol monitors

Table 47 Ambient Mean continuous SO_2 monitoring ($\mu g/m^3$)

Site No.	Location	Sodium (annual average) (µg/m3)	Range (µg/m3)	Percent Run time	NAQS*
1	Kenrick's House	2.6	0 - 15.8	92	<50
9	Foynes	2.6	0 - 25.4	95	<50

*NAQS shown is lower assessment threshold for SO_2 (40% of 24-hour limit value)

8.6 Bund, Tank & Pipeline Integrity Testing

Condition 6 of the IPPC Licence (Control and Monitoring) states the requirements for the protection of groundwater from spills, leaks and improper storage. Specifically, conditions 6.9 and 6.10 deal with the inspection and testing of bunding structures, tanks and underground pipelines.

8.6.1 Bunds & Tanks

The site has a number of integrity testing and repair programmes.

The integrity testing of all bunding structures and tanks is carried out on an ongoing three-year cycle. In total, there are 346 separate items requiring integrity testing at AAL and in 2008 the integrity of 144 items was confirmed.

In addition, significant areas of selected process bunds have been plated using steel plating to provide additional protection to the bund structure. The steel plate is welded in situ and subsequently a hydrostatic test is conducted to confirm the integrity of the structure.

The resources dedicated to routine repairs of concrete slabs and jointing was further expanded in 2008 over previous years. This programme was started in 2004 and will be ongoing for the foreseeable future.

In the past few years substantial sections of the drains have been upgraded with a steel or stainless steel liner in order to minimise the risk of groundwater contamination.

8.6.2 Underground Pipelines

All non-process effluent pipelines (sanitary) were tested in 2007 and all necessary repairs are completed. The report on this testing was included in the 2007 AER.

8.7 Decommissioning & Residual Management Plan Update

Condition 10 of IPPC Licence No. P0035-04 requires that AAL shall continue to maintain a fully detailed and costed plan which is adequate to assure the Agency that AAL is at all times financially capable of financing the Decommissioning & Residuals Management Plan (DRMP).

The review of the DRMP takes account of any changes or significant modifications to the range of processes carried out, layout of the plant or range of chemicals and equipment used which may influence the DRMP and associated cost.

8.7.1 Amendment to DRMP

In 2007 the DRMP was updated to reflect updated costs of closure and aftercare of the entire facility. The total cost of decommissioning all areas within the AAL site along with long term management and monitoring was estimated to be €15,975,609.

8.7.2 Update of Closure Costs

The projected decommissioning costs for 2008, based on the Wholesale Price Index, Capital Goods; materials &wages (as published by the Central Statistic Office for year 2008) January 2008 to December 2008, amounts to:

€15,975,609 x 159.9 / 154.1 = € 16,576,897

Rusal, AAL's Parent Company, has underwritten the cost of closure and de-commissioning of the facility based on the 'De-commissioning and Closure Report' issued by AAL to the EPA in June 1999. The structure of the underwriting for this activity is such that it allows for escalations based on changes to scope or to the Wholesale Price Index (WPI).

8.8 Environmental Liabilities Risk Assessment Review

AAL commissioned a comprehensive Environmental Liabilities Risk Assessment (ERLA), which was submitted to the Agency in 1999.

The ELRA is intended to form the basis for determination of an appropriate level of environmental insurance cover and is to be reviewed annually in accordance with Condition 10.2.2 of the current IPPC licence no P0035-04.

Using Shannon Estuary Oil Spill (SEOS) Computer Model to predict the movement and fate of a potential oil slick resulting from a significant spillage during a theoretical "worst case" incident, the ELRA calculated an environmental liability of IR£6 million (in 1998 IR£). This figure was based on international norms in the determination of costs associated with clean up after a major spill.

The figure has been updated annually based on the Wholesale Price Index (WPI-Capital Goods; material and wages; as published by the Central Statistic Office for year 2008) January 2008 to December 2008, is used to calculate this figure. In line with IPPC Licence Condition 15.2.4 the WPI is used to calculate this figure.

The updated figure for 2008 was calculated as follows:
€ 11.39 m x 159.9 / 154.1 = € 11.82m

Based on the above and in today's terms, AAL could generate €11.82 million pollution clean-up costs in an extreme worst-case scenario. AAL is required to have insurance cover in place to address this potential liability. The following is the summary of AAL's insurance arrangements.

General Liability Insurance

AAL has General Liability Insurance which provides environmental insurance cover to a level greater than €11.82 million in respect of:

- Liability for injury or loss of or physical damage to or destruction of tangible property, or loss of use of such property damaged or destroyed directly or indirectly caused by seepage, pollution or contamination where such seepage, pollution or contamination is caused by a sudden, unintended and unexpected happening during the Period of Insurance

- The cost of removing, nullifying or cleaning-up seeping, polluting or contaminating substances where the seepage, pollution or contamination is caused by a sudden, unintended and unexpected happening during the Period of Insurance

Details of the relevant insurance policies have been provided to the EPA under separate cover.

8.9 Annual Landfill Status Report

Operational information required under Schedule D of the IPPC Licence in respect of the Bauxite Residue Disposal Area (BRDA) is tabulated on Table 48 below. There are no closed areas within the BRDA and all areas are currently operational.

Table 48 Landfill Operational Status

Parameter	Active Areas
Landfill name & licence number	Aughinish Alumina Ltd. (BRDA) IPPCL Reg. P0035-04
Landfill location	Aughinish Island (National Grid R 127300E, 152200N)
Reporting period	Jan 01 – Dec 31, 2008
Owner and/or operator	Aughinish Alumina Ltd.
Area occupied by waste	94.5 hectares
Tonnage and composition of waste deposited in the preceding year	1,240,695 tonnes (See Table 50)
Methods of depositing	Pumping/Trucking
Time and duration of depositing	24 hours per day, 366 days per year
Total accumulated quantities of waste deposited	19,263,651 t (See Table 51)
Calculated remaining capacity	3,963,791 t (Table 52)
Calculated final capacity of site	23,227,442 t
Year in which final capacity of site is expected to be reached	2012
Stability checks undertaken	See section 8.9.3
Results of monitoring programme	See section 8.9.3
Summary of any monitoring non-compliances and corrective actions taken	Not Applicable
Summary of any development/remedial works carried out in the preceding year	See section 8.9.5
Revisions to Landfill Operational Plan	None
Progress on restoration of completed cells	Not Applicable

8.9.1 Waste Composition and Tonnage Data

Information on current and projected waste disposal rates, together with a breakdown of waste types is tabulated on the following tables.

Table 49 Waste Composition & Tonnage (2008)

Waste Stream	EWC Code	Jan – Dec '08 Total (t)	As % of total waste land filled
Fluestack Residues (dry)	16 11 04	110	0.01%
Lime Grits (wet)	01 03 99	7,509	0.61%
Process Waste (wet)	01 03 99	71,750	5.78%
Red Mud (dry)	01 03 09	1,148,738	92.59%
Salt Cake (wet)	01 03 07	12,558	1.01%
Total Waste		**1,240,695**	**100%**

Table 50 Accumulated Quantities of Waste (1983 to Dec 2008)

Waste Stream	EWC Code	1983 – Dec.'08 Total (t)	As % of total waste landfilled
Effluent Sludge A34 Clarifier (dry) *	06 05 03	4,380	0.02%
Fluestack Residues (dry)	16 11 04	4,396	0.02%
Lime Grits (wet)	01 03 99	101,130	0.52%
Process Waste (wet)	01 03 99	1,843,390	9.83%
Red Mud (dry)	01 03 09	17,016,737	88.04%
Salt Cake (wet)	01 03 07	293,587	1.56%
Total Waste		**19,263,651**	**100%**

(Note1: The data for all residues for 1983 - 1997 other than red mud are estimated based on pro-rata tonnages for the period 1997 to 2000.

* Material no longer generated at plant.

Engineering estimates of the total occupied and remaining capacity of the BRDA have been updated to reflect recorded quantities of waste deposited at the facility during 2008 and are tabulated below.

Table 51 Estimated Capacity of BRDA.

Period	MOM*	Waste during period (t)	Accumulated waste (t)	Remaining capacity of BRDA (t)
'83 to '00	R	9,952,703	9,952,703	9,762,404
2001	R	1,110,916	11,063,619	8,651,488
2002	R	1,111,886	12,175,505	7,539,602
2003	R	1,053,818	13,229,323	6,485,784
2004	R	1,077,940	14,307,263	5,407,844
2005	R	1,224,053	15,531,316	4,183,791
2006	R	1,270,270	16,801,586	2,913,520
2007	R	1,221,369	18,022,955	1,692,151
2008	R	1,240,695	19,263,651	451,455
2009	E	855,200	20,118,851	3,108,591**
2010	E	855,200	20,974,051	2,253,391
2011	E	855,200	21,829,251	1,398,191
2012	E	855,200	22,684,451	542,991

*Note: MOM – Method of Measurement; R = Recorded (Measured); E = Engineering Estimate
**Note: Increased in capacity of BRDA with increase in height to 32 meters (going from Stage 7 perimeter lift to Stage 10 perimeter lift) following issue of IPPC P0035-04 in 2008.

8.9.2 BRDA Containment Capacity

Containment capacity within the BRDA is developed by the construction of rock fill terrace embankments around the BRDA perimeter. These embankments are constructed in stages, each stage increasing the elevation of the BRDA by 2 metres. Approximately 10% of the BRDA perimeter is currently at Stage 8, 45% is at stage 7, 15% is at Stage 6 and the remainder 30% of the perimeter is at Stage 5 perimeter lift. The revised IPPC license and planning permission permits the entire existing BRDA perimeter to be raised to stage 10. This will extend the lifetime of the existing BRDA to mid year 2013 at forecasted reduced production rates.

8.9.3 Results of BRDA Monitoring programme

During 2008, Golder Associates undertook monthly piezometer monitoring and monitoring at six monthly intervals of extensometers and inclinometers. Golder Associates advise that the results of the monitoring indicate stable and consistent readings since mid year 2007.

Monitoring of environmental conditions at the BRDA is undertaken on a routine basis through the collection of samples of groundwater and surface waters for analysis. The results of monitoring in the area of the BRDA are detailed in Section 2.2.7 (Surface waters) and 4.2.3 (Groundwater) of this AER.

There are 20 dust deposition gauges located at points along the BRDA perimeter in order to determine rates of dusting in the vicinity of the BRDA. The results of monitoring are tabulated in Section 4.4 (Fugitive Emissions in the AAL Plant Area).

8.9.4 Revisions to BRDA Operational Plan

The BRDA Operational Plan, updated in 2005, is appended in Attachment 11.

In November 2004 AAL submitted a proposal to the satisfaction of the Agency to demonstrate the long-term viability of the BRDA closure plan. A trial site of 0.8 ha within the BRDA has been designated for this purpose. The conditioning of the red mud for the trial work vegetation was commenced in 2008 and complementary data was collected. The future results of this project will be used to predetermine the environmental effects of closing the existing BRDA and conducting the direct vegetation for this programme will be ongoing for the foreseeable future.

8.9.5 Summary of BRDA development/remedial works 2008

The storm water pond (SWP) was removed from service in June 2007, the residual sludge on the floor of the pond was dredged out and pumped into the BRDA. The SWP was then drained to remove all standing liquid. A contract was awarded to Priority Construction Ltd to install a composite lined system for the entire SWP in accordance with the CQA Plan submitted to the Agency. That contact was completed by November 2007 and the SWP has been back in service since December 2007. A large sump and 220kW submersible pump was installed in the perimeter channel of the BRDA to pump storm water and leachate from the BRDA directly back to the process effluent neutralisation and clarification system.

A contract was awarded in late July 2008 to BAM Contractors (previously named Ascon Ltd) to construct the Phase 2 BRDA extension in accordance with the design agreed with the Agency. The contract date for completion of the Phase 2 BRDA was defined as 31st October 2009.

The works in progress by year end 2008 comprised the near completion of the rockfill component of the outer perimeter dam wall and approximately 80 % the necessary explosive blasting to excavate out the limestone outcrop in the townlands of Glenbane West and Fawnamore down to formation level to facilitate the development of part of the basin area within those townlands. Drainage formation works were substantially completed in the Aughinish East and Aughinish West parts of the basin area before year end.

8.9.6 Progress on Closure Planning & Revegeatation of BRDA

IPPC licence conditions 8.3.14 requires that AAL continues to strive to implement the recommendations in the relevant sub-sections of the Residues Solutions Report submitted to the Agency in July 2007. The subsections to be addressed were:

- Closure Planning
- Closure Revegetation
- Post-Closure Management
- Alternative Uses of Residue

For the last number of years AAL, in conjunction with the University of Limerick, has been carrying out an extensive research programme with the specific aim of developing the knowledge required for the closure and successful revegetation of the BRDA. This research programme has been carried out both on and off site by AAL personnel and contracted researchers.

A report on this research programme is appended to this AER as Attachment 10.

8.10 BOD Reduction Programme

Condition 2.2.2.2(iii) of the IPPC licence requires that the following is included in the annual Schedule of Environmental Objectives and Targets:

"Reduction in BOD loading discharged to the River Shannon through W1-1 with the aim of achieving BOD levels of not more than 1500kg/day"

Over the past five years Aughinish Alumina has conducted a significant review of organic contaminants in the effluent discharged to the river. The organics at individual levels are low and mostly undetectable using Gas Chromatography-Mass Spectrometry (GC-MS). The organics present are similar to those present in the process liquor.

AAL have, in conjunction with Bio-industries, Dublin, conducted extensive trials with a large range of bacteria in order to determine their ability to degrade the organics currently present. Aughinish has completed a 3 year project to produce bacterial cultures on-site for addition to the industrial effluent treatment process to reduce the BOD. The organics in the effluent have been reduced by 30% as a result of this project. Further reductions in the BOD will be dependent on correcting deficiencies in the concentration of macro and micro nutrients.

8.11 Progress on Bauxite Residue Neutralisation

AAL was requested as a condition of the revised IPPC licence issued in April 2008 to review possible methods for the neutralisation of bauxite residue (red mud) prior to disposal to the Phase 2 BRDA.

- IPPC licence condition 8.3.15 states that by the 1st of January 2012 the mud and sand residues in Phase 2 shall be subject to a neutralisation step (soluble alkalinity as a minimum).
- Licence condition 8.3.17 dictates that unless otherwise agreed in writing the neutralisation referred to in Condition 8.3.15 shall be the Carbonation process. Any request for variation in this specified technology shall be supported by a comprehensive feasibility / unfeasibility statement having regard to the principles of Best Available Techniques (BAT).

PM Group and Sinclair Knight Merz were engaged by AAL to investigate red mud neutralisation by carbonation and to prepare a comprehensive feasibility report with regard to the principles of BAT. A copy of the completed report will be forwarded to the Agency during Q2, 2009. A brief overview of the scope of this report as well as an outline of the preliminary findings is given below in sections 8.11.1 to 8.11.4.

The key preliminary findings of the PM & SKM neutralisation review are:

- The technology for carbon dioxide neutralisation of red mud is not developed for the specific circumstances prevalent at AAL. CO_2 neutralisation cannot be considered "Available" within the context of BAT.
- There are no feasible sources of CO_2 locally as carbon capture and storage technology is not yet commercially available. AAL should maintain a review of these technologies
- The capitol and operating costs of a carbon neutralisation far exceed those for sulphuric acid
- The application of sulphuric acid neutralisation is the only feasible short/medium term solution and should be pursued
- AAL should maintain a watching brief on the development of CO_2 neutralisation.

8.11.1 Overview

The Irish technical consultancy firm PM Group, in conjunction with Sinclair Knight Merz (SKM Australia), was contracted to conduct a feasibility study of neutralization by carbonation of the mud residue going to the BRDA. PM Group has an experienced Environmental Group and SKM has expertise in the mining and environmental sectors. SKM is based in Australia and brings familiarity with the Australian alumina industry to the study. Preliminary conclusions indicate that neutralization by carbonation is not currently feasible at AAL when assessed under the Best Available Techniques (BAT) principle. A more viable option is neutralization using sulphuric acid. Elements considered in the draft report included technology transfer and development, retrofit requirements, climate, carbon dioxide sourcing, net carbon balance, and economics.

8.11.2 Availability

Carbonation is known to be used for neutralization in the alumina industry only by Alcoa's Kwinana refinery near Perth in Western Australia. This is a patented process in use in only one location across the industry, thus, it is not sufficiently

developed to be classified as available for implementation when economical and technical conditions are considered. There is no evidence that residue can be carbonated at 58% solids, and likewise there is no evidence that carbonated residue can be re-thickened and disposed of, (without any negative rheology impact), to a BRDA such as the one in AAL which sees heavy rainfall unlike the BRDA in Perth. The availability of this technique is therefore limited to being a concept implemented in one location, and would require significant and successful lab scale, pilot scale and engineering development work that would need to indicate technical viability, before becoming a realistic business venture.

8.11.3 Environmental Benefit and Carbon Dioxide Procurement

CO_2 is not available from an ammonia plant nearby as it is for Kwinana Australia, thus this raw material would have to be captured on-site, captured elsewhere in Ireland, or imported. Since carbon capture technology is not yet commercially available, the capture of CO_2 from flue streams at AAL and elsewhere (such as at Irish Cement) is not feasible. Hence, importation from the UK by trucking would be the only procurement option. Estimates for trucking CO_2 from Teesside, UK to Foynes, Co. Limerick indicate carbon emissions of 7,425 t/a in order to import the 25,000 t/a of CO_2 that AAL would require for this neutralization process. The CO_2 balance would still involve the inputs of the CO_2 emissions to produce the imported CO_2, and the CO_2 emissions to conduct the carbonation process on-site. The net CO_2 capture would be significantly less than 25,000 t/a.

8.11.4 Project & Environmental Economics

From an economic viewpoint, this project competes with the more viable neutralization option which uses sulphuric acid, a raw material which is already in use around the site at AAL. This means that the expertise and safety auxiliary equipment are already available for handling and storage of the acid, which is not the case when it comes to liquid and gaseous CO_2.

When raw material costs are considered, the operating cost of the sulphuric acid plant is €1.6 million/a whereas the operating cost of the carbonation plant is €4.8million/a. With an Environmental burden Cost for 25,000 tCO2 of €1.7million (based on the UK Stern Report), the carbonation process would result in annual operating expenditure of more than €4.8 million to abate “damages” worth only €1.7 million, thereby resulting in an annual loss, in environmental economics terms, of €3.1million. At April 2009 European Energy Exchange (EEX) prices of €13 per tonne of carbon, and a possible sink at AAL of 25,000 tonne per annum via the carbonation process, AAL would have carbon credits valued at €0.325 million per annum. However, from the other perspective, AAL could buy 25,000 tonnes of carbon credits for €0.325million per annum, rather than spend €4.8million per annum in order to acquire these credits.

The capital expenditure for the sulphuric acid project is €1.2 million since this only requires acid injection in the BRDA line in which the neutralization reaction can take place. The CO_2 neutralization project, that would involve thinning, carbonating in a pressure reactor, then re-thickening the slurry, would require: CO_2 receiving, handling and storage facilities; new filtration equipment; and high pressure reactor equipment. Hypothetically, this would be on the order of magnitude of greater than €35 million, +/- €5million, at a minimum. (It cost approximately €7.2 million to install a filter building annex with 2 new filters and auxiliaries a decade ago, thus more than €28.8million alone would be required for a new filtration building containing 8 filters.)

Thus the capital and operating costs of carbon neutralization far outweigh those for sulphuric acid by 30 times and 3 times, respectively. It should be noted that

acid installation does not preclude later installation of carbonation if circumstances changed to improve its viability at AAL.

8.12 Raw Materials Efficiency and Waste Reduction

AAL continually strives to improve the efficiency of its processes in order to reduce the raw materials consumed and the waste produced. Table 53 shows the volumes of raw materials consumed and waste produced for 2007 and 2008. The relative consumption for each parameter is calculated as the volume consumed per tonne of alumina produced. As can be seen in Table 53, the relative consumption for virtually all raw materials has improved in 2008 versus 2007. The one exception was bauxite ore consumption which remained the same over the two years.

Table 52 Raw material Efficiency and Waste Reduction

Material	2007 Consumption	Relative Consumption (Volume/tonne alumina)	2008 Consumption	Relative Consumption (Volume/tonne alumina)
Alumina Produced (tonnes)	1,803,149	N/A	1,890,200	N/A
Waste Produced (tonnes)	1,224,504	0.68	1,242,451	0.69
Raw Materials				
Bauxite Ore (tonnes)	4,027,556	2.2	4,238,178	2.2
Sodium Hydroxide (tonnes)	130,278,841	72.3	117,705,425	62.3
Sulphuric Acid (tonnes)	17,040,995	9.5	13,788,786	7.3
Heavy Fuel Oil (tonnes)	229,919	0.13	219,123	0.12
Water (M^3)	5,584,421	3.1	5,359,462	2.8
Energy (MW)	728.3	0.0004	696.4	0.00037

8.13 Programme for Public Information

As per IPPC licence condition 2.2.2.7, AAL maintains a public awareness and information programme. As agreed with the agency, copies of quarterly monitoring reports, monthly complaint reports and annual environmental reports are retained at the gatehouse on the AAL site. This documentation can be reviewed by any member of the public at all reasonable times.
An annual neighbours meeting is also held by AAL to which all neighbours within a specified radius are invited. This meeting provides a forum at which people living in the vicinity of the site are updated on recent significant environmental events and also allows any issues to be raised. The key item on the agenda at the meeting held on 14th of August, 2008 was the proposed expansion of BRDA.

Attachment 1
Toxicity Test Reports

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CONFIDENTIAL REPORT
SHANNON AQUATIC TOXICITY LABORATORY

ISO 17025 INAB ACCREDITED TESTING DETAILED IN SCOPE REG NO.0801

Front Cover Report Sheet

Dept. Toxicity
Sheet no. 1 of 4 sheets Tox F020 Ver. 2.0

Client
Aughinish Alumina
Askeaton
Co Limerick

Title
Toxicological analysis of two samples

Attn: Mr Trevor Montgomery

Report ref.: 08T108 Order no.: 2664209

File no.: Report by: Kathleen O'Rourke
Robert Hernan

Date recd.: 25.03.08 Approved by: Jim Clancy
Head of Department

Copies to: R.6. Files Date: 14.04.08

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7. This contract is governed by the laws of Ireland whose courts shall have exclusive jurisdiction.

Test report relates only to the sample(s) tested
* Indicates that test result is not INAB accredited
Opinions and interpretations expressed are outside the scope of INAB accreditation

TOXICOLOGICAL TESTING REPORT Form No.: ToxF035-1 Ver 2.0

TEST RESULTS

Customer: Aughinish Alumina

Customer sample description: Final effluent, 23.3.08, W1-1A

Tox. Ref. No.: 08T108-1

Test Date: *Tisbe battagliai* – 23.03.08
Vibrio fischeri – 23.03.08

	Test Results			
Test Parameter	**Concentration % vol./vol.**	**Toxic Units**	**95% Confidence Limits % vol./vol.**	**Method of Calculation**
* 48 h LC_{50} to *Tisbe battagliai*	> 32	< 3.1	n/a	n/a
5 min EC_{50} to *Vibrio fischeri*	> 45	< 2.2	n/a	n/a
15 min EC_{50} to *Vibrio fischeri*	> 45	< 2.2	n/a	n/a

***** indicates that test result is not INAB accredited

Comments:

48 h LC_{50} to *Tisbe battagliai*
25% mortality occurred at 32% vol./vol.

5, 15 min EC_{50} to *Vibrio fischeri*
Less than 42% light inhibition occurred at 45% vol./vol. compared to the control.

Test Method(s):
Appendix on back of page 4
Method 3 – *Tisbe battagliai*
Method 2 – *Vibrio fischeri*

TOXICOLOGICAL TESTING REPORT Form No.: ToxF035-1 Ver 2.0

TEST RESULTS

Customer: Aughinish Alumina

Customer sample description: Final effluent, 23.03.08, W1-1B

Tox. Ref. No.: 08T108-2

Test Date: *Tisbe battagliai* – 23.03.08
Vibrio fischeri – 23.03.08

	Test Results			
Test Parameter	**Concentration % vol./vol.**	**Toxic Units**	**95% Confidence Limits % vol./vol.**	**Method of Calculation**
* 48 h LC_{50} to *Tisbe battagliai*	30.8	3.2	n/a	Binomial
5 min EC_{50} to *Vibrio fischeri*	> 45	< 2.2	n/a	n/a
15 min EC_{50} to *Vibrio fischeri*	> 45	< 2.2	n/a	n/a

***** indicates that test result is not INAB accredited

Comments:

48 h LC_{50} to *Tisbe battagliai*
55% mortality occurred at 32% vol./vol.
No mortality occurred at 18% vol./vol.

5, 15 min EC_{50} to *Vibrio fischeri*
Less than 39% light inhibition occurred at 45% vol./vol. compared to the control.

Test Method(s):
Appendix on back of page 4
Method 3 – *Tisbe battagliai*
Method 2 – *Vibrio fischeri*

SAMPLE INFORMATION
(supporting data not within scope of INAB accreditation)

	SATL	Customer	Other
Sampled by:	☐	✓	☐
Collected by:	✓	☐	☐

Tox Ref. No.	08T108-1	08T108-2
Sampling procedure	n/a	n/a
Date of receipt	23.03.08	23.03.08
Storage conditions(°C)	3 ± 3	3 ± 3
Temperature (°C)	21.0	20.9
pH	8.1 @ 21.1°C	8.2 @ 20.9°C
Dissolved oxygen (mg/l)	9.1	8.7
Dissolved oxygen (% saturation)	106.3	100.1
Conductivity (mS/cm at 25°C)	13.0	13.2
Salinity (‰ at 20°C)	7.5	7.7

EURO environmental services

Environmental Science & Management
Water,Soil & Air Testing

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Co. Louth
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Web: www.euroenv.ie
email: info@euroenv.ie

Customer	Trevor Montgomery Aughinish Alumina Ltd Auginish Island Askeaton Co Limerick Ireland	*Lab Report Ref. No.*	3120/285/01
		Date of Receipt	19/11/2008
		Date Testing Commenced	19/11/2008
		Received or Collected	Courier: DHL
		Condition on Receipt	Acceptable
Customer PO	2685667	*Date of Report*	08/12/2008
Customer Ref	W1-1A 17/112008	*Sample Type*	Trade Effluent

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Toxicity (Copepoda, Crustacae)*	0	LC50	<3.1	Toxic units	
Toxicity (vibrio fischeri) 15 mins	0	EC 50	2.3	Toxic units	
Toxicity (vibrio fischeri) 5 min	0	EC 50	<2.2	Toxic units	

Web Certificate ***Date : 08/12/2008***

Donna Heslin - Laboratory Manager

Acc. : Accredited Parameters by ISO 17025:2005

All organic results are analysed as received and all results are corrected for dry weight at 104 C

Results contained in this report relate only to the samples tested

*Subcontracted

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		Date of Receipt	19/11/2008
		Date Testing Commenced	19/11/2008
		Received or Collected	Courier: DHL
		Condition on Receipt	Acceptable
Customer PO	2685667	*Date of Report*	08/12/2008
Customer Ref	W1-1B 17/112008	*Sample Type*	Trade Effluent

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Toxicity (vibrio fischeri) 15 mins	0	EC 50	<2.2	Toxic units	
Toxicity (vibrio fischeri) 5 min	0	EC 50	<2.2	Toxic units	

Web Certificate ***Date : 08/12/2008***

Donna Heslin - Laboratory Manager

Acc. : Accredited Parameters by ISO 17025:2005

All organic results are analysed as received and all results are corrected for dry weight at 104 C
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Results contained in this report relate only to the samples tested

*Subcontracted

Attachment 2
VOC Screening Report

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Customer Name	Trevor Montgomery	**Lab Report Ref.**	No. 3120/254/01
Company	Aughinish Alumina Ltd	**Date of Receipt**	10/04/2008
Address	Auginish Island	**Date Testing**	13/04/2008
	Askeaton Co Limerick	**Received or Collected**	Delivered by Customer
	Ireland	**Condition on Receipt**	Acceptable
Customer PO	2665419	**Date of Report**	23/04/2008

CERTIFICATE OF ANALYSIS

Lab Ref **3120/254/01**
Client Ref **W1-1A**

Sample Type **Water**

Test Parameter	SOP	Analytical Technique	Result	Units
US EPA Method 524.2	154	GC-MS 1	<1	µg/L
Ethanol	154	GC-MS 1	<1	µg/L
Acaetonitrile	154	GC-MS 1	<1	µg/L
IPA	154	GC-MS 1	<1	µg/L
Methanol	154	GC-MS 1	<1	µg/L
Acetone	154	GC-MS 1	<1	µg/L
MEK	154	GC-MS 1	<1	µg/L

Date : 23/04/2008

Katherine McQuillan -Deputy Technical Manager

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Customer Name	Trevor Montgomery	**Lab Report Ref.**	No. 3120/265/01
Company	Aughinish Alumina Ltd	**Date of Receipt**	05/09/2008
Address	Auginish Island	**Date Testing**	06/09/2009
	Askeaton Co Limerick	**Received or Collected**	Delivered by Customer
	Ireland	**Condition on Receipt**	Acceptable
Customer PO	2665419	**Date of Report**	14/09/2008

CERTIFICATE OF ANALYSIS

Lab Ref **3120/265/01**
Client Ref **W1-1A**

Sample Type **Water**

Test Parameter	SOP	Analytical Technique	Result	Units
US EPA Method 524.2	154	GC-MS 1	<1	µg/L
Ethanol	154	GC-MS 1	<1	µg/L
Acaetonitrile	154	GC-MS 1	<1	µg/L
IPA	154	GC-MS 1	<1	µg/L
Methanol	154	GC-MS 1	<1	µg/L
Acetone	154	GC-MS 1	<1	µg/L
MEK	154	GC-MS 1	<1	µg/L

Date : 14/09/2008

Katherine McQuillan -Deputy Technical Manager

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W eb: www.euroenv.ie
email: info@euroenv.ie

Customer Name	Trevor Montgomery	**Lab Report Ref.**	No. 3120/265/01
Company	Aughinish Alumina Ltd	**Date of Receipt**	05/09/2008
Address	Auginish Island	**Date Testing**	06/09/2009
	Askeaton Co Limerick	**Received or Collected**	Delivered by Customer
	Ireland	**Condition on Receipt**	Acceptable
Customer PO	2665419	**Date of Report**	14/09/2008

CERTIFICATE OF ANALYSIS

Lab Ref **3120/265/01**
Client Ref **W1-1A**

Sample Type **Water**

Test Parameter	SOP	Analytical Technique	Result	Units
US EPA Method 524.2	154	GC-MS 1	<1	µg/L
Ethanol	154	GC-MS 1	<1	µg/L
Acaetonitrile	154	GC-MS 1	<1	µg/L
IPA	154	GC-MS 1	<1	µg/L
Methanol	154	GC-MS 1	<1	µg/L
Acetone	154	GC-MS 1	<1	µg/L
MEK	154	GC-MS 1	<1	µg/L

Date : 14/09/2008

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Customer Name	Trevor Montgomery	**Lab Report Ref.**	No. 3120/265/02
Company	Aughinish Alumina Ltd	**Date of Receipt**	05/09/2008
Address	Auginish Island	**Date Testing**	06/09/2008
	Askeaton Co Limerick	**Received or Collected**	Delivered by Customer
	Ireland	**Condition on Receipt**	Acceptable
Customer PO	2665419	**Date of Report**	14/09/2008

CERTIFICATE OF ANALYSIS

Lab Ref **3120/265/02**
Client Ref **W1-1B**

Sample Type **Water**

Test Parameter	SOP	Analytical Technique	Result	Units
US EPA Method 524.2	154	GC-MS 1	<1	µg/L
Ethanol	154	GC-MS 1	<1	µg/L
Acaetonitrile	154	GC-MS 1	<1	µg/L
IPA	154	GC-MS 1	<1	µg/L
Methanol	154	GC-MS 1	<1	µg/L
Acetone	154	GC-MS 1	<1	µg/L
MEK	154	GC-MS 1	<1	µg/L

Date : 14/09/2008

Katherine McQuillan -Deputy Technical Manager

* INAB Accredited Test

Attachment 3
Results of Waste Analysis

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Month: January '08

Parameter		IPPC Limits	Waste Class					
			Red Mud	Sand	Salt Cake	Leachate from Red Mud Stack		Sludge from Sanitary Treatment Plant
pH		None	12.6	12.2	>13	12.4		
Dry matter	% w/w	None	60.5	78.8	56.3			
Total alkalinity	mg/Kg $CaCO_3$	None	16,320	8,976	306,059	6,558	mg/l	
Chloride	mg/Kg	None	59.11	67.95	2,231	51.8	mg/l	
Fluoride	mg/Kg	None	57.14	44.65	2,287	16.7	mg/l	
Soda	mg/Kg	None	9,915	4,882	222,526	3,235	mg/l	
Nitrogen	mg/l	None						
Organic matter	%	None						
Heavy metals	mg/l	None						
Phosphorous	mg/l	None						

Month: February '08

Parameter		IPPC Limits	Waste Class					
			Red Mud	Sand	Salt Cake	Leachate from Red Mud Stack		Sludge from Sanitary Treatment Plant
pH		None	12.5	12.5	>13	12.14		
Dry matter	% w/w	None	61.6	79.8	56.55			
Total alkalinity	mg/Kg $CaCO_3$	None	14,679	16,047	303,302	4,119	mg/l	
Chloride	mg/Kg	None	44.91	38.48	1,114	265.0	mg/l	
Fluoride	mg/Kg	None	63.27	78.56	1,988	11.3	mg/l	
Soda	mg/Kg	None	9,037	8,803	221,394	2,629	mg/l	
Nitrogen	mg/l	None						
Organic matter	%	None						
Heavy metals	mg/l	None						
Phosphorous	mg/l	None						

Month: March '08

Parameter		IPPC Limits	Waste Class					
			Red Mud	Sand	Salt Cake	Leachate from Red Mud Stack		Sludge from Sanitary Treatment Plant
pH		None	12.4	12.4	>13	12.58		
Dry matter	% w/w	None	59.7	75.6	56.85			
Total alkalinity	mg/Kg $CaCO_3$	None	11,144	18,187	317,271	5,284	mg/l	
Chloride	mg/Kg	None	38.11	55.88	1,425	263.1	mg/l	
Fluoride	mg/Kg	None	56.58	80.23	3,264	16.7	mg/l	
Soda	mg/Kg	None	6,601	9,989	237,230	3,640	mg/l	
Nitrogen	mg/l	None						
Organic matter	%	None						
Heavy metals	mg/l	None						
Phosphorous	mg/l	None						

Month: April '08

Parameter		IPPC Limits	Waste Class					
			Red Mud	Sand	Salt Cake	Leachate from Red Mud Stack		Sludge from Sanitary Treatment Plant
pH		None	12.4	12.7	>13	12.34		
Dry matter	% w/w	None	60.6	78.9	57.07			
Total alkalinity	mg/Kg $CaCO_3$	None	5,370	12,327	293,391	3,972	mg/l	
Chloride	mg/Kg	None	30.76	71.85	1,538	175.7	mg/l	
Fluoride	mg/Kg	None	50.35	94.4	1,726	12.6	mg/l	
Soda	mg/Kg	None	6,681	15,339	230,398	2,979	mg/l	
Nitrogen	mg/l	None						
Organic matter	%	None						
Heavy metals	mg/l	None						
Phosphorous	mg/l	None						

Month: May '08

Parameter		IPPC Limits	Waste Class					
			Red Mud	Sand	Salt Cake	Leachate from Red Mud Stack		Sludge from Sanitary Treatment Plant
pH		N/A	11.9	12.2	>13	12.3		
Dry matter	% w/w	N/A	62.0	79.9	55.72			
Total alkalinity	mg/Kg $CaCO_3$	N/A	8,270	7,741	294,885	5,162	mg/l	
Chloride	mg/Kg	N/A	26.3	19.53	590	147.9	mg/l	
Fluoride	mg/Kg	N/A	36.7	37.8	2,316	15.4	mg/l	
Soda	mg/Kg	N/A	5,111	4,444	226,985	3,888	mg/l	
Nitrogen	mg/l	N/A						
Organic matter	%	N/A						
Heavy metals	mg/l	N/A						
Phosphorous	mg/l	N/A						

Month: June '08

Parameter		IPPC Limits	Waste Class					
			Red Mud	Sand	Salt Cake	Leachate from Red Mud Stack		Sludge from Sanitary Treatment Plant
pH		N/A	12.3	12.5	>13	11.9		
Dry matter	% w/w	N/A	61.7	79.9	57.25			
Total alkalinity	mg/Kg $CaCO_3$	N/A	10,408	16,967	338,814	5,934	mg/l	
Chloride	mg/Kg	N/A	36.39	34.98	1,187	144.6	mg/l	
Fluoride	mg/Kg	N/A	60.43	92.67	8,551	19.6	mg/l	
Soda	mg/Kg	N/A	6,395	9,153	263,365	4,731	mg/l	
Nitrogen	mg/l	N/A						
Organic matter	%	N/A						
Heavy metals	mg/l	N/A						
Phosphorous	mg/l	N/A						

Month: July '08

Parameter		IPPC Limits	Waste Class					
			Red Mud	Sand	Salt Cake	Leachate from Red Mud Stack		Sludge from Sanitary Treatment Plant
pH		N/A	12.3	12.7	>13	11.9		
Dry matter	% w/w	N/A	60.5	84.2	56.53			
Total alkalinity	mg/Kg $CaCO_3$	N/A	10,049	11,482	310,390	3,294	mg/l	
Chloride	mg/Kg	N/A	32.91	18.49	573	215.5	mg/l	
Fluoride	mg/Kg	N/A	64.27	80.65	9,414	13.0	mg/l	
Soda	mg/Kg	N/A	6,243	6,865	246,601	2,406	mg/l	
Nitrogen	mg/l	N/A						
Organic matter	%	N/A						
Heavy metals	mg/l	N/A						
Phosphorous	mg/l	N/A						

Month: August '08

Parameter		IPPC Limits	Waste Class					
			Red Mud	Sand	Salt Cake	Leachate from Red Mud Stack		Sludge from Sanitary Treatment Plant
pH		N/A	12.4	12.7	>13	11.8		
Dry matter	% w/w	N/A	60.6	59.5	55.66			
Total alkalinity	mg/Kg $CaCO_3$	N/A	8,940	16,388	371,702	4,713	mg/l	
Chloride	mg/Kg	N/A	47.75	56.36	2,220	94.5	mg/l	
Fluoride	mg/Kg	N/A	45.81	54.96	9,217	21.0	mg/l	
Soda	mg/Kg	N/A	5,855	10,081	279,829	3,714	mg/l	
Nitrogen	mg/l	N/A						
Organic matter	%	N/A						
Heavy metals	mg/l	N/A						
Phosphorous	mg/l	N/A						

Month: September '08

Parameter		IPCL Limits	Waste Class					
			Red Mud	Sand	Salt Cake	Leachate from Red Mud Stack		Sludge from Sanitary Treatment Plant
pH		N/A	12.3	12.3	>13	11.7		
Dry matter	% w/w	N/A	61.5	79.2	54.56			
Total alkalinity	mg/Kg $CaCO_3$	N/A	7,983	8,426	304,059	3,674	mg/l	
Chloride	mg/Kg	N/A	24.66	6.19	925	162.0	mg/l	
Fluoride	mg/Kg	N/A	46.34	39.66	2,852	21.6	mg/l	
Soda	mg/Kg	N/A	5,097	4,977	224,476	3,768	mg/l	
Nitrogen	mg/l	N/A						
Organic matter	%	N/A						
Heavy metals	mg/l	N/A						
Phosphorous	mg/l	N/A						

Month: October '08

Parameter		IPPC Limits	Waste Class					
			Red Mud	Sand	Salt Cake	Leachate from Red Mud Stack		Sludge from Sanitary Treatment Plant
pH		N/A	12.4	12.4	>13	12.2		
Dry matter	% w/w	N/A	59.8	79.8	56.92			
Total alkalinity	mg/Kg $CaCO_3$	N/A	9,669	11,004	313,752	4,450	mg/l	
Chloride	mg/Kg	N/A	29.51	6.25	103	68.0	mg/l	
Fluoride	mg/Kg	N/A	50.02	58.8	4,146	19.8	mg/l	
Soda	mg/Kg	N/A	6,234	6,588	232,616	3,080	mg/l	
Nitrogen	mg/l	N/A						
Organic matter	%	N/A						
Heavy metals	mg/l	N/A						
Phosphorous	mg/l	N/A						

Month: November '08

Parameter		IPPC Limits	Waste Class					
			Red Mud	Sand	Salt Cake	Leachate from Red Mud Stack		Sludge from Sanitary Treatment Plant
pH		N/A	12.4	12.2	>13	12.1		
Dry matter	% w/w	N/A	58.3	81.2	55.42			
Total alkalinity	mg/Kg $CaCO_3$	N/A	8,739	6,922	299,601	4,526	mg/l	
Chloride	mg/Kg	N/A	22.3	7	149	54.4	mg/l	
Fluoride	mg/Kg	N/A	40.9	62.1	2,732	15.4	mg/l	
Soda	mg/Kg	N/A	5,739	4,137	219,907	3,141	mg/l	
Nitrogen	mg/l	N/A						
Organic matter	%	N/A						
Heavy metals	mg/l	N/A						
Phosphorous	mg/l	N/A						

Month: December '08

Parameter		IPPC Limits	Waste Class					
			Red Mud	Sand	Salt Cake	Leachate from Red Mud Stack		Sludge from Sanitary Treatment Plant
pH		N/A	12.2	11.9	>13	12.4		
Dry matter	% w/w	N/A	59.0	80.0	55.33			
Total alkalinity	mg/Kg $CaCO_3$	N/A	7,157	3,534	300,277	1,992	mg/l	
Chloride	mg/Kg	N/A	15.9	9.2	1,279	94.5	mg/l	
Fluoride	mg/Kg	N/A	34.1	33.1	1,436	7.9	mg/l	
Soda	mg/Kg	N/A	4,361	1,964	218,830	1,543	mg/l	
Nitrogen	mg/l	N/A						
Organic matter	%	N/A						
Heavy metals	mg/l	N/A						
Phosphorous	mg/l	N/A						

Attachment 4
Environmental Management Programme

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No.	Objective	Targets	Responsibility	Target Date	Plan	Target Date	Status
1	2000-01 Reduce raw water consumption	2000-01-01 Conduct feasibility study to reduce Raw Water Consumption by 20%	AK	Q2 2000	Build pilot plant	Q4 1999	Objective Achieved
					Operate pilot plant	Q1 2000	Objective Achieved
					Prepare feasibility report	Q2 2000	Objective Achieved
					Management decision go /no go	Q3 2000	Deferred for present due to high cost
					Install reuse of treated effluent to Area 02, 31, 34,	Q4 2005	Objective Achieved
					once CHP/Sweeting in place re-visited reduction of potable water usage	Q4 2006	In Progress
					Complete review for the installation of Condensate treatment system	Q4 2006	testing complete with system design
					Installation of Condensate treatment system	Q4 2007	Full project shelved, trial plant operated successfully using a DAF unit
		2002-01-02 Evaluate if Water Treatment Plant regen can be recovered for re-use to displace potable water	EL	Q4 2002	Examine control parameter interaction	Q2 2002	cannot reduce WTP regen
					Develop model	Q3 2002	Use split regen streams in A-34
					Test model in plant	Q4 2002	Project for A-34 in Q4 2002
						Q4 2003	Have split acid and caustic regens in area 14
						Q2 2005	Acid stream direct to buffer tank of 35 m clarifier - Completed
						Q4 2006	Use Effluent in Bauxite scrubbers
						Q1 2007	Use Effluent in flush on Area 38 to plant line
2	2000-02 Improve Energy Efficiency	2000-02-01 Conduct feasibility study into Gas Fired Cogeneration at AAL (per IPCL Condition 5.9)	GH	Q4 2000	Examine environmental impacts	Q4 1999	Complete - very positive
					Secured contract from CER	Q4 2003	Successful bid
					Build 150 MW CHP Plant	Q4 2005	Objective Achieved
		2000-02-02 Reduce digester steam usage by 2% i.e. to 149 kg/ton boiler oil	BT	Q4 2002	Rationalise steam export	Q4 2000	P046190 - new LP steam line installed
					Commission Slurry heater (to reduce waste steam)	Q1 2000	P030410 - IBS heater - not operational??
					Reduce shell side fouling	Q4 2000	P651530 - oxalate removal capacity increased
						Q4 2001	P046130 - FT1/3/4 bottom entry installed
					Increase liquor productivity	Q4 2001	P046220 - caustic header up to FT5 complete
		2004-02-03 Implement Digester Sweeting to reduce Digester energy demand to 142 kg/ton	KS	Q4 2006		Q4 2003	Test Sweeting and successful
						Q4 2006	Full Sweeting system in place. Objective Achieved
		Reduce digestion energy to 6.1 GJ	BT	Q4 2008	Implement Max HT in digestion	Q4 2008	System in place - ongoing monitoring

No.	Objective	Targets	Responsibility	Target Date	Plan	Target Date	Status
3	2000-03 Improve quality of effluent to River Shannon	2000-03-01 Achieve less than 50 mg/l suspended solids	Pac	Q4 1999	Install new 35 m clarifier	Q2 2000	P341540 - commissioned - odour/septic problems
		(Complete)	PMcM			Q3 2003	Odour Problems eliminated
					Install permanent bioreactor	Q2 2005	Objective Achieved
					improve pumping capacity to 35 m clarifier	Q4 2007	New pumping system from Perimeter Channel
		2000-03-02 Determine required flow limit (current IPC limit 900 m3/hr)	PMcM	Q1 2000	Examine winter pumping loads	Q1 2000	Local 2 water balance investigation
					Determine max pumping requirement	Q1 2000	~900 m3/hr required (vs 720 permitted)
						Q4 2003	revised IPCL issued 900 m3/hr and 2360 Kg BOD/gay
						Q3 2005	investigated capacities of both A34 Clarifiers - Completed 20 metre 450 m3/hr and 35 m 900 m3/hr
							Objective Achieved
		2001-03-03 Improve Sanitary Effluent	*MOD*	*Q2 2003*	*Prepare PID & cost estimate*	*Q2 2002*	*Objective Achieved*
					Install balancing tank and associated facilities to facilitate peak loads	*Q3 2004*	*Objective Achieved*
					installation of permanent bio-reactor	*Q2 2005*	*completed*
		2004-03-04 Reduce industrial effluent BOD	*TM*	*Q4 2006*	*Explain origins of BOD*	*Q2 2004*	*completed*
					investigate feasibility of reducing BOD	Q4 2004	completed
					Evaluate a pilot plant feasibility	Q2 2005	completed
					Evaluate a full scale plant feasibility	Q4 2005	completed
						Q4 2006	In progress 2 bio-reactors with organic reducing bacterial on trial for Q2 complete study by Q4
					Implement Solution	Q4 2007	Working in progress adding new bacterial species to reduce organics limited by micro-nutrients (proposal submitted currently under review)
						Q4 2008	achieve better than 30% reduction currently being achieved
						2009	Continue to achieve BOD discharge levels at <1500kg/day

No.	Objective	Targets	Responsibility	Target Date	Plan	Target Date	Status
4	2000-04 Protect Ground Water against soda contamination	2000-04-01 Implement recommendations from Dames & Moore Groundwater study - 1999	TM	Q4 2004	Repeat baseline study of estuary	Q4 2005	not completed
		2000-04-02 Test integrity of all process sumps & drains	TM	ongoing	Establish 3 year rolling schedule in Asset Care sys	Q4 2004	sumps on a 3 year programme, cycle end in 03 with > 95% compliance.
				ongoing	Implement at Local level		On local scheduled maintenance plans
						Q4 2004	drain programme to upgrade & line drains now being prepared
					Dye-test East and West Ponds	Q2 2003	East pond not leaking
						Q3 2003	West pond not leaking
					Area 05	Q4 2003	A-05 steel plated 50%
					Area 05	Q4 2004	A-05 steel plated 100%
					Area 27	Q4 2004	review if steel plating required
					Area 14	Q4 2004	Drain repaired & steel plated
					Area 38	Q3 2003	Area 38 steel plated 30%
					Area 38	Q3 2004	Area 38 steel plated 100%
					Area 39	Q1 2005	Complete investigation of A38 & A05
						Q1 2005	Area 65 sump replacement
						Q3 2005	Deep abstraction well installed at TT4 & POW1
					Area 28	Q1 2006	steel plating in pump stations in A28
					Area 28	Q2 2006	steel plating of drain from A14 to A28
					Area 06	Q3 2007	Repair cracks and wear in concrete
					Interstage A	Q1 2008	steel plating
					Interstage B	Q4 2008	steel plating
					Blow off & PRT Area	Q3 2008	Steel plating
					Area 07	2009	
		2000-04-03 Improve Integrity of Concrete Process Pads	PG	ongoing		ongoing	Contractor team on small repair programme
						Q2 2004	Using URS & BMA to identify problem areas via groundwater resistivity testing
		Integrity testing programme	EB	ongoing	Programme ongoing	Q2 2006	Planned
						Q1 2008	Programme progressing as per plan
						Q2 2008	Programme progressing as per plan
						Q3 2008	Programme progressing as per plan
						Q4 2008	Programme progressing as per plan
						2009	As per 3 year schedule
		2000-04-04 Increase size of process slabs where required	PG	Ongoing	Visual Survey of all Concrete bunds	Q4 2004	Ongoing
						Q3 2004	On Track
					Review adequacy each year	Q3 2003	Complete
					Expand Area 06	Q2 2004	Complete
					Expand Area 03 Pad	Q4 2003	Completed
					Expand A-08 Pad	2005	Completed
					Expand A-34 bund for process waste skips	2006	Completed

No.	Objective	Targets	Responsibility	Target Date	Plan	Target Date	Status
		2000-04-05 Assess the Integrity of certifiable Bunding Structures	TH	ongoing		Q2 2008	All raw material bunds tested except A-23 HFO tanks. Will submit a proposal re: Area 23 in 2008
						2008	Proposal on A23 completed
					On 3 year cycle	2009	Q2 2009 Repairs to A23 bund
		2000-04-07 Ensure that underground tanks are not leaking (per IPCL condition 9.3.5)	TM	Ongoing	Decommission two diesel tanks	Q4 2004	Emptied underground white diesel tank for temporary above ground tank
						Q2 2005	Replace White & green diesel tank with above ground tanks
						Q2 2008	develop proposal on Petrol tank decom
4 (cont)	2000-04 Protect Ground Water against soda contamination	2000-04-08 Test & inspect the underground foul/sewer pipes	EB	ongoing	Examine 50% of system by camera	Q2 3006	Complete survey of all sewers and underground pipes and repair all defects
			EB	Q4 2006	100 examination completed	Q4 2006	survey showed repairs required
						Q3 2007	repairs to follow inspection
						Q1 2008	Repair of sewer system
						Q2 2008	Repairs completed
		2000-04-09 Remediate leak from SWP using abstraction Wells	TH	Q4 2006	Eliminate Leak at OW1 / OW2	Q4 2004	submit proposal to agency
						Q4 2006	complete solution
						Q8 2008	complete recovery of groundwater at OW 1 &2
		2006-04-09 Extra groundwater recovery wells	TM	Q2 2006	Well at West Pond, East Pond and Area 48/50	Q4 2007	Planned
			TH	Q4 2008	Golders reviewing all Groundwater data and best way forward for groundwater protection programme	Q4 2008	implement revised groundwater protection programme
		2002-05-03 Develop an automatic system to control NOx	*MF*	*Q4 2003*	*Develop combustion control model*	*Q3 2003*	New low Nox burner tips in place
		and Opacity on the boilers				*Q4 2003*	Automatic excess O2 control with CO feedback trim for opacity & Nox control completed
			MO'D	*Q3 2006*	*Develop proposal for NOx reduction to 450 mg/m3*	*Q3 2006*	In progress
			AG	*Q4 2007*	*Implement Nox reduction programme*	*Q2 2008*	In progress
					Implement Nox reduction programme	*2009*	Programme to be expanded
		2002-05-04 Prevent mud Stack dusting	*D.McE*	*Q4 2002*	*Install sprinkler network*	*Q4 2003*	completed
				Q4 2004	*Install new pump and controls*	*Q1 2005*	Completed
5	2000-05 Improve air quality						
		2005-05-05 Commission CHP	*JR*	*Q2 2005*	*Implementation & evaluation*	*Q2 2006*	In Progress
		2005-05-06 Implement Modifications to Calciner	*TO'B*	*Q2 2005*	*Calciner 3 - reduce particulates emissions*	*Q2 2005*	Complete
			TO'B	*Q2 2006*	*Calciner 2 - reduce particulates emissions*	*Q2 2006*	Planned
			TO'B	*Q3 2006*	*humidity control on ESP for dust control*	*Q" 2006*	Planned
		2006-05-07 Inner Berth Loader - spillage reduction	*JH*	*Q3 2006*	*Improve dust collection system*	*Q3 2006*	Planned
		2006-05-07 Agreement on proposed NERP	*LF*	*Q3 2006*	*Need agreement on NERP from DOE & EU*	*Q2 2006*	In progress

No.	Objective	Targets	Responsibility	Target Date	Plan	Target Date	Status
6	2000-06 Improve Stack and Ambient Air monitoring	2000-06-01 Install a Continuous Monitoring System for Calciner particulates (per IPCL condition 5.5, schedule 1(iii))	JB	Q2 2000	Identify a suitable instrument	Q4 1999	P103640 Erwin Sick reflected light (£20K)
			RO'N	Q4 2003	Implement on 3 Calciners	Q4 2003	Completed
		2000-06-04 Install Ambient Air Monitoring for SOx (Q2/2000) (per IPCL condition 10.11)	SC	Q4 2002	Agree locations with EPA	Q3 1999	Foynes & Askeaton
					Install unit near Foynes	Q1 2000	P976101- complete for Foynes unit Q2 2001
				Q4 2004	Install second unit	Q1 2006	2nd unit installed at Ballysteen
				Q2 2007	Install 5 Orisis Monitors	Q2 2007	At location agreed with EPA (AWN report)
		2000-06-05 Install permanent sampling access platforms for Calciners	MR	Q4 2005	Define best location for isokinetic sampling	Q4 2005	Completed
				Q2 2007	Install sampling enclosure for Calciner 1	Q2 2007	in progress
		2000-06-06 Conduct routine monitoring of Fugitive Emissions to Air	MR	ongoing	Per schedule	Q4 2005	Ongoing
			TM	Q4 2004	New Dust Gauges & Locations	Q4 2004	complete
		2004-06-07 Conduct on-site monitoring of particulates	TM	Q2 2004	Conduct on-site investigation	Q4 2004	Completed
					Submit a proposal to the Agency for ongoing monitoring	Q2 2005	In AER 2005
7	2000-07 Monitor Noise Emissions from AAL operations	2000-07-01 Carry out Annual Noise Surveys (per IPCL condition 8.2)	TM	ongoing	Use specialist contractor	Q2 2000	Completed in April - no problems
				Yearly	Report survey via AER	Q2 2001	No problems
						Q2 2002	No problems
						Q3 2003	No problems
						Q3 2004	No problems
						Q3 2005	No problems
						Q3 2006	No problems
						Q3 2007	No problems
						Q2 2008	No problems
					Ensure that Noise levels during Phase 2 BRDA construction is within IPPC license limits	Q3 & 4 2008	Objective achieved
						Q2 2009	2009 survey planned

No.	Objective	Targets	Responsibility	Target Date	Plan	Target Date	Status
8	2000-08 Reduce waste disposal to landfill, operate the on-site landfill to best practice	2000-08-01 Investigate Options for Waste Recycling & Minimisation (per IPCL condition 2.1)	LF	Q4 2001	Monitor Alcan investigation into red mud	Q4 2004	AAL participating with Aluminium Industry in options for red mud utilisation
			TH	Q1 2005	Revised Landfill Conditioning Plan	Q3 2005	Objective achieved
		2000-08-02 Investigate properties of red mud	LF	ongoing	develop database of reference material	ongoing	Part of Closure plan work
			LF/MF	2009	Develop knowledge on Neutralisation of Red Mud	2009	Programme of work underway with University of Limerick
			EL/TH	2009	Develop system to neutralise Red Mud	Q4 2008	Pilot plant to assessment to try neutralisation
						Q4 2009	implement full scale plant
		2002-08-03 Install dust control system	*TH*	ongoing	Develop long-term plan	*Q3 2004*	*New Organisation structure in place to manage stack operations*
					Implement extensive sprinkler network	*Q3 2003*	*Objective achieved*
					Improve water supply to sprinklers	Q3 2003	Objective achieved
		2006-08-04 Demonstrate closure plan & model it	MMcG	ongoing	Review all available reports	Q2 2006	Planned
			MMcG	Q2 2006	Visit Bumtisland in Scotland	Q3 2006	completed
			TH/TM	Q2 2006	Planning Permission for BRDA extension	Q2 2006	planning received by TH- appealed to ABP
			EL/TH	2011	Implementation of recommendations of Golders Associates Report	2009	Risk reduction assessment to be completed
			LF/RC	2012	Revegetation of BRDA as per Residual Solutions Report	2009	Grassing of trial cell to be completed
9	2000-09 Improve Visual Appearance of AAL	2000-09-02 Improve Plant Visual Appearance	BMcG	ongoing	Develop a 5 year landscaping plan	Q4 2006	ongoing - greening of plant underway and landscaping design from BSM.
			TM	*Q4 2003*	*Choke vents & route to BO pots*	*Q4 2003*	*1st phase in 2002*
		2002-09-03 Reduce digestion plume		Q4 2006	Implement Sweeting	Q4 2006	Objective achieved
				Q4 2008	Implement HT Max	Q4 2008	In progress
						2009	Project continuing
10	2000-10 Establish Effective Emergency preparedness	2000-10-01 Maintain High Level of Emergency Preparedness	JJ	Ongoing	Revisit Emergency Standard	Q2 2000	Complete
					Modify procedures to ISO14001 standard	Q2 2000	Procedures in electronic format & up-to-date
					Conduct Local exercises yearly	Q2 2006	Planned
					Revise Emergency Response plan	Q2 2008	Planned
		2000-10-02 Prepare an 'Emergency response trailer for spillages'	ED	Q2 2002	Equip for oil spillage rapid response	Q3 2003	Plant unit in place - jetty in 2003. New supplies will be added as required
					Ongoing test use of procedures & equipment	Q4 2004	completed
			TM	Q1 2007	Completed Emergency response area with necessary markings and equipment	Q1 2007	underway
			EB	Q3 2008	Conduct emergency response exercises	Q3 2008	Planned in 3 locals
						Q4 2008	3 exercises completed

No.	Objective	Targets	Responsibility	Target Date	Plan	Target Date	Status
11	2000-11 Establish an EMS (per IPCL condition 2.1)	2000-11-03 Improve maintenance management	LF	Q3 2001	Review 'Environmental instruments & equipment' per local	Annually	Completed by G.O'F
					Define required reports	Q1 2001	Completed
					Modify system to install all environmental instruments in Asset care	Q3 2004	Completed
				Q1 2007	Review all ISO Environmental Instruments to ensure calibration frequency correct	Q1 2007	Completed
				Q1 2008	Review all ISO Environmental Instruments to ensure calibration frequency correct	Q1 2008	underway
		2000-11-05 Bird Sanctuary & Related lands Management Plan	NK	Q1 2001	Develop Bird Sanctuary Plan	Q4 2000	1st pass complete
						Q3 2006	review plan
			LF	ongoing	Demonstrate that		
		2000-12-01 Update Site Closure Plan technically & financially (per IPCL condition 13.2.1)			- mud stack dusting stops within 5 years	Q4 2000	Consultant commissioned (Enviroplan)
					- stack run-off pH < 9.0 within 5 years	Q4 2000	Consultant's 1st report received
						Q1 2005	closure plan currently under revision
						Q2 2006	trial area to be constructed, filled with red and restoration started
						Q3 2006	review work to date and report to the agency
						Q2 2007	As part of the BRDA phase 2 - complete review of all closure techniques underway
						Q4 2007	Completion of Mick McGrath PhD on determine leachate and pH quality from the BRDA
		2000- 12-02 Update the Liabilities Risk Assessment technically & financially (per IPCL 14.3.1)	LF	ongoing	Status letter to the EPA	Q4 2000	Complete - to be repeated annually
		2000-12-03 Prepare landfill status report	TH	ongoing	Use the standard report template	yearly	Planned for Q4 (for AER)
		2006-12-04 Department Re-organisation	TM	on-going	Devolvement of filing system for envn documentation	Q2 2006	In progress
			TM	Q2 2007	re-organising department	Q2 2006	Completed
					Training for environmental Technologists (Post Graduate Diploma, MCerts, Auditing)	Ongoing	In progress
12	2000-12 Conduct AER driven reviews	2000-13-01 Implement Environmental Training Plans for AAL Employees and Contractors (per IPCL condition 2.7)	TM	Q4 2000	Prepare & deliver IPCL awareness module	Q1 2000	Complete
					Prepare & deliver ISO14001 module	Q2 2000	Complete
					Update Environmental part of AAL contracts	Q2 2000	Environmental regulations issued to Contractors
							Environmental regs also included in H&S plans
							Contractor hand-book being updated
					Prepare/deliver module on groundwater	Q1 2002	Delivered in Q1 2002
				Q2 2004	Present AER as a Monthly meeting	Q2 2004	Objective achieved
				Q3 2005	Present AER & two other topics	Q2 2005	Objective achieved
				Q3 2006	Present AER & two other topics	Q3 2006	Objective achieved
				Q1 2007	Present AER & two other topics	Q3 2006	Objective achieved
				Q1 2007	Presentation to facilitators and coordinators	Q1 2007	Objective achieved
				Q2 2008	Presentation to facilitators and coordinators	Q2 2008	Objective achieved
				Q2 2009	Presentation to facilitators and coordinators	Q2 2009	Planned

No.	Objective	Targets	Responsibility	Target Date	Plan	Target Date	Status
13	2000-13 Increase Environmental Awareness Within AAL	2000-13-02 Train new Alliance Contract facilitators	POL	Q3 2003	Deliver general training module	Q3 2002	Complete
					Prepare objectives	Q4 2002	Complete
					Develop EMS for Alliance	Q3 2003	Complete
14	2000-14 Maintain Public Communications Programme	2000-14-01 Extend the use of the Visitor Centre and the Nature trails (per IPCL condition 2.9.1)	PL	ongoing	Develop www page	Q4 2004	Complete
					Conduct yearly Community meetings	yearly	Dec-07
		Management of the Nature Trials	NK	Ongoing	Conduct weekly inspection of the Nature Trials and surrounding lands	Weekly	ongoing
			NK	Ongoing	Look for areas of improvement on the nature trials	Q4 2007	ongoing
15	2003-1 5 Add caustic to the PER for the Plant	2003-15-1 Develop a caustic mass balance for inclusion in the AER	LF	Q4 2004	Conduct regular monitoring on all ambient emission to determine NaOH emission to air	Q4 2003	1st pass completed on 19 emission points
						Q3 2004	2nd pass to be completed
						Q4 2004	Mass balance to be closed
						Q4 2005	odour & Sodium models completed
						Q2 2007	implement changes to ambient air sampling programme as agreed after review completed
			TM	Q3 2008	Install new Osiris Monitors	Q3 2008	Equipment spec ready, RFA to be raised
		2003-15-2 develop a ambient NaOH monitoring capacity	TM	Q4 2005	Submit feasibility study to Agency	Q4 2004	Planned
					Implement recommendation after agreement with the agency	Q1 2005	Partisol monitors on-site to be rolled out t by end of Q1
						Q1 2006	complete review of 2005 data for AER 2005
						Q1 2007	complete review of 2006 data for AER 2006
						Q1 2008	complete review of 2007 data for AER 2007
						Q1 2009	complete review of 2008 data for AER 2008
16	Reduction in CO2 emissions from site		LF/EB/TM	Ongoing	Continue to reduce the quantity of CO2 produced per tonne product	2009	Assess the feasibility of reducing boiler usage
17	Fugitive Emissions Programme	Reduce amount of fugitive emissions from site	TM	Ongoing		2009	Survey of fugitive emissions to be carried out & plan submitted to EPA
18	Review of sampling & analysis methods		TM	2009		Q2 2009	Review of all sampling and analysis methods to be completed
						Q4 2009	Assess compliance of methods to EPA guidelines

Attachment 5
Caustic Mass Balance Methodology

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CAUSTIC LOSS CALCULATIONS

REVISION HISTORY

REVISION NO	REVISED BY	DATE	DETAILS
1	JOE VAUGHAN	23/02/08	1. NET EFFLUENT CALCULATION CHANGED TO INCLUDE ADDITIONAL 14" STORM WATER RETURN FROM THE PERIMETER CHANNEL, WHICH HAS ITS OWN SODA ANALYSIS. 2. ALSO THE 8" RETURN LINE FLOW IN RECOVERY NOW USES (34FT0071 - 65FT0470) IN PLACE OF (34FT0071) DUE TO THE FACT THAT MOST OF THIS FLOW REPORTS BACK TO THE SOUTH POND VIA THE SPIRAL HEAT EXCHANGER IN A65. 3. BIRD SANCTUARY HAS BEEN REMOVED FROM THE RECOVERY CALCULATION AS IT HAS NOT ASSUMED TO BE LOST AND SO CANNOT BE ASSUMED TO BE RECOVERED.

CAUSTIC LOSS CALCULATIONS

Controllable Losses

SALTCAKE LOSSES (KG/T)

- Saltcake (kg/t)

$$\left[\frac{(Oxalate + Carbonate + Caustic + Sulphate + Organic\ Carbon) * 1000}{\text{Production}}\right]$$

- Dry saltcake production (tonnes)

Dry oxalate production: 65HB9678.PE monthly total *(tonnes)*
Saltcake % oxalate: 65HU9013.LI avg monthly composite *(%)*

$$\left[\frac{\text{Dry oxalate production} * 100}{\text{Oxalate \% in saltcake}}\right]$$

- Oxalate (tonnes)

Saltcake % oxalate: 65HU9013.LI monthly composite *(%)*

$$\left[\text{Dry saltcake production} * \left[\frac{\text{\% Oxalate in saltcake}}{100}\right] * \frac{80}{134}\right]$$

- Carbonate (tonnes)

Saltcake % carbonate: 65HU9014.LI monthly composite *(%)*

$$\left[\text{Dry saltcake production} * \left[\frac{\text{\% Carbonate in saltcake}}{100}\right] * \frac{80}{106}\right]$$

- Caustic (tonnes)

Saltcake % caustic: 65HU9011.LI monthly composite *(%)*

$$\left[\text{Dry saltcake production} * \left[\frac{\text{\% Caustic in saltcake}}{100}\right] * \frac{80}{106}\right]$$

- Sulphate (tonnes)

Saltcake % sulphate: 65HU9015.LI monthly composite *(%)*

$$\left[\text{Dry saltcake production} * \left[\frac{\text{\% Sulphate in saltcake}}{100}\right] * \frac{80}{142}\right]$$

- Organic Carbon (tonnes)

Saltcake % o. carbon: 65HU9016.LI monthly composite *(%)*

$$\left(\text{Dry saltcake production} * \left(\frac{\text{\% O. carbon in saltcake}}{100}\right) * \frac{120}{126}\right)$$

NET EFFLUENT LOSSES (KG/T)

- $$\left(\left(\frac{\text{total monthly eff} * \text{avg eff} * 80}{\text{soda} \quad 62} \right) - \left(\frac{\text{monthly} * \text{soda} * 80}{\text{SWP ret} \quad 62} \right) - \left(\frac{\text{monthly} * \text{soda} * 80}{\text{PIC ret} \quad 62} \right) \right) \Big/ \text{Monthly hydrate production}$$

Total Monthly Effluent (m^3)

Daily total effluent: 54FQ0032.DT *(m^3/d)*

Total monthly effluent: $\frac{\Sigma \text{ 1months (54FQ0032.DT)}}{\text{\# entries/month}} * \text{\#days/month}$ *(m^3)*

Combined Weighted Average Monthly Effluent Soda - avg eff soda (gpl)

'A' daily composite soda: 54HU9010.LI *(gpl)*

'A' daily avg flow: 54FT0032.PV *(m^3/hr)*

'B' daily composite soda: 54HU9000.LI *(gpl)*

'B' daily avg flow: 54FT0014.PV *(m^3/hr)*

Combined daily avg flow: 54FB0014.DA *(m^3/hr)*

Combined daily avg soda: $\left(\frac{(54HU9010.LI*54FT0032.PV)+(54HU9000.LI*54FT0014.PV)}{54FB0014.DA} \right)$

Monthly avg eff soda: $\left(\frac{\Sigma \text{ 1months(Combined daily avg soda*54FQ0032.DT)}}{\Sigma \text{ 1months(54FQ0032.DT)}} \right)$ (gpl)

Monthly SWP Return (m^3)

SWP return flow: 34FC0330.PV *(m^3/hr)*

Hourly avg SWP return: Hourly avg of (34FC0330.PV) *(m^3/hr)*

Monthly SWP return: Hourly avg SWP return * 24 * #days/month *(m^3)*

Monthly SWP Average Soda – soda (gpl)

Monthly SWP soda: Calculate monthly avg using 1 grab sample/week

Monthly PIC Return (m^3)

PIC return flow: 34FT0632.PV *(m^3/hr)*

Hourly avg PIC return: Hourly avg of (34FT0632.PV) *(m^3/hr)*

Monthly PIC return: Hourly avg PIC return * 24 * #days/month *(m^3)*

Monthly SWP Average Soda – soda (gpl)

Monthly PIC soda: Calculate monthly avg using 1 grab sample/week

The effluent flow to the Shannon, lines 'A' & 'B', are sampled in parallel using isolok samplers and individually analysed daily. The effluent flow is continuously monitored enabling the calculation of a weighted average soda loss.

The SWP return is made up from leachate from the mud stack and excess west pond effluent, losses individually accounted for. An 8" line supplies storm water return to A34 for recycle while a 10" line leads to the 35m clarifier for effluent treatment. An additional 14" line also leads directly to the 35m clarifier from the Perimeter Interceptor Channel. The 10" and 14" line flows are therefore subtracted from the total effluent to determine net effluent, to avoid double accounting.

The SWP return is sampled manually on a weekly basis for soda content from a location beside the WP inlet to the SWP. Therefore, soda errors due to sampling method and location

are possible. The installation and daily operation of an isolok sampler on the 10" and 14" line for soda analysis would eliminate this error. This would also reduce the reported variation in SWP caustic, 2.8 – 9.8 gpl. A 1gpl variation in SWP caustic may result in a variation up to ± 1kg/t in the Net effluent figure.

RECOVERY (KG/T)

- $$\left(\frac{\text{-net SWP return} * \text{avg SWP soda} * \frac{80}{62}}{\text{Monthly hydrate production}} \right)$$

Net SWP 8" return to A34: (34FT0071.PV – 65FT0470.PV) *(m^3/hr)*
Note this flow can't be less than 0

Monthly avg SWP return: $\left(\frac{\Sigma \text{ 1months (34FT0071.PV– 65FT0470.PV)}}{\text{\# entries/month}} \right)$ *(m^3/hr)*

Total SWP return: Monthly avg SWP return * 24 * # days/month *(m^3)*

Avg SWP soda: M. Ryan monthly figure from 1 grab sample/week *(gpl)*

Storm water pond recovery, 8" line, is pumped to A34 where it is directed to the PWT or CCMT for re-use, but primarily to the PWT. However a large proportion of the pond water flow leaving the PWT is sent to the spiral heat exchanger in A65 which ends up back in the SP and so has already been accounted for. The weekly SWP grab sample taken from beside the WP inlet to the SWP is applied in this calculation also. A 1gpl variation in SWP caustic may result in a variation up to ± 0.35 kg/t in the Recovery figure.

PRODUCT LOSSES (KG/T)

- Total Monthly Soda Losses

$$\left(\frac{\left[\text{Monthly alumina calcined} * \text{total soda monthly avg} * \frac{80}{62} \right] * 1000}{\text{Monthly hydrate production}} \right)$$

Alumina calcined monthly: C.Brassill monthly inventory figure *(tonnes)*
Total soda daily value: 10HU9207.LI *(%)*
Total soda monthly avg: $\left[\frac{\Sigma \text{ 1months (10HU9207.LI)}}{\text{\# entries/month}} \right]$ *(%)*

The 10HU9207.LI sample result is based upon the 10-1,2,3 composite sample, which is the daily composite of the 10-1, 10-2, 10-3 samples taken 4 times per day. Therefore, this is a very accurate figure.
The "Total Monthly Product Soda Losses" figure is now represented as the following separate items.

- Residual Soda Losses

$$\left(\frac{\left[\text{Monthly alumina calcined} * \text{monthly avg residual soda} * \frac{80}{62} \right] * 1000}{\text{Monthly hydrate production}} \right)$$

Alumina calcined monthly: C.Brassill monthly inventory figure *(tonnes)*
07-18 daily residual soda: 07HU9199.LI *(%)*
07-19 daily residual soda: 07HU9428.LI *(%)*
Residual soda monthly avg: $\left[\frac{\Sigma \text{ 1months (07HU9199.LI + 07HU9428.LI)}}{\text{\# entries/month} * 2} \right]$ *(%)*

The residual soda figure is based upon a daily sample taken from the u/f of a primary classifier. The sample is washed with de-ionised water and calcined in the laboratory to measure soda using the XRD.

- Leachable Soda Losses

$$\left(\frac{\left[\text{Monthly alumina calcined} * \text{leachable soda monthly avg} * \frac{80}{62} \right] * 1000}{\text{Monthly hydrate production}} \right)$$

Alumina calcined monthly: C.Brassill monthly inventory figure *(tonnes)*
Leachable soda monthly avg: $\left[\frac{\Sigma \text{ 1months((10HU9207.LI – daily avg (07-18 + 07-19))}}{\text{\# entries/month}} \right]$ *(%)*

MUD LIQUOR LOSSES (KG/T)

- $\left(\text{Mud factor} * \left(\frac{1 - \text{monthly avg \% solids}}{\text{monthly avg \% solids}} \right) * \text{monthly avg soda in mud} * \left(\frac{80}{62} \right) \right)$

*Daily comp % solids: 34HU9011.LI *(%)*
Monthly avg % solids: $\left(\frac{\Sigma \text{ 1months (34HU9011.LI)}}{\text{\# entries/month}} \right)$

*Daily comp Na_2O in mud: 34HU9010.LI *(gpl)*
Monthly avg soda in mud: $\left(\frac{\Sigma \text{ 1months (34HU9010.LI)}}{\text{\# entries/month}} \right)$

- Composite sample is a daily composite of A, B, C & D daily samples taken at 21:00.

The composite sample mentioned above is sampled daily from the suction of each of the on-line mud pumps. The % solids figure is relatively constant but the mud liquor gpl soda is more variable. This observation may be the result of the grab sample technique employed and the daily variation in A34 filter washes.

SAND LOSSES (KG/T)

The Caustic losses for Sand should include:

1. Chemical Losses

   A: Total Dry Sand Production
   B: Total Wet Sand Production
   C: Wet Sand Moisture %
   D: % Na_2O in Sand
   E: Dry Sand Moisture %

   ((((A – (A*E)) + (B-(B*C))) * D /1000) * 80 /62) / (Monthly Hydrate Production)

2. Washed Sand Leachable

   (((A-(A*E)*D/1000) * 80/62) / Monthly Hydrate Production

3. Unwashed Sand Leachable

   (((B-(B*C)*D/1000) * 80/62) / Monthly Hydrate Production

HYDRATE SHIPMENT LOSSES (KG/T)

- $$\left(\frac{\left[\text{Hydrate monthly sales} * 1.53 * \text{Hydrate \% caustic monthly avg} * \frac{80}{62} \right]}{\text{Monthly hydrate production}} * 1000 \right)$$

Hydrate monthly sales: Z:\Catherine\Quality\HydShip.xls *(tonnes as Al_2O_3)*
Hydrate % caustic avg: Z:\Catherine\Quality\HydShip.xls (%)

TURNAROUND LOSSES (KG/T)

- $$\left(\frac{\text{Process Tonnage Lost} * 1000}{\text{Monthly hydrate production}} \right)$$

Process tonnage lost: C. Brassill monthly figure *(tonnes)*

WEST POND LOSSES (KG/T)

- $$\left(\frac{\text{Monthly average soda loss} * 24 * \#\ \text{days/month} * \frac{80}{62}}{\text{Monthly hydrate production}} \right)$$

Daily avg flow to SWP: 54FT0041.DA *(m^3/hr)*
Weekday grab-sample soda: 97HU9010.LI *(gpl)*
Synchronised daily soda: 97HU9010.LI sync. daily soda to daily avg flow
Monthly avg soda loss: $\left(\frac{\Sigma\ 1\text{months (54FT0041.DA} * \text{sync. daily soda)}}{\#\ \text{days / months}} \right)$ *(kg/hr)*

The west pond loss results from the excess pond water being pumped to the SWP to prevent any overflow. The grab-sample for soda analysis is taken irregularly and therefore requires synchronization with the daily average flows reported by the on-line flowmeter. PI data-link achieved this synchronization and enables a monthly average calculation. Process dumps from A65 etc. may result in the grab sample not being truly representative, but occur in-frequently of recent. However, the monthly average soda figure should be acceptable.

SPILLAGE LOSSES (KG/T)

- $$\left(\frac{\text{Total monthly spillage} * \%\ \text{caustic} * \frac{80}{106} * 1000}{\text{Monthly hydrate production}} \right)$$

Total monthly spillage: C. Brassill figure *(m^3)*
% Caustic: C. Brassill figure *(%)*

Uncontrollable Losses

DESILICATION LOSS (KG/T)

Bauxite Factor * Residue Factor * % Na_2O in Mud * 10 * 80/62

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Attachment 6
Noise Survey Report

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2008 ANNUAL IPPC LICENCE NOISE SURVEY FOR AUGHINISH ALUMINA LIMITED, ASKEATON, CO. LIMERICK

Technical Report Prepared For

Environmental Department
Aughinish Alumina Limited
Aughinish Island
Askeaton
Co Limerick

Technical Report Prepared By

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Our Reference

LS/08/4334NR01

Date Of Issue

18 June 2008

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EXECUTIVE SUMMARY

AWN Consulting has been commissioned to measure environmental noise levels in order to establish the noise climate at a number of boundary and noise sensitive locations in the vicinity of the Aughinish Alumina Limited site at Aughinish Island, Co. Limerick. The survey is required to confirm that the site is operating in accordance with the appropriate Integrated Pollution Prevention & Control (IPPC) Licence. This document reviews the survey data and presents it in a form suitable for submittal to the Environmental Protection Agency (EPA) as part of Aughinish Alumina Annual Environmental Report (AER).

Two environmental noise surveys have been carried out, one daytime and one night-time, at the boundary and noise sensitive locations in the vicinity of the site.

The survey data has been analysed and it may be concluded that this facility is in compliance with Condition 4.5 and 6.13 of its IPPC Licence at the five assessment locations.

Report Prepared By:

Louis Smith
Acoustic Consultant

Report Checked By:

MIKE SIMMS
Senior Acoustic Consultant

CONTENTS Page

1.0 INTRODUCTION

It is a requirement of the IPPC Licence held by Aughinish Alumina Limited that environmental noise levels at five noise sensitive locations in the vicinity of the facility are monitored on an annual basis. Condition 8 of the Licence sets out the following requirements in relation to noise:

- Activities on-site shall not give rise to noise levels off site, at noise-sensitive locations, (at specified noise sensitive locations) which exceed the following sound pressure limits ($L_{eq,15min}$) :

  Daytime: 55dB(A)
  Night-time: 45dB(A)

- There shall be no clearly audible tonal or impulsive components at any noise-sensitive locations.

- A noise survey of site operations shall be carried out on an annual basis.

The above noise limits relate to the following criteria:

Daytime (08:00hrs to 22:00hrs): 55dB $L_{Aeq,15min}$
Night-time (22:00hrs to 08:00hrs): 45dB $L_{Aeq,15min}$

AWN Consulting has been commissioned to conduct a noise survey in accordance with the EPA's requirements in order to establish whether or not the facility is operating in compliance with the criteria outlined above.

2.0 SURVEY DETAILS AND MEASURED NOISE LEVELS

An environmental noise survey was conducted in order to quantify the noise environment. The survey was conducted generally in accordance with ISO 1996: 2007: *Acoustics – Description and measurement of environmental noise*. Specific details are set out below.

2.1 Choice of Measurement Locations

Whilst the IPPC Licence criteria relate to noise levels at five noise sensitive locations, noise measurements were also conducted at seven positions on the site boundary. The seven boundary locations (B1 to B7) and the five noise sensitive locations (NSL1 to NSL5) are shown on Figure 1. These locations are described below.

Position B1 is at the north-west corner of the jetty where ships are unloaded.

Position B2 is at the bend in the fencing to the north-east of the cooling towers to the east of the site.

Position B3 is on the north side of the main access road into the site.

Position B4 is on the east side of the main access road into the site, in the vicinity to the cattle grates.

Position B5 is in the north western corner of the site.

Position B6 is to the side of the access road towards to south-west of the main plant area.

Position B7 is in the south western corner of the site.

Position NSL1 is at the dwelling to the east side of Poulawela Creek. The dwelling is disused at present.

Position NSL2 is in the vicinity of a residential dwelling located beyond the south eastern boundary of the site.

Position NSL3 is at the Oorla dwelling to the south of the site.

Position NSL4 is at the eastern end of Foynes Port, to the west-south-west of the site.

Position NSL5 is in the vicinity of a residential dwelling located along the main access road, beyond the southern boundary of the site.

2.2 Survey Periods

Measurements were conducted over the course of two survey periods as follows:

- Daytime 13:07hrs to 17:12hrs on 16 June 2008,
- Night-time 22:26hrs on 16 June 2008 to 02:22hrs on 17 June 2008

During the survey periods noted above, it is understood that the facility was in normal operation.

The weather during the daytime survey was mild (nominally 15 to 17°C) and fresh (wind speeds in the range of 2 to 4ms^{-1}). During the night-time it remained calm (wind speeds in the range 1 to 2ms^{-1}) and the temperature dropped to around 10°C, conditions remained dry throughout both periods.

2.3 Personnel and Instrumentation

Louis Smith (AWN) conducted the noise level measurements during both survey periods.

The measurements were performed using a Brüel & Kjær Type 2260 Modular Precision Sound Analyzer. Before and after the survey the measurement apparatus was check calibrated using a Brüel & Kjær Type 4231 Sound Level Calibrator.

2.4 Procedure

Boundary measurements were conducted on a cyclical basis. Sample periods were 15 minutes during both the daytime and night-time surveys. The results were saved to the instrument memory for later analysis where appropriate. Survey personnel noted all primary noise sources contributing to noise build-up.

2.5 Measurement Parameters

The boundary survey results are presented in terms of the following five parameters:

L_{Aeq} is the equivalent continuous sound level. It is a type of average and is used to describe a fluctuating noise in terms of a single noise level over the sample period.

L_{Amax} is the instantaneous maximum sound level measured during the sample period.

L_{Amin} is the instantaneous minimum sound level measured during the sample period.

L_{A10} is the sound level that is exceeded for 10% of the sample period. It is typically used as a descriptor for traffic noise.

L_{A90} is the sound level that is exceeded for 90% of the sample period. It is typically used as a descriptor for background noise.

The "A" suffix denotes the fact that the sound levels have been "A-weighted" in order to account for the non-linear nature of human hearing.

All sound levels in this report are expressed in terms of decibels (dB) relative to $2x10^{-5}$ Pa.

2.6 Survey Results

2.6.1 Position B1

The results of measurements taken during the surveys conducted at Position B1 are summarised in Table 1.

Time	Period	Measured Noise Levels (dB re. 2x10-5 Pa)				
		L_{Aeq}	L_{Amax}	L_{Amin}	L_{A10}	L_{A90}
15:31 - 15:46	Day	61	79	52	61	54
00:46 - 01:01	Night	57	73	54	58	54

Table 1 Summary of results for Position B1

Emissions from ship loading operations dominated the noise environment at this location during both survey periods. During the day survey period occasional vehicle movements on the jetty and water noise were also noted to contribute to noise build up. Occasional aircraft movements overhead also contributed to the noise climate at this location.

The measured daytime noise level was 61dB L_{Aeq} and 54dB L_{A90}. The measured night-time noise level was 57dB L_{Aeq} and 54dB L_{A90}.

2.6.2 Position B2

The results of measurements taken during the surveys conducted at Position B2 are summarised in Table 2.

Time	Period	Measured Noise Levels (dB re. 2x10-5 Pa)				
		L_{Aeq}	L_{Amax}	L_{Amin}	L_{A10}	L_{A90}
15:52 - 16:07	Day	61	75	56	62	58
01:07 - 01:22	Night	61	67	57	62	59

Table 2 Summary of results for Position B2

Site noise from the Aughinish Alumina Limited facility dominated the noise climate at this location. The primary sources of noise during both periods were Cooling Towers and pumps.

The measured daytime noise level was 61dB L_{Aeq} and 58dB L_{A90}. The measured night-time noise level was 61dB L_{Aeq} and 59dB L_{A90}.

2.6.3 Position B3

The results of measurements taken during the surveys conducted at Position B3 are summarised in Table 3.

Time	Period	Measured Noise Levels (dB re. 2x10-5 Pa)				
		L_{Aeq}	L_{Amax}	L_{Amin}	L_{A10}	L_{A90}
15:07 - 15:22	Day	56	82	40	45	41
00:19 - 00:34	Night	48	76	23	36	24

Table 3 Summary of results for Position B3

Passing vehicles, birdsong and a degree of wind generated noise were the primary noise sources during the day period. The measured night period level was dominated by three passing vehicles. Plant noise was just audible at this location during lulls in other sources.

The measured daytime noise level was 56dB L_{Aeq} and 41dB L_{A90}. The measured night-time noise level was 48dB L_{Aeq} and 24dB L_{A90}.

2.6.4 Position B4

The results of measurements taken during the surveys conducted at Position B4 are summarised in Table 4.

Time	Period	Measured Noise Levels (dB re. 2x10-5 Pa)				
		L_{Aeq}	L_{Amax}	L_{Amin}	L_{A10}	L_{A90}
14:50 - 15:05	Day	57	78	38	54	44
00:02 - 00:17	Night	55	80	26	35	27

Table 4 Summary of results for Position B4

During the daytime the primary noise sources were passing cars on the main access road, birdsong, aircraft passing overhead and a degree of wind generated noise from nearby foliage. During the night-time two vehicles passed the monitoring location with the Aughinish Alumina Limited plant being just audible during lulls other sources.

The measured daytime noise level was 57dB L_{Aeq} and 44dB L_{A90}. The measured night-time noise level was 55dB L_{Aeq} and 27dB L_{A90}.

2.6.5 Position B5

The results of measurements taken during the surveys conducted at Position B5 are summarised in Table 5.

Time	Period	Measured Noise Levels (dB re. 2x10-5 Pa)				
		L_{Aeq}	L_{Amax}	L_{Amin}	L_{A10}	L_{A90}
16:37 - 16:52	Day	43	60	38	46	40
01:50 - 02:05	Night	40	67	31	41	33

Table 5 Summary of results for Position B5

During the daytime and night time, distant plant noise from the Aughinish Alumina Limited facility was audible. Also noted was birdsong and intermittent pump noise.

The measured daytime noise level was 43dB L_{Aeq} and 40dB L_{A90}. The measured night-time noise level was 40dB L_{Aeq} and 33dB L_{A90}.

2.6.6 Position B6

The results of measurements taken during the surveys conducted at Position B6 are summarised in Table 6.

Time	Period	Measured Noise Levels (dB re. 2x10-5 Pa)				
		L_{Aeq}	L_{Amax}	L_{Amin}	L_{A10}	L_{A90}
16:15 - 16:30	Day	51	61	46	52	48
01:28 - 01:43	Night	50	60	46	52	48

Table 6 Summary of results for Position B6

Plant noise associated with activity at the Aughinish Alumina Limited facility dominated the noise climate at this location during both survey periods.

The measured daytime noise level was 51dB L_{Aeq} and 48dB L_{A90}. The measured night-time noise level was 51dB L_{Aeq} and 48dB L_{A90}.

2.6.7 Position B7

The results of measurements taken during the surveys conducted at Position B7 are summarised in Table 7.

Time	Period	Measured Noise Levels (dB re. 2x10-5 Pa)				
		L_{Aeq}	L_{Amax}	L_{Amin}	L_{A10}	L_{A90}
16:57 - 17:12	Day	46	63	33	47	36
02:07 - 02:22	Night	35	63	28	34	29

Table 7 Summary of results for Position B7

Plant noise from the Aughinish Alumina Limited facility was not audible at this location during either period. Sources noted included a degree of wind generated noise and birdsong.

The measured daytime noise level was 46dB L_{Aeq} and 36dB L_{A90}. The measured night-time noise level was 35dB L_{Aeq} and 29dB L_{A90}.

2.6.8 Position NSL1

The results of measurements taken during the surveys conducted at Position NSL1 are summarised in Table 8.

Time	Period	Measured Noise Levels (dB re. 2x10-5 Pa)				
		L_{Aeq}	L_{Amax}	L_{Amin}	L_{A10}	L_{A90}
14:29 - 14:44	Day	50	58	46	51	48
23:42 - 23:57	Night	43	54	36	49	39

Table 8 Summary of results for Position NSL1

The background noise environment at this location was dominated by plant associated with the Aughinish Alumina facility during both survey periods.

The measured daytime noise level was 50dB L_{Aeq} and 48dB L_{A90}. The measured night-time noise level was 43dB L_{Aeq} and 39dB L_{A90}.

2.6.9 Position NSL2

The results of measurements taken during the surveys conducted at Position NSL2 are summarised in Table 9.

Time	Period	Measured Noise Levels (dB re. 2x10-5 Pa)				
		L_{Aeq}	L_{Amax}	L_{Amin}	L_{A10}	L_{A90}
14:11 - 14:26	Day	48	73	38	48	41
23:23 - 23:38	Night	39	54	27	41	31

Table 9 Summary of results for Position NSL2

The primary sources of noise contributing to the noise climate at this location were local and distant road traffic, wind generated noise from the tree tops and birdsong. Plant noise associated with the Aughinish facility was not audible at this location during the measurement periods.

The measured daytime noise level was 48dB L_{Aeq} and 41dB L_{A90}. The measured night-time noise level was 39dB L_{Aeq} and 31dB L_{A90}.

2.6.10 Position NSL3

The results of measurements taken during the surveys conducted at Position NSL3 are summarised in Table 10.

Time	Period	Measured Noise Levels (dB re. 2x10-5 Pa)				
		L_{Aeq}	L_{Amax}	L_{Amin}	L_{A10}	L_{A90}
13:32 - 13:47	Day	46	60	37	48	42
22:47 - 23:02	Night	45	67	35	48	39

Table 10 Summary of results for Position NSL3

During the both survey periods, the noise climate was dominated by distant oad traffic movements along the N69. Other sources of noise that contributed to the noise climate included aircraft movements, farm machinery in operation, wind generated noise and birdsong. The Aughinish Alumina Limited facility was not audible at this location during the measurement periods.

The measured daytime noise level was 46dB L_{Aeq} and 42dB L_{A90}. The measured night-time noise level was 45dB L_{Aeq} and 39dB L_{A90}.

2.6.11 Position NSL4

The results of measurements taken during the surveys conducted at Position NSL4 are summarised in Table 11.

Time	Period	Measured Noise Levels (dB re. 2x10-5 Pa)				
		L_{Aeq}	L_{Amax}	L_{Amin}	L_{A10}	L_{A90}
13:07 - 13:22	Day	41	59	30	44	34
22:26 - 22:41	Night	39	58	28	41	33

Table 11 Summary of results for Position NSL4

During the daytime, the noise climate was dominated by construction activity from within the port itself.

Access to this location was restricted during the night period, therefore a measurement was conducted at the locked gate into Foynes port. Intermittent road traffic noise from the N69 was the primary source of noise at this location.

Noise from the Aughinish Alumina facility was inaudible at either location during both survey periods.

The measured daytime noise level was 41dB L_{Aeq} and 34dB L_{A90}. The measured night-time noise level was 39dB L_{Aeq} and 33dB L_{A90}.

2.6.12 Position NSL5

The results of measurements taken during the surveys conducted at Position NSL5 are summarised in Table 12.

Time	Period	Measured Noise Levels (dB re. 2x10-5 Pa)				
		L_{Aeq}	L_{Amax}	L_{Amin}	L_{A10}	L_{A90}
13:51 - 14:06	Day	59	82	33	53	37
23:06 - 23:21	Night	52	78	30	43	34

Table 12 Summary of results for Position NSL5

Passing vehicles along the main access road into Aughinish Alumina dominated noise measurements during both survey periods. During the daytime, birdsong, wind generated noise and aircraft traffic overhead were also observed. Noise from the Aughinish Alumina facility was inaudible at this location.

The measured daytime noise level was 59dB L_{Aeq} and 37dB L_{A90}. The measured night-time noise level was 52dB L_{Aeq} and 34dB L_{A90}.

3.0 DISCUSSION AND CONCLUSIONS

3.1 Summary of Results

The measured noise levels at the five noise-sensitive locations (NSL's 1 to 5) are summarised below in Table 13.

NSL	Daytime			Night-time		
	Measured Noise Level dB(A)	Criterion dB(A)	Satisfies?	Measured Noise Level dB(A)	Criterion dB(A)	Satisfies?
1	50	55	Y	43	45	Y
2	48		Y	39		Y
3	46		Y	45		Y
4	41		Y	39		Y
5	59		N	52		N

Table 13 Summary of Results

The survey results indicate that the measured noise levels are within the both the day and night-time criteria of 55dB L_{Aeq} and 45dB L_{Aeq} at NSL2, NSL3 and NSL4.

There were no clearly audible tonal or impulsive components associated with the facility at any of the noise-sensitive locations.

3.2 NSL5

The measured day and night-time levels at NSL5 of 59 and 52dB L_{Aeq} respectively exceed the criteria. These L_{Aeq} levels are dominated by vehicle movements along the site access road and not by emissions from the Aughinish facility itself. Given that L_{Aeq} is an energy average over a period of time, in this instance 15 minutes, it can be significantly affected by high noise level events of short duration (for example, a single vehicle pass-by at a relatively quiet monitoring location may raise the period L_{Aeq} by several decibels). Therefore the L_{Aeq} parameter is not considered to represent an accurate measure of the noise emissions from the Aughinish facility at NSL5.

The Environmental Protection Agency document entitled, *Environmental Noise Survey Guidance Document* (2003) states the following:

"For some noise surveys, the L_{A90} index may be used to give a good indication of the actual noise output from the site, where the noise emissions on site are relatively steady"

It was noted that noise emissions from the Aughinish facility were relatively constant. Therefore the L_{A90} parameter is considered to provide a more accurate measure of noise from the site. In effect, this assumes that the site emissions represent the background noise level. Note that, in the absence of intrusive noise sources, values for L_{A90} are very close to or even the same as values for L_{Aeq}.

The measured background levels of 37 and 34dB $L_{Aeq,15min}$ are within the day and night-time criteria respectively, therefore the noise level at this location due to emissions from the Aughinish facility is within the IPPC licence limits.

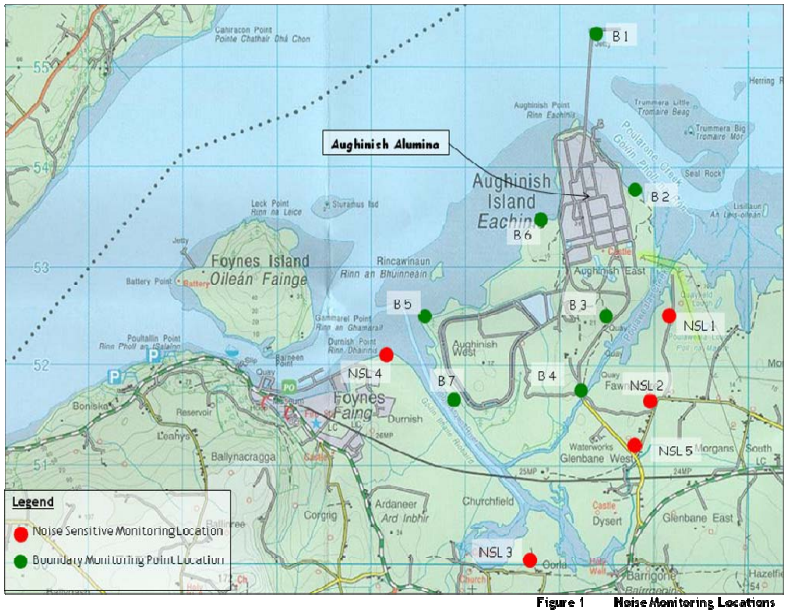

Figure 1 Noise Monitoring Locations

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Project
Aughinish Alumina IPPC 2008

Reference
LS/08/4334NR01

Figure 1
Noise Monitoring Locations

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Attachment 7
Air Emissions Monitoring Report

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Aughinish Alumina

Ambient Sulphur Dioxide Monitoring Programme Synthesis Report January-December 2008

March 2009

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Aughinish Alumina

Ambient Sulphur Dioxide Monitoring Programme Synthesis Report January-December 2008

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Rev	Description	Origin	Review	Changes/Amendments	OES Approval	Date
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0B	1017_12	UN	POL			31/03/09

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Executive Summary

OES Consulting was commissioned by Aughinish Alumina to carry out an ambient sulphur dioxide monitoring programme in the vicinity of the installation. The purpose of monitoring was to measure the concentrations of sulphur dioxide in the general environs of the plant.

Diffusion tubes located at nine pre-selected sites measured monthly average concentrations of SO_2 to give annual average concentrations to be compared with National Air Quality Standards (NAQS) for the protection of ecosystems.

Continuous analysers at Ballysteen and at Foynes measure hourly average concentrations to give average daily concentrations to be compared with NAQS limit values for the protection of human health.

Duplicate diffusion tubes are co-located with the continuous analysers to allow a correlation factor for the diffusion tubes. The aim is to apply this correlation factor to the other diffusion tube locations to obtain an extensive spatial coverage of the SO_2 gradient in the area.

SO_2 monitoring results show that the ambient measurements for SO_2 at all locations during 2008 were substantially below the NAQS for the protection of human health and for the protection of ecosystems.

Analysis of the data from the continuous analysers and the co-located diffusion tubes shows that, at this stage, no correlation can be made between the SO_2 levels recorded at each co-located sampling point.

Aughinish Alumina

Monthly Ambient Sulphur Dioxide Monitoring Programme Synthesis Report

March 2009

Contents

Tables

Figures

1.0 Introduction

Aughinish Alumina is an alumina refinery situated on Aughinish Island on the south side of the Shannon estuary between Askeaton and Foynes.

Sulphur dioxide (SO_2) is emitted from several major emission points including the boiler stack (A1) and the calciner stack (A2).

Ambient monitoring for SO_2 is conducted by OES Consulting, in accordance with *Schedule C.6: Ambient Air Monitoring* of the IPPC Licence (Ref: P0035-04), in order to determine the concentrations of SO_2 emissions from Aughinish Alumina in the vicinity of the site.

SO_2 monitoring is carried out on an on going basis and the following report details the results for the 2008 annual period. The results are compared with the National Air Quality Standards specified in the Air Quality Standards Regulations 2002 (SI No 271 of 2002).

1.1 2006 Air Monitoring Programme and Procedures Review

AWN Consulting Ltd. carried out an independent review of the ambient air monitoring programme and procedures at Aughinish Alumina Ltd. in 2006.

The report recommended an alternative, more effective monitoring programme. It was suggested to replace the bubbler method with diffusion tubes and to increase the number of monitoring locations to increase the spatial coverage of the method.

1.2 Ambient Air Quality Compliance Criteria

Measured SO_2 results are compared with the National Air Quality Standards (NAQS) specified in the Air Quality Standards Regulations 2002 (SI No 271 of 2002). These standards are based on the limit values specified in the EU Council Directive 1999/30/EC, which was adopted under the 1996 Framework Directive on Air Quality Assessment and Management (96/62/EC).

Limit values for SO_2 under the National Air Quality Standards are described in Table 1.

Table 1: NAQS Limit Values for Sulphur Dioxide

Standard	Averaging Period	Limit Value
Hourly Limit Value for the protection of human health	1 hour	350 µg/m^3 *not to be exceeded more than 24 times a calendar year*
Daily Limit Value for the protection of human health	24 hours	125 µg/m^3 *not to be exceeded more than 3 times a calendar year*
Limit Value for Protection of Ecosystems	Calender Year & Winter (1st Oct-31st Mar)	20 µg/m^3
Alert Threshold		500 µg/m^3 *over 3 consecutive hours*

The National Air Quality Standards also specifies upper and lower assessment thresholds for SO_2. Assessment thresholds are levels below the limit value, used solely in the determination of the level of monitoring needed. The greatest monitoring effort applies if concentrations are above the upper assessment threshold.

Table 2: NAQS Upper and Lower Assessment Thresholds for SO_2

Threshold	Health Protection	Ecosystem Protection
Upper Assessment Threshold	60% of 24-hour limit value- 75 µg/m^3 *not to be exceeded more than 3 times in any calendar year*	60% of winter limit value- 12 µg/m^3
Lower Assessment Threshold	40% of 24-hour limit value- 50 µg/m^3 *not to be exceeded more than 3 times in any calendar year*	40% of winter limit value- 8 µg/m^3

The 2006 report determined the levels of sulphur dioxide at Aughinish Alumina as below the lower assessment threshold. Therefore, in accordance with Article 2.14 of Directive 1999/30/EC, modelling or objective estimation techniques may be used to assess ambient air quality.

2.0 Methodology

2.1 Monitoring Locations

Sulphur dioxide concentrations at Aughinish Alumina were measured using suitable indicative techniques, diffusion tubes and continuous analysers.

The sites selected for monitoring are described in Table 3 below.

Table 3: Monitoring Locations

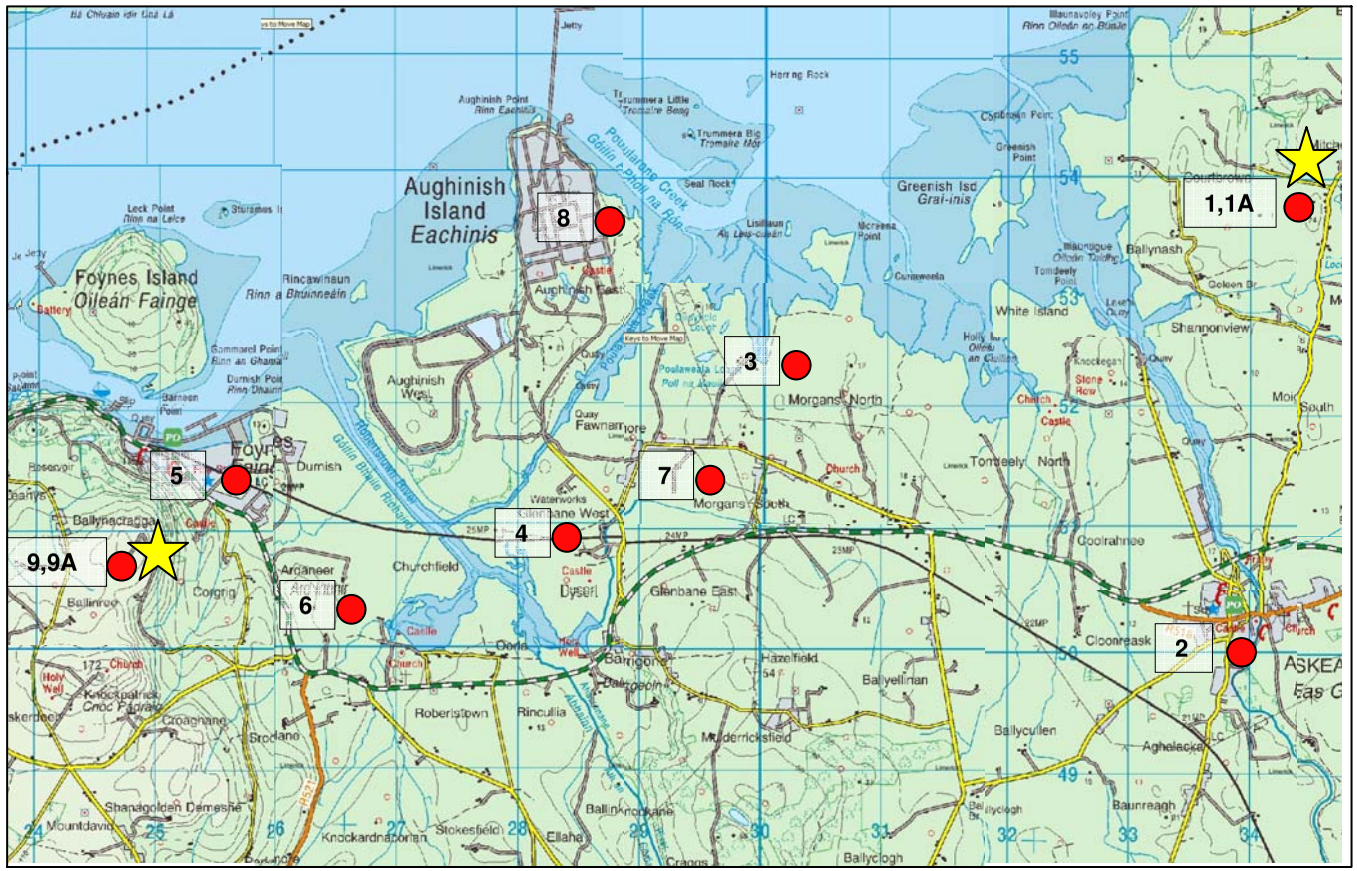
No	Description	Location
1, 1A	Kenricks' House	Ballysteen, Askeaton
2	Raw Intake	Water Intake, Askeaton
3	Keanes' House	Morgans' Land, Barrigone, Askeaton
4	Aughinish Water Works	CoCo Waterworks, Aughinish
5	Foynes Port	Foynes
6	Morans' House	Barrigone Askeaton
7	Fitzsimons' House	Barrigone, Askeaton
8	Aughinish	Aughinish Island
9, 9A	Foynes Reservoir	Foynes

Duplicate diffusion tubes are located at Ballysteen (Ref No. 1 and 1A) and at Foynes Reservoir (Ref No. 9 and 9A). All other monitoring locations have one diffusion tube.

Fluorescent SO_2 continuous analysers are co-located with the duplicate diffusion tubes at Ballysteen and at Foynes Reservoir

This co-location of the diffusion tubes with the continuous analysers allows a correlation factor for the diffusion tubes. This correlation factor can then be applied to the other diffusion tube locations to obtain an extensive spatial coverage of the SO_2 gradient in the area

All monitoring locations are shown in Figure 1.



Legend:

SO_2 Diffusion Tube

Continuous Analyser

No.	Location	Grid Reference
1,1A	Kenrick's House Ballysteen	E35328, N55023
2	Raw Intake	E34354, N49172
3	Keane's House	E29399, N51604
4	Water Works	E28344, N51253
5	Foynes	E26170, N51193
6	Moran's House	E26441, N50058
7	FitzsimonHouse	E29881, N52405
8	Aughinish	E28509, N54086
9,9A	Resevoir	E24269, N 51720

Issue no.	Date	By	Checked	Approved	Note Ref	Date Scanned

OES consulting

environmental health and safety engineering project management

Tel: 353 (0)667128321 Fax: 353 (0)66 7180061 Email: info@oes.ie

Client: Aughinish Alumina

Title: **Air Monitoring Locations**

Scale.	NTS	Project No.	1017_12
Drawing No.	Figure 1	Rev.	01

2.2 Diffusion Tubes

A sulphur dioxide passive diffusion tube is a clear plastic tube, with purple and white thermoplastic rubber caps. The coloured cap contains a pollutant absorbing chemical, in this case, Potassium Hydroxide. A one micron porosity filter is fitted to the white cap to prevent the ingress of particles loaded with sulphur, i.e. diesel fumes.

The diffusion tube collects SO_2 during the exposure period and then is sealed and returned to the laboratory for analysis. Each tube at Aughinish Alumina is exposed for a month period.

The laboratory assesses the quantity of the pollutant absorbed by calculating the average ambient SO_2 concentration over the exposure period. This is determined by Ion Chromatography with reference to a calibration curve derived from the analysis of standard sulphate solutions.

Monitoring of SO_2 concentrations in 2008 commenced on January 3rd 2008. Diffusion tubes were replaced at each monitoring location and sent for analysis once a month until January 9th 2009.

In addition, the following procedure was applied:

- An accredited laboratory which is part of the UK Network Inter-comparison Exercise was used in order to achieve the necessary degree of accuracy.
- Diffusion tubes were kept in a sealed bag with the travel blank during transit to/from the site and the laboratory.
- Exposed samples were immediately capped after collection.
- Post-sampling and prior to couriering to the laboratory, all samples were stored in a refrigeration unit.
- Samples were couriered to the laboratory the day of collection or the following day.

This method supplies monthly average concentrations of SO_2 to give annual average concentrations to be compared with NAQS limit values.

2.3 Continuous Analysers

Continuous ambient monitoring for SO_2 is undertaken using a UV fluorescence analyser. The air sampled is exposed to a UV light source which causes excitation of the SO_2 molecules in the gas stream, which occurs in the presence of a specific wavelength of UV light. The subsequent reaction results in an emission of fluorescent radiation that is detected by a multiplier tube as the SO_2 molecules return to their initial state.

Aughinish Alumina operate the continuous analysers using an in-house Standard Work Method (SWM) entitled *"Checking, Calibration and Downloading of data from the Continuous Ambient Sulphur Dioxide Monitors (SWM 7520)"*

The monitors are calibrated every two weeks coinciding with a site visit thus, ensuring that the period of unattended operation is never more than 14 days.

The data are downloaded by modem every 2 weeks and inspected for suspect data.

This method of measurement provides high resolution measurements of SO_2 to give hourly average values that allow hourly and daily average concentrations to be compared with NAQS limit values.

3.0 Results

3.1 Hourly and Daily Concentrations

The maximum hourly average concentration recorded at Ballysteen in the January-December 2008 survey period was 66.55 µg/m^3 , well below the NAQS limit value of 350 µg/m^3. Similarly, the maximum hourly average concentration recorded at Foynes Reservoir was 66.55 µg/m^3

The alert threshold (500 µg/m^3) was not breached during 2008.

The daily average concentrations measured at both Ballysteen and Foynes Reservoir were below the lower assessment threshold for the protection of human health and hence, well below the upper assessment threshold and the limit value. The average daily results recorded at Ballysteen and at Foynes Reservoir and their compliance with NAQS limit values are given in Figures 2 and 3 respectively.

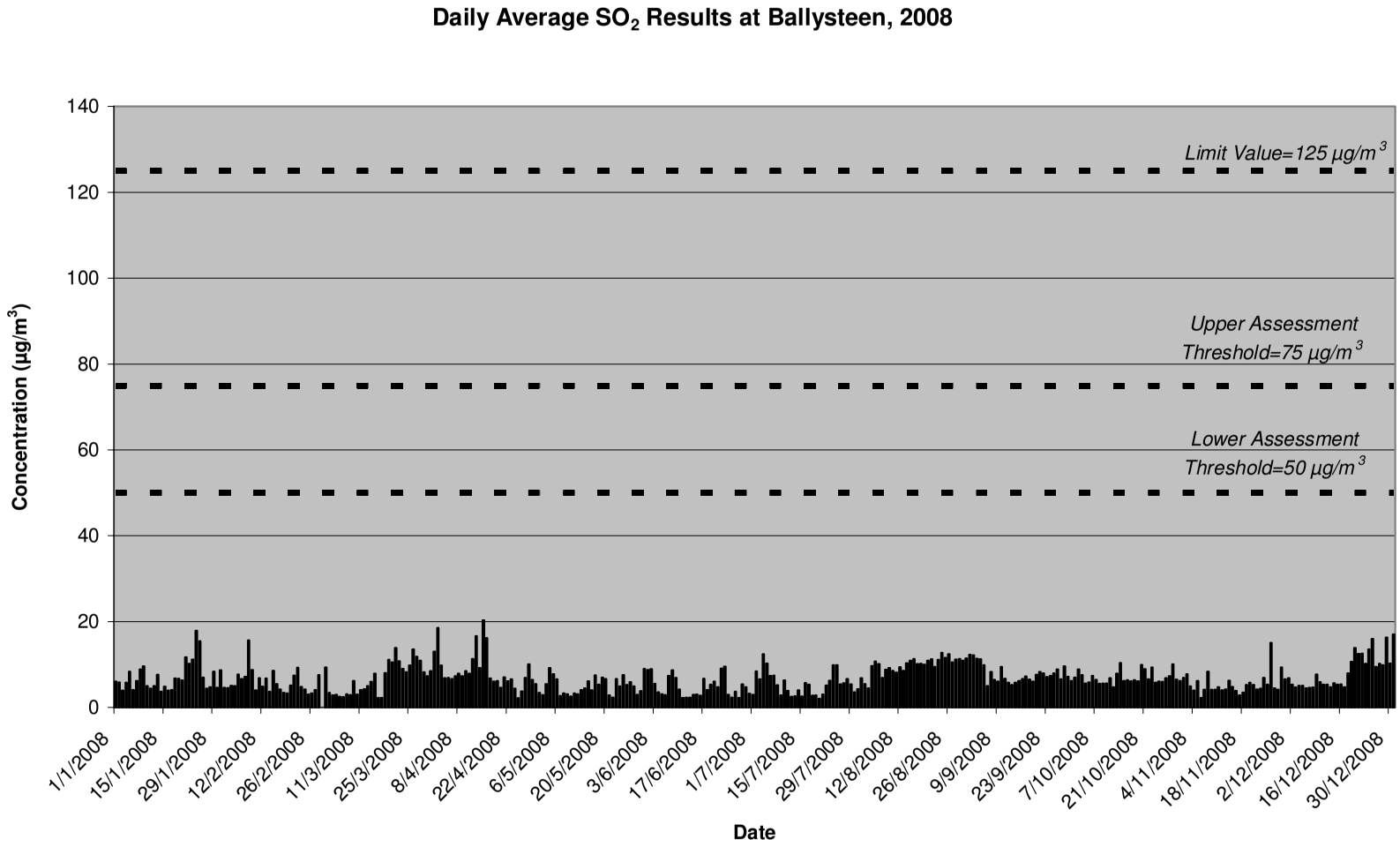


Figure 2: Daily Average Concentrations and NAQS Compliance at Ballysteen

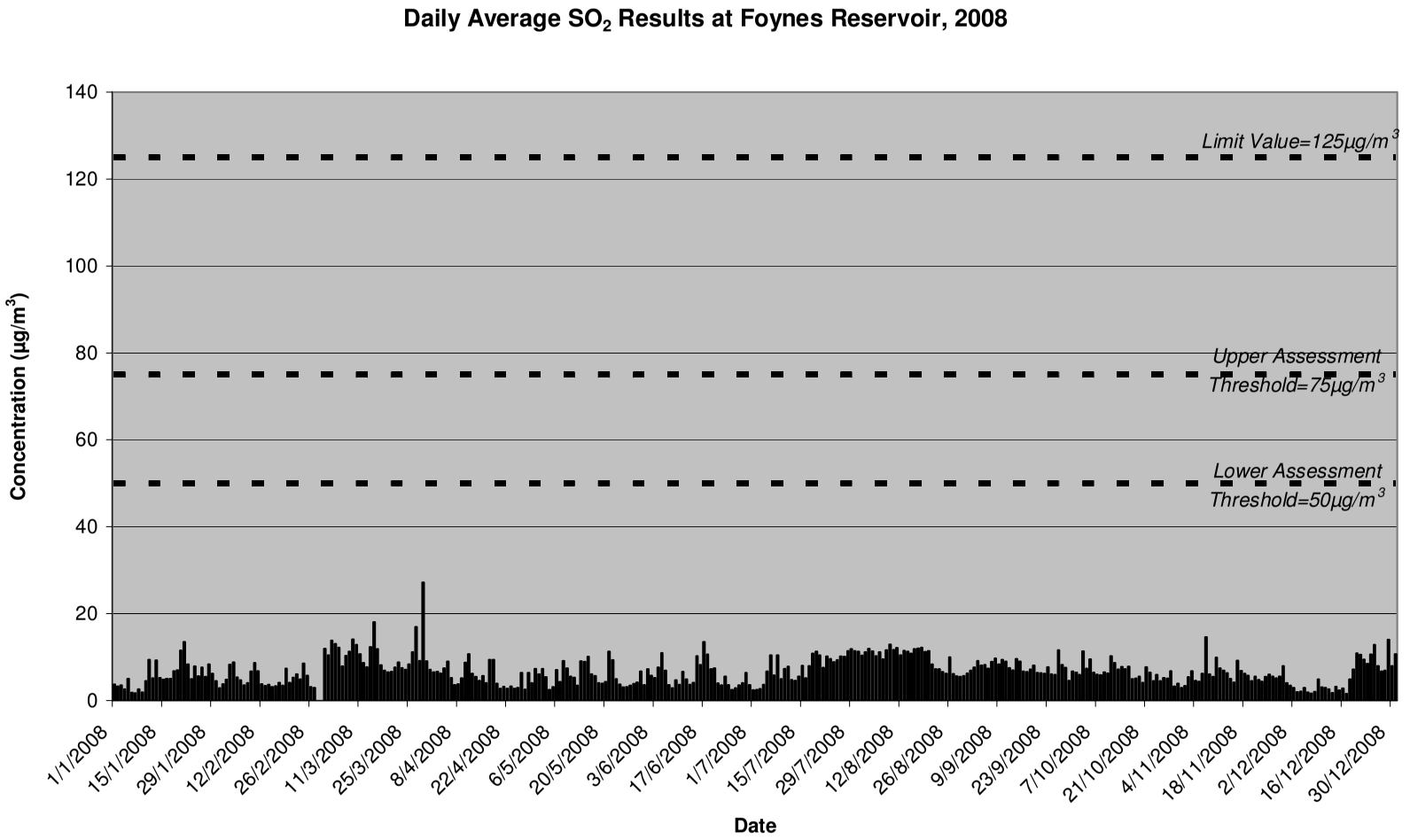


Figure 3: Daily Average Concentrations and NAQS Compliance at Foynes Reservoir

3.2 Monthly and Annual Concentrations

Results of monthly monitoring of SO_2 by diffusion tubes during 2008 are given in Table 4 as monthly mean concentrations and annual mean concentrations at each monitoring location. Table 5 also shows Aughinish Alumina's compliance NAQS limit values.

All annual mean concentrations recorded during 2008 were below the lower assessment threshold for the protection of ecosystems (8 µg/m^3) and hence well below the limit value (20 µg/m^3). Figure 3 illustrates this.

3.3 Correlation Factor

Analysis of the data from the continuous monitors and co-located diffusion tubes concluded that at this stage, no correlation can be made between the SO_2 levels recorded at each co-located sampling point.

Table 4: 2008 Monthly Mean Concentrations of SO_2 (µg/m^3)

Location	Kennick's House	Kennick's House	Raw Intake	Keane's House	Water Works	Foynes	Moran's House	Fitzsimon's House	Aughinish	Reservoir	Reservoir
Tube No	**1**	**1A**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**9A**
January	4.9	4.78	5.51	5.57	9.53	6.07	5.12	5.83	10.23	5.51	5.21
February	0.66	1.18	0.95	0.78	0.52	2.48	0.4	0.78	1.71	32.19	2.5
March	3.52	3.51	2.59	4.96	3.65	4.41	2.23	3.02	6.78	2.3	3.1
April	1.41	1.98	1.65	20.94	5.55	14.86	10.97	7.68	8.73	14.46	11.64
May	1.27	0.91	0.73	1.09	1.63	2.18	1.63	1.45	1.81	1.63	3.81
June	6.82	6.29	8.22	36.48	5.94	16.61	6.12	10.67	14.33	5.77	3.49
July	3.71	2.72	3.29	3.47	3.94	2.51	2.97	4.59	4.67	4.35	2.57
August	2.86	3.49	2.65	3.07	4.72	3.82	3.7	4.54	5.98	2.38	4.27
September	0.63	0.6	1.17	0.88	0.68	<LOD*	0.77	1.21	1.5	<LOD*	<LOD*
October	<LOD*	<LOD*	<LOD*	<LOD*	<LOD*	1.55	<LOD*	<LOD*	1.71	<LOD*	<LOD*
November	<LOD*	<LOD*	<LOD*	<LOD*	<LOD*	<LOD*	<LOD*	<LOD*	1.01	1.48	<LOD*
December	<LOD*	<LOD*	<LOD*	<LOD*	<LOD*	1.81	2.14	1.67	1.55	1.59	1.73
NAQS Limit	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**
Annual Mean	**2.15**	**2.12**	**2.23**	**6.44**	**3.01**	**4.69**	**3**	**3.45**	**5**	**5.97**	**3.19**
Compliant?	√	√	√	√	√	√	√	√	√	√	√

**<LOD means below Limit of Detection*

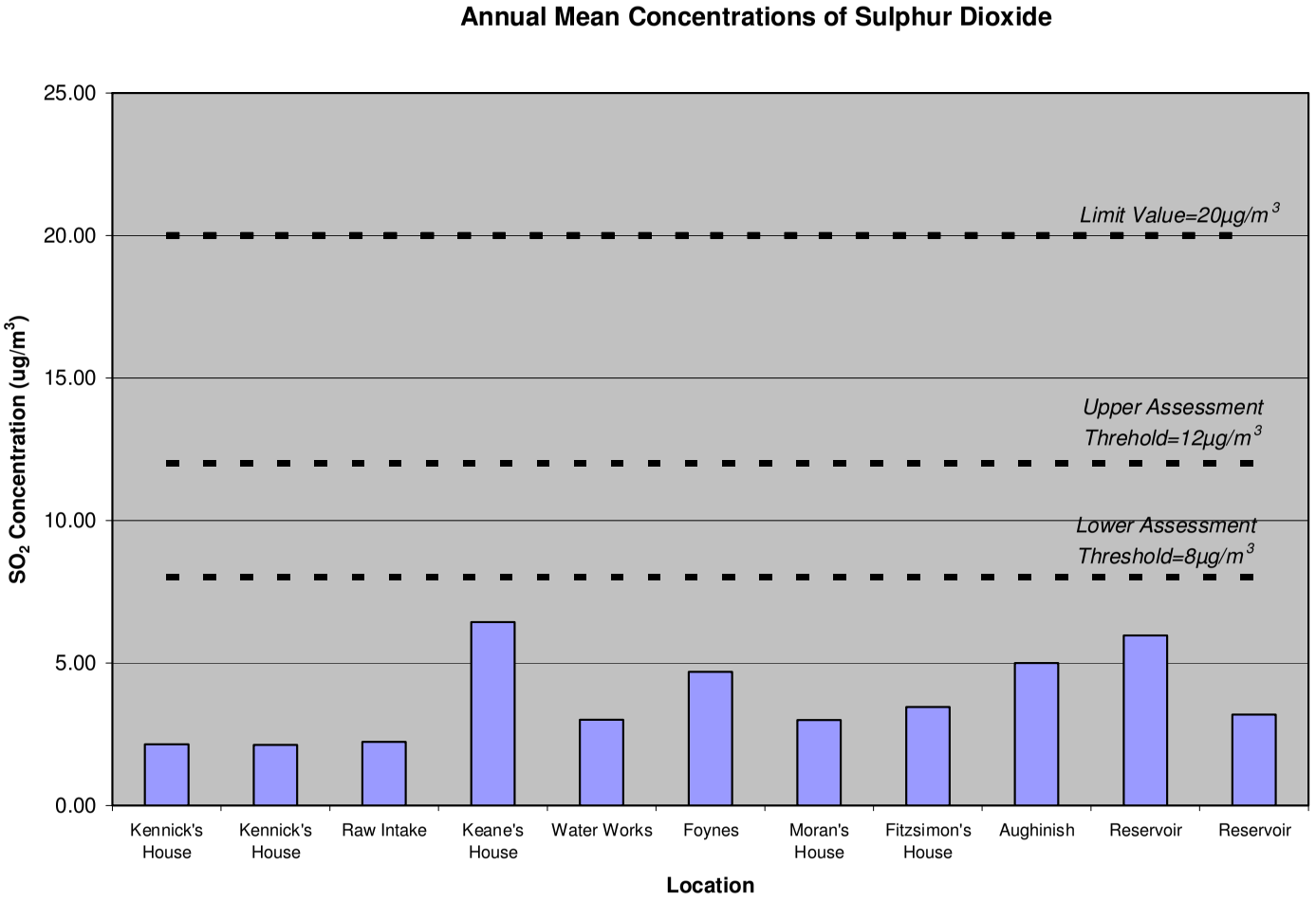


Figure 4: Annual Average Concentrations and NAQS Compliance

4.0 Conclusion

The air quality monitoring results obtained at the nine monitoring sites in the vicinity of Aughinish Alumina demonstrate that the ambient measurements for SO_2 during the 2008 survey period were substantially below the National Air Quality Standards (NAQS) for protection of human health and for protection of ecosystems specified in the 2002 Regulations.

As the levels of sulphur dioxide are below the lower threshold limit, it is satisfactory to use modelling or objective estimation techniques to assess ambient air quality at Aughinish Alumina according to Article 2.14 of EU Directive 1999/30/EC

Analysis of the data from the continuous analysers and co-located diffusion tubes shows that, at this stage, no correlation can be made between the SO_2 levels recorded at each co-located sampling point.

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Attachment 8
Ballysteen & Foynes SO_2 Graphs
Ballysteen, Alumina Plant & Foynes PM10 Graphs
Ballysteen, Alumina Plant & Foynes Sodium Graphs

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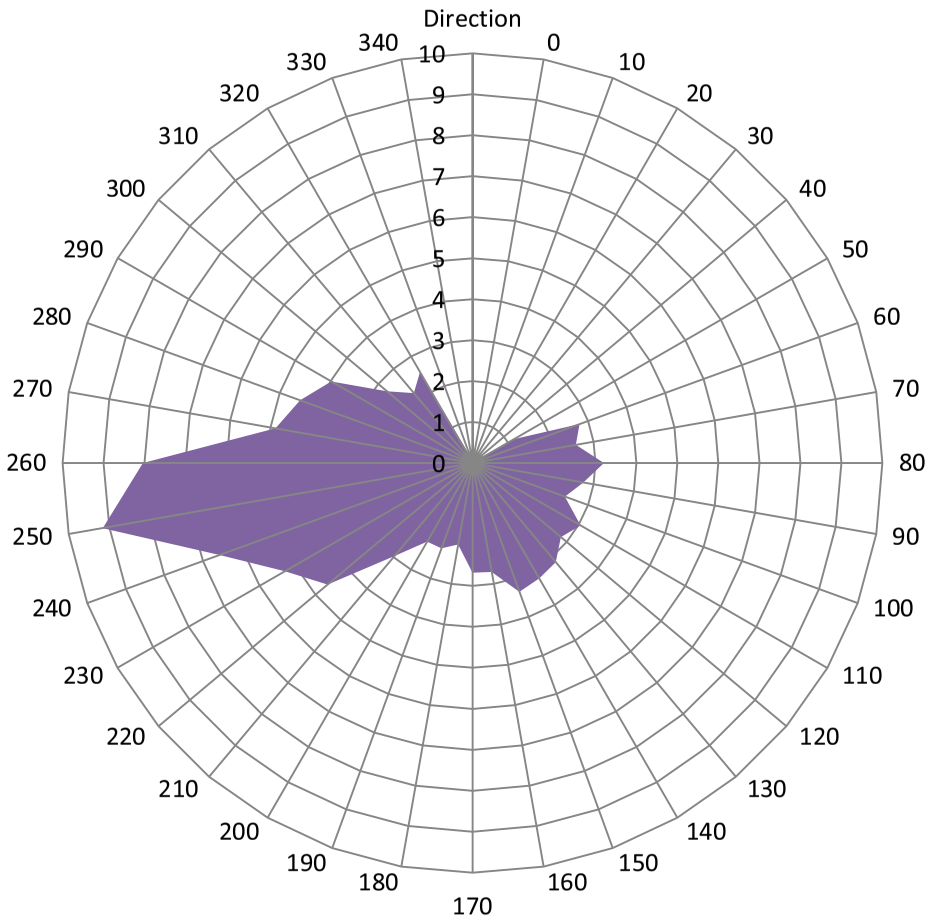
Percentage Entries >0.1mg/m3 using Foynes Continuous SO2 data from 1ts Jan - 31st December 08. (based upon 8667 data points from 8763 hourly mean SO2 and wind direction data)

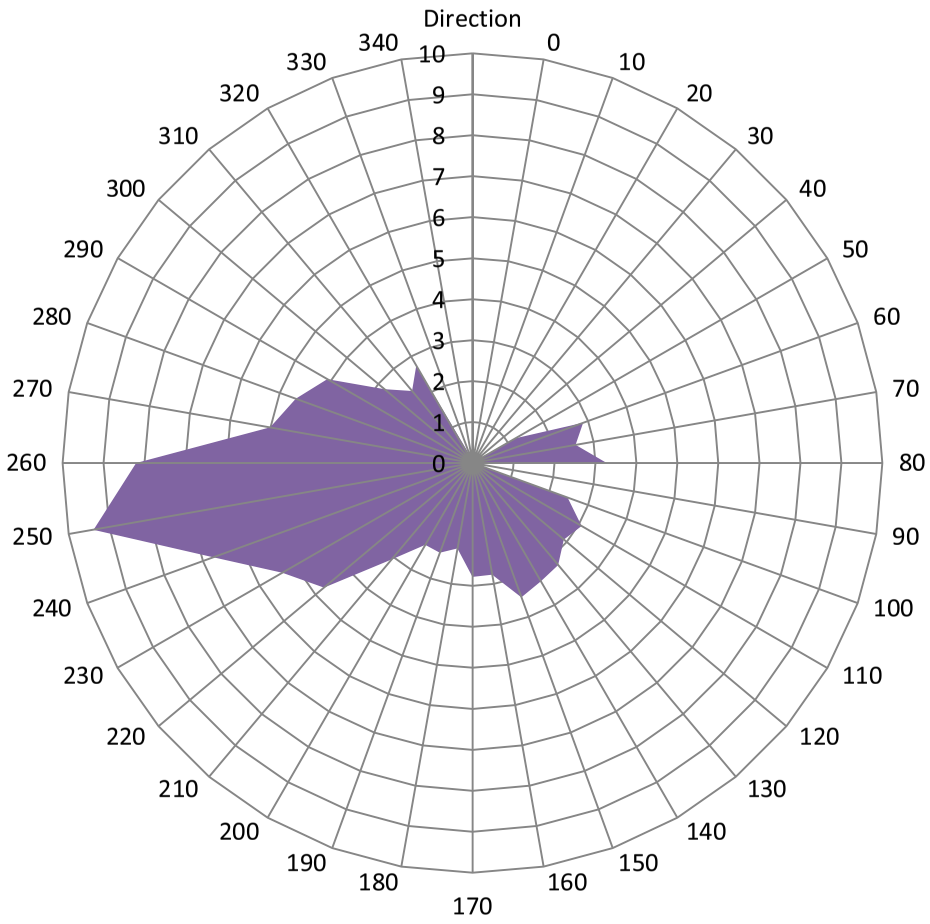


Note:

45-90° wind direction accounts for only 9% of the above entries, that required for AAL emissions to be carried in the direction of Foynes station.

0-10$\mu g/m^3$ is considered a typical countryside SO_2 level.

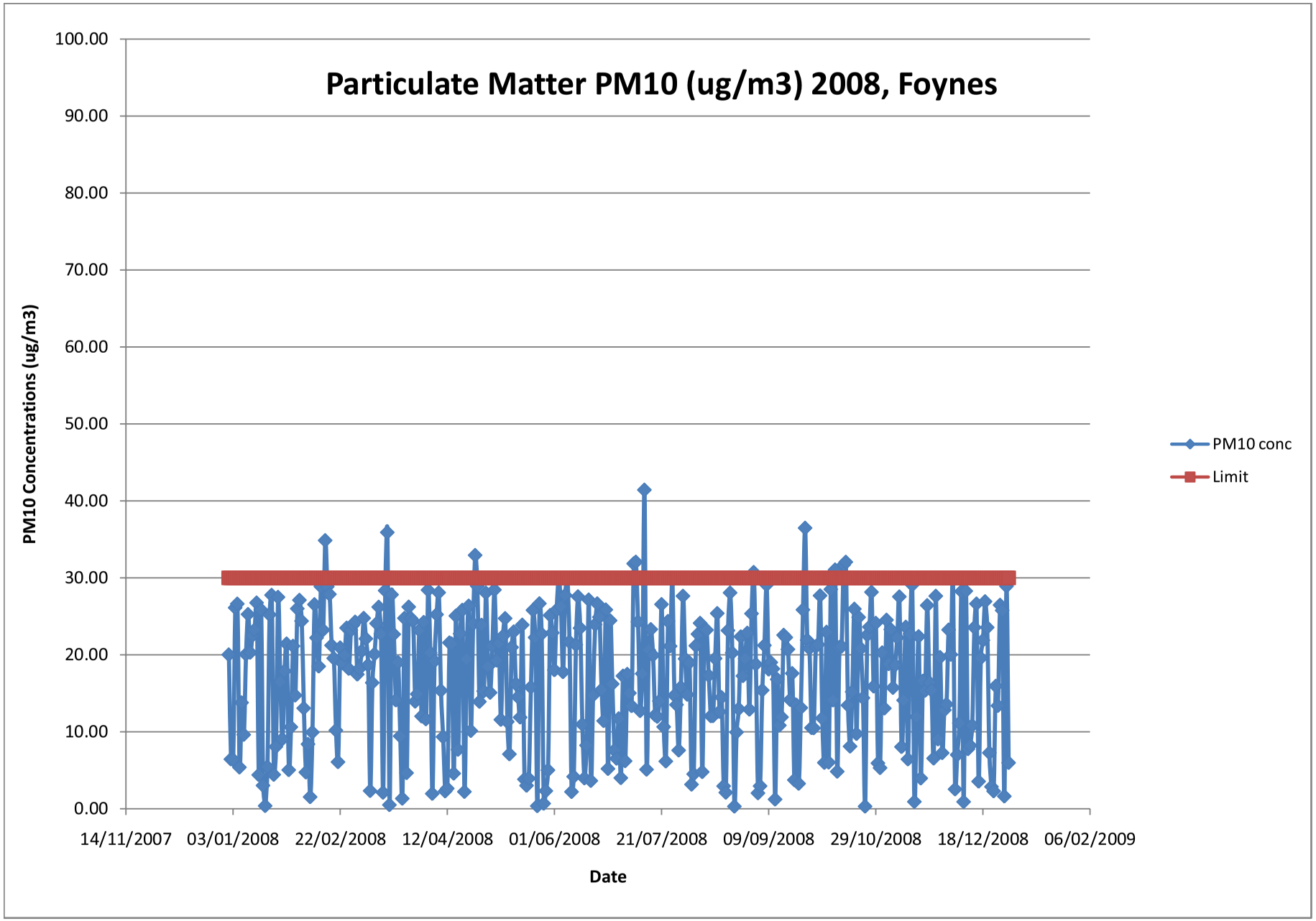
Percentage Entries >0.1mg/m3 using Ballysteen Continuous SO2 data from 1ts Jan - 31st December 08. (based upon 8456 data points from 8737 hourly mean SO2 and wind direction data)

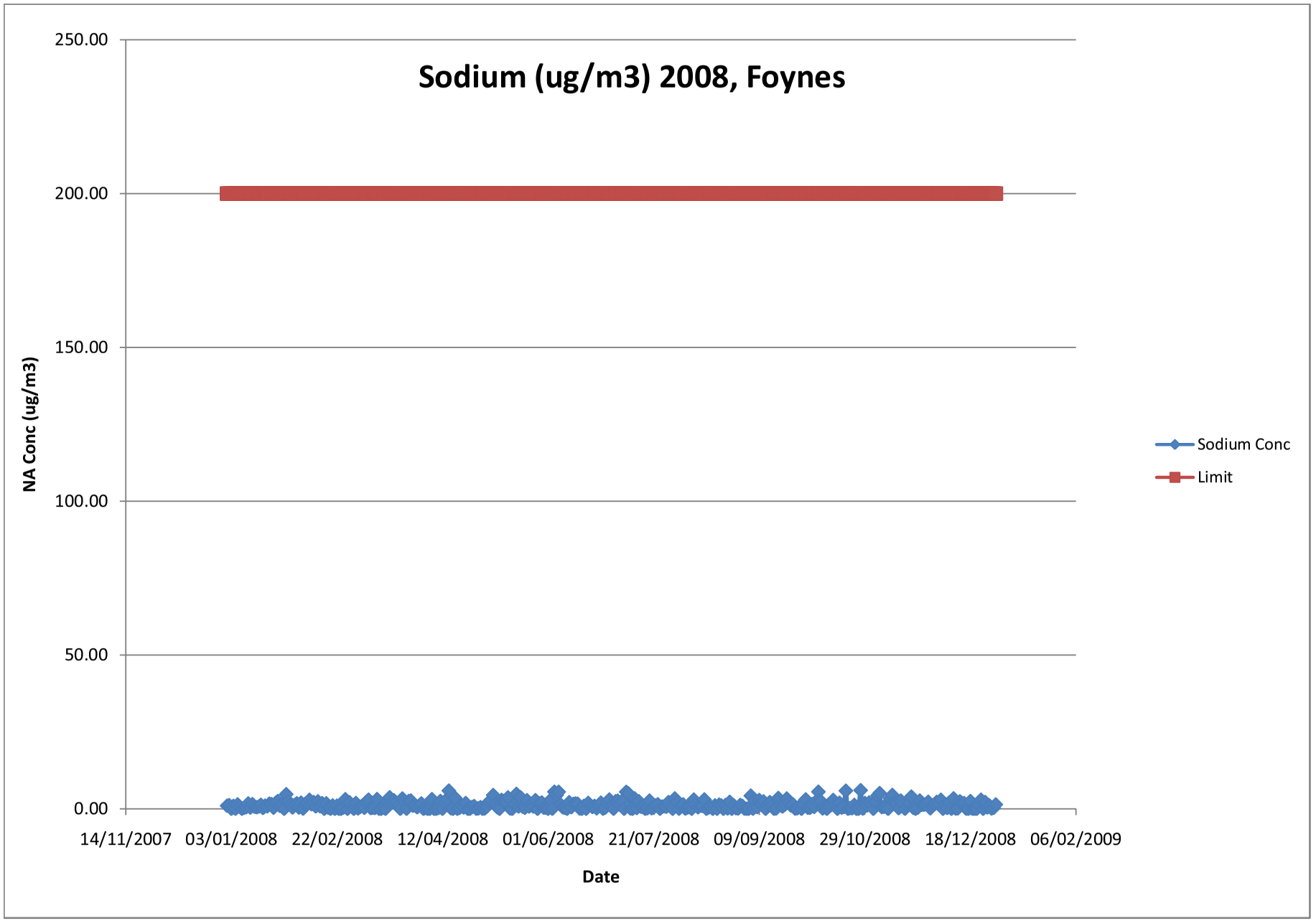


Note:

45-90° wind direction accounts for only 9% of the above entries, that required for AAL emissions to be carried in the direction of Foynes station.

0-10$\mu g/m^3$ is considered a typical countryside SO_2 level.


Particulate Matter PM10 (ug/m3) 2008, Foynes
PM10 Concentrations (ug/m3)
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
14/11/2007
03/01/2008
22/02/2008
12/04/2008
01/06/2008
21/07/2008
09/09/2008
29/10/2008
18/12/2008
06/02/2009
Date
PM10 conc
Limit


Sodium (ug/m3) 2008, Foynes
250.00
200.00
150.00
100.00
50.00
0.00
NA Conc (ug/m3)
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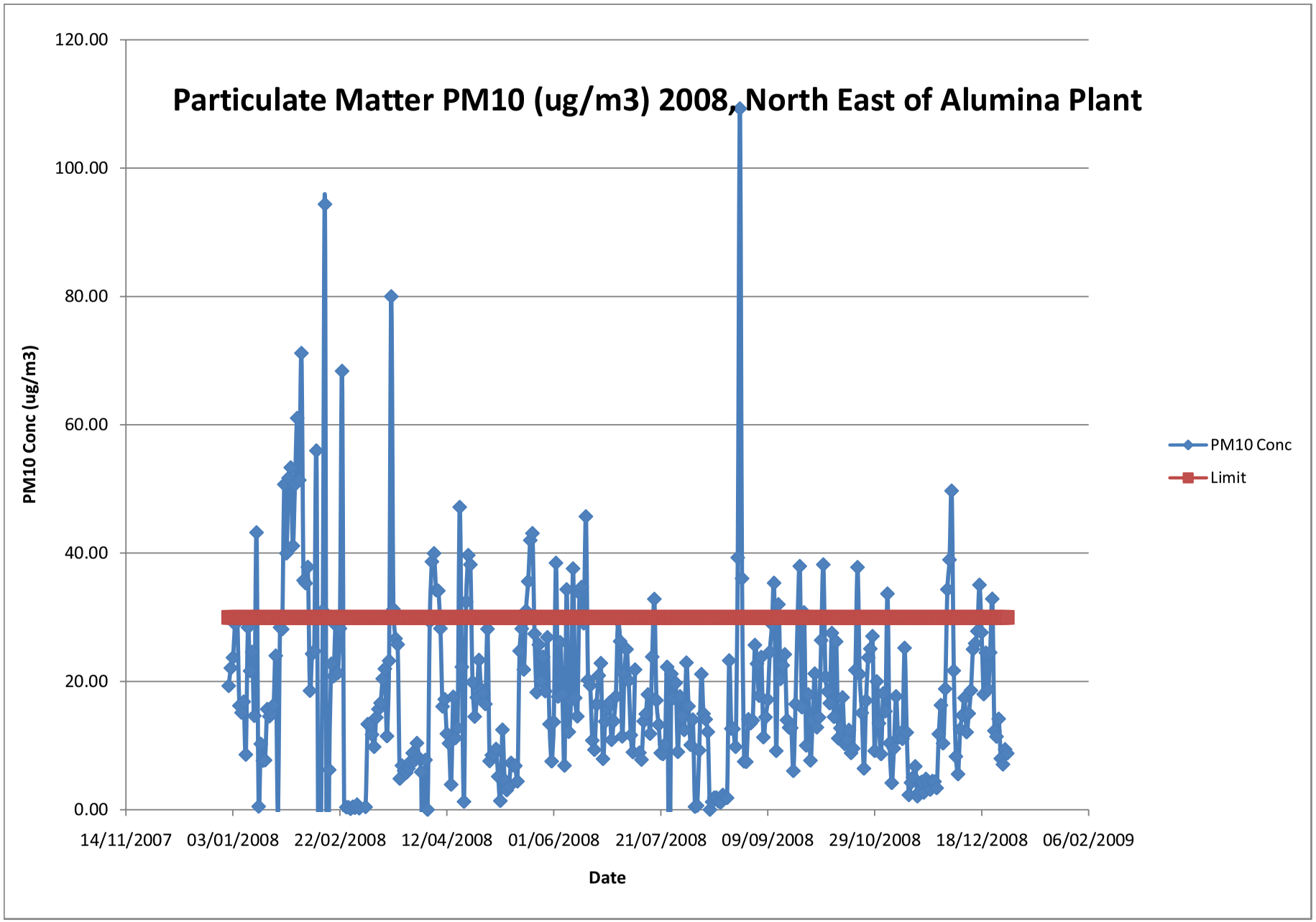
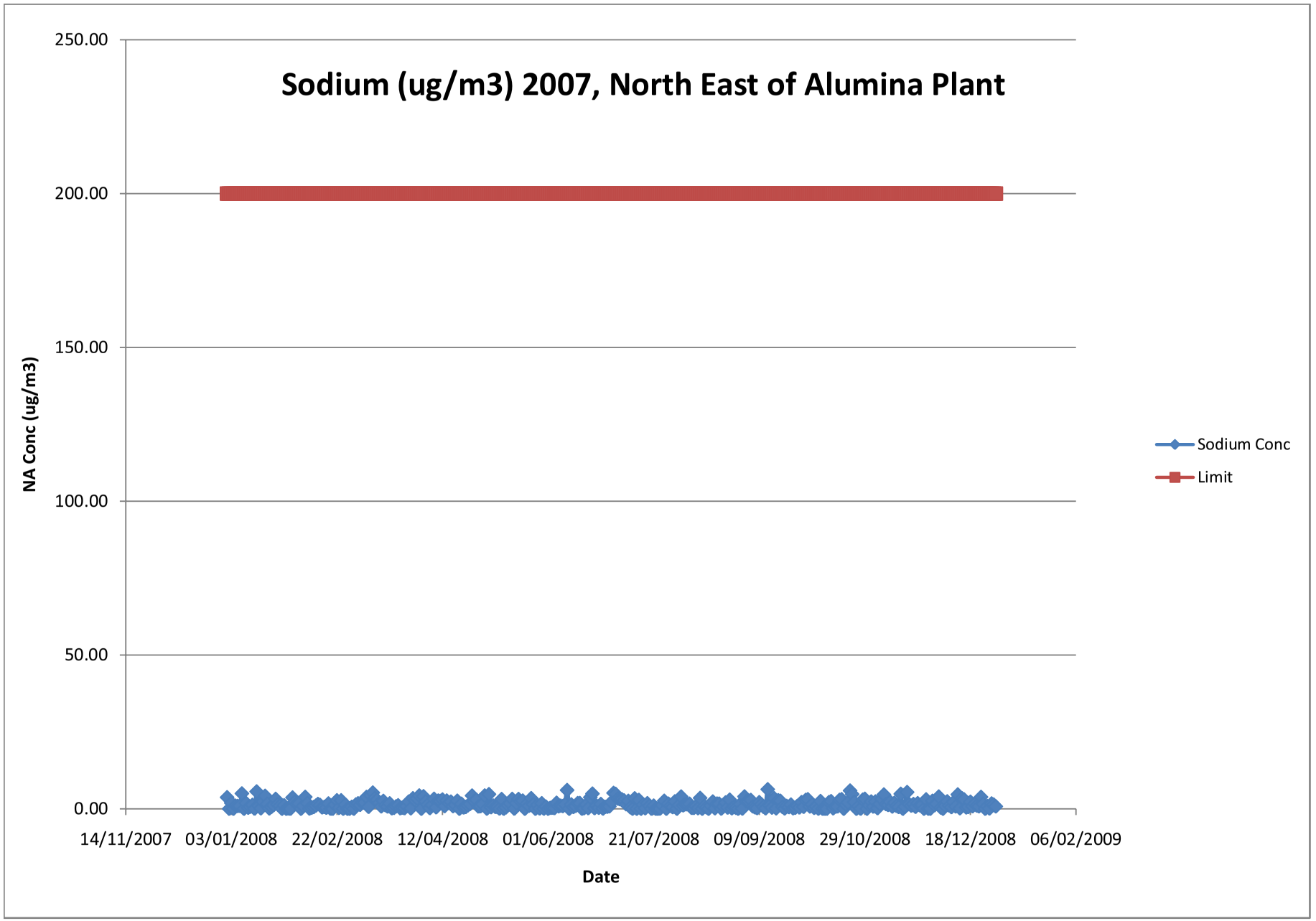
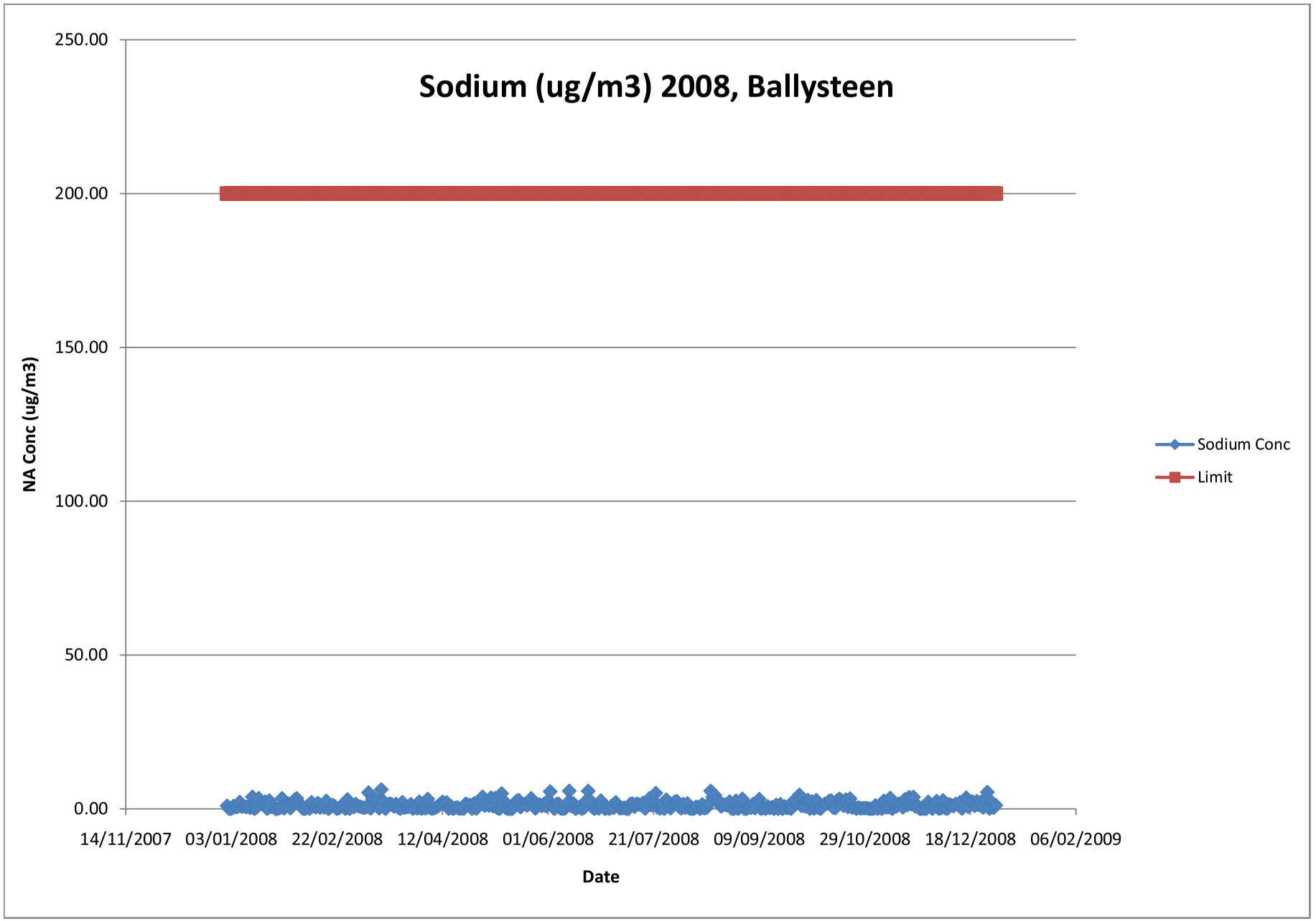
03/01/2008
22/02/2008
12/04/2008
01/06/2008
21/07/2008
09/09/2008
29/10/2008
18/12/2008
06/02/2009
Date
Sodium Conc
Limit


Particulate Matter PM10 (ug/m3) 2008, North East of Alumina Plant
120.00
100.00
80.00
60.00
40.00
20.00
0.00
PM10 Conc (ug/m3)
14/11/2007
03/01/2008
22/02/2008
12/04/2008
01/06/2008
21/07/2008
09/09/2008
29/10/2008
18/12/2008
06/02/2009
Date
PM10 Conc
Limit


Sodium (ug/m3) 2007, North East of Alumina Plant
250.00
200.00
150.00
100.00
50.00
0.00
NA Conc (ug/m3)
14/11/2007
03/01/2008
22/02/2008
12/04/2008
01/06/2008
21/07/2008
09/09/2008
29/10/2008
18/12/2008
06/02/2009
Date
Sodium Conc
Limit


Sodium (ug/m3) 2008, Ballysteen
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200.00
150.00
100.00
50.00
0.00
NA Conc (ug/m3)
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03/01/2008
22/02/2008
12/04/2008
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21/07/2008
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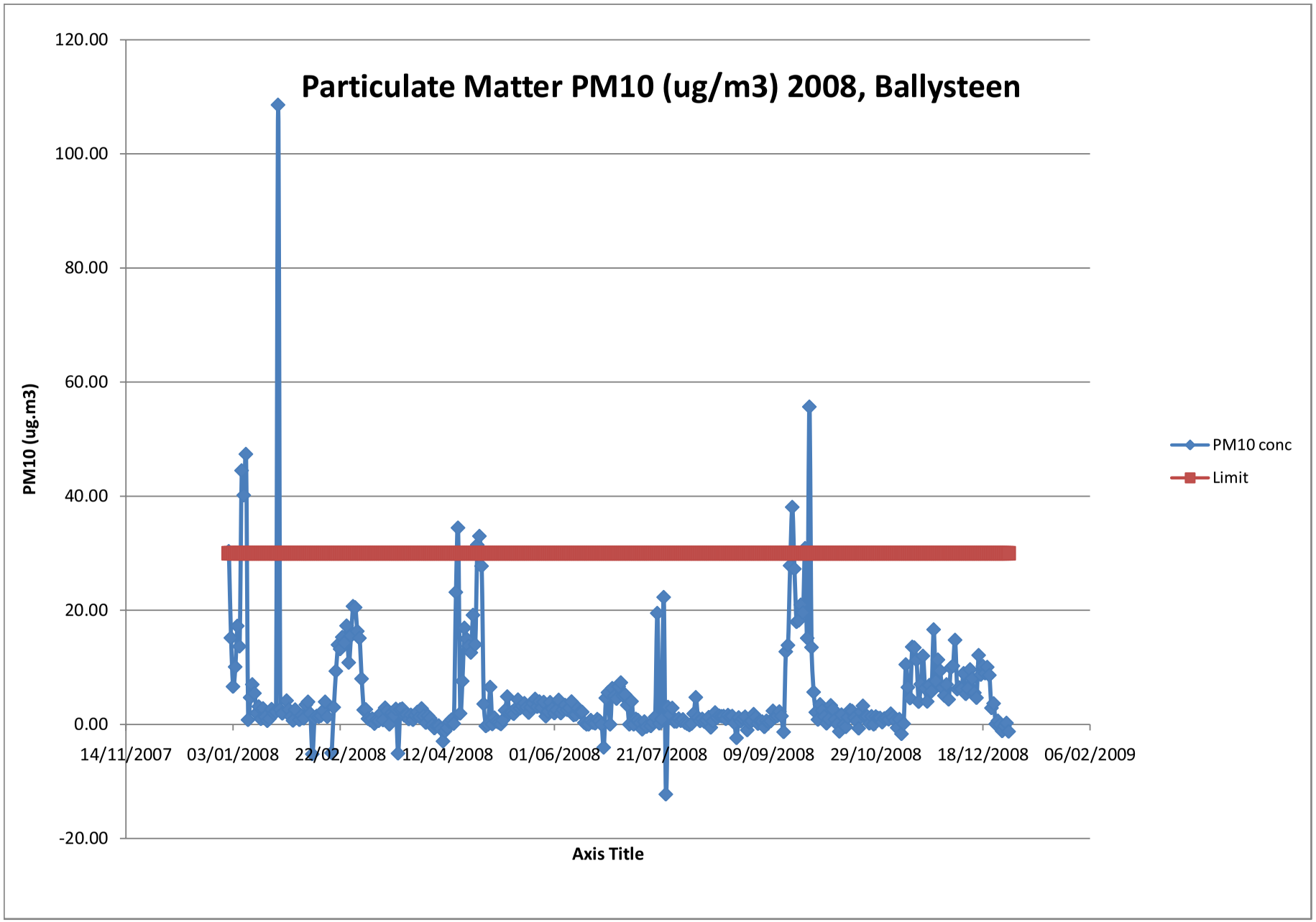
29/10/2008
18/12/2008
06/02/2009
Date
Sodium Conc
Limit


Particulate Matter PM10 (ug/m3) 2008, Ballysteen
120.00
100.00
80.00
60.00
40.00
20.00
0.00
-20.00
PM10 (ug.m3)
14/11/2007
03/01/2008
22/02/2008
12/04/2008
01/06/2008
21/07/2008
09/09/2008
29/10/2008
18/12/2008
06/02/2009
Axis Title
PM10 conc
Limit

Attachment 9
Graphs trending pH and Soda for the Estuarine Streams

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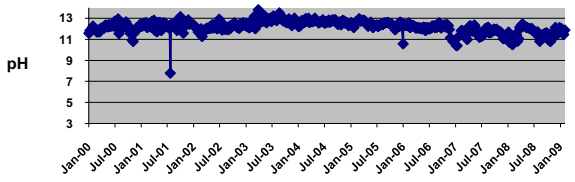
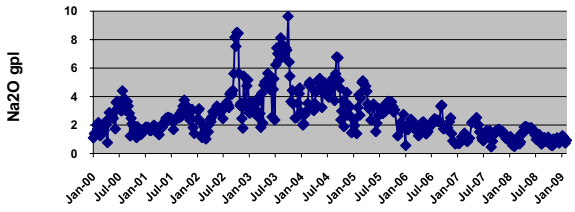
Estuary Streams (ES 1 - 16) Profiles

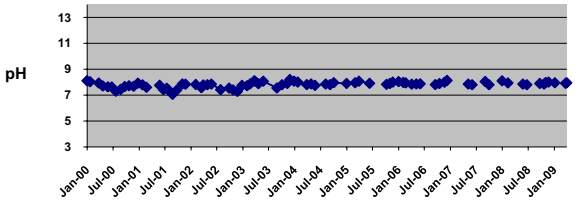
ES 1 (West of Area 28 / West Pond) Local 2 Returned to Area 34



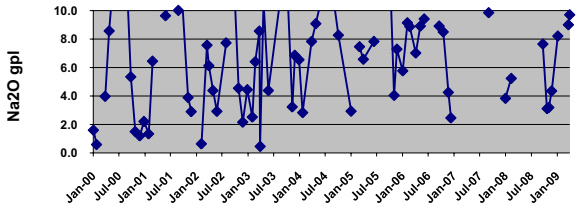
ES 1



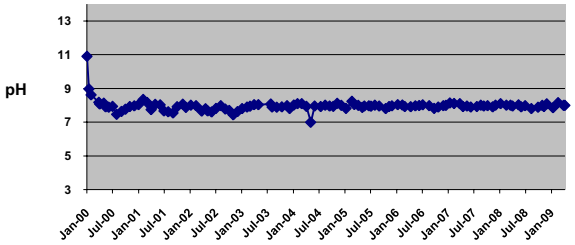
ES 2 (East of Area 58) Local 3



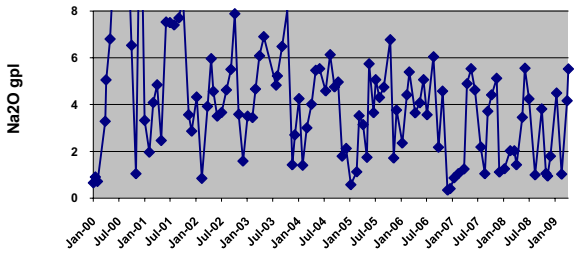
ES 2 (*Saline*)



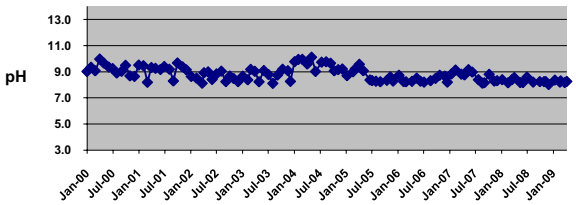
ES 3 (East of East Pond) Local 3



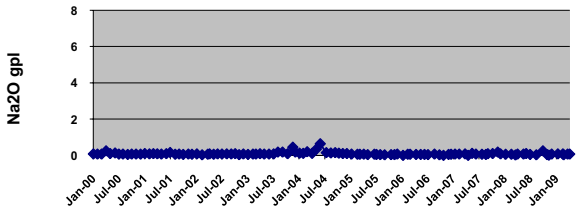
ES 3 (*Saline*)



ES 5 (East of A 09) Local 5



ES 5



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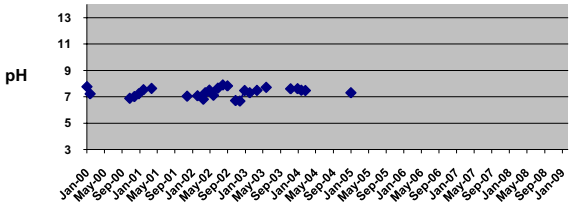
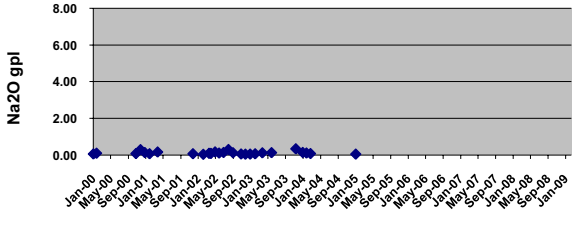
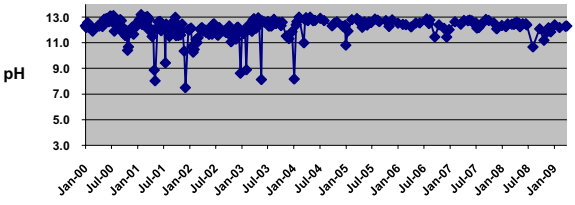


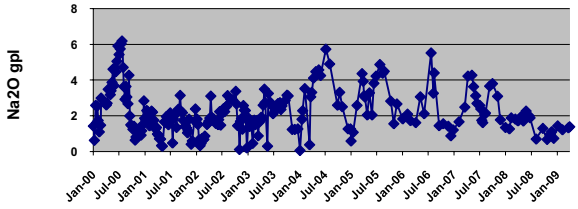
ES 6



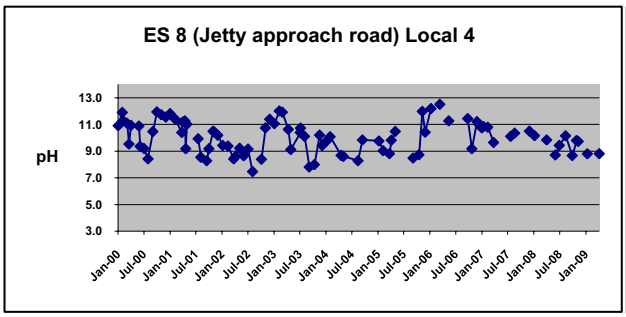
ES 7/12 (East of Area 06) Local 3 Returned to E. Pond

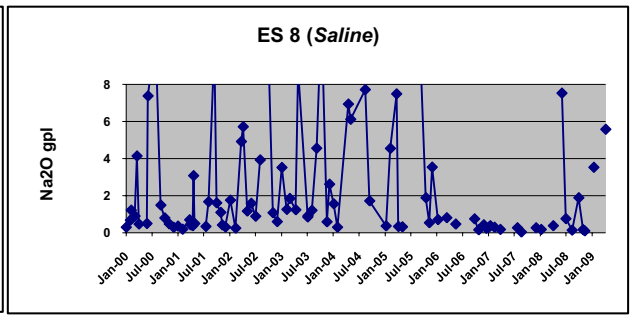


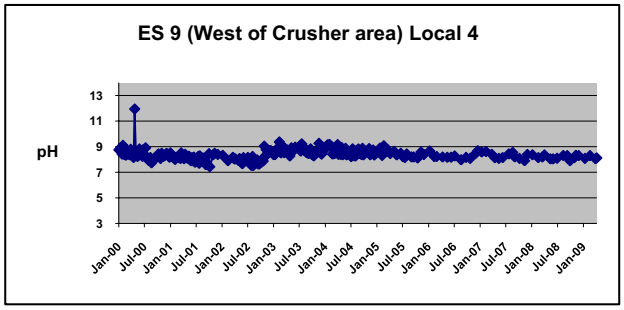
ES 7/12 Returned to E. Pond

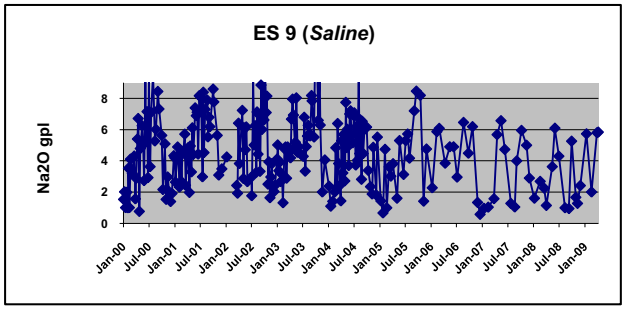


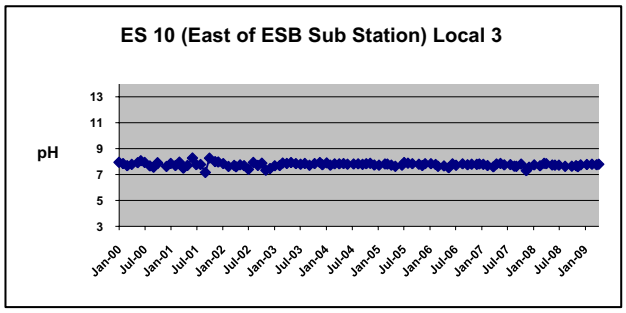
Estuary Streams (ES 1 - 16) Profiles

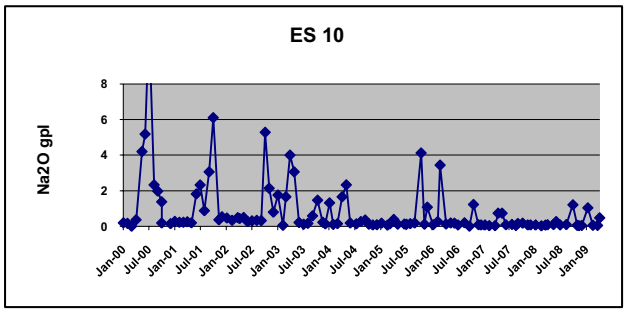


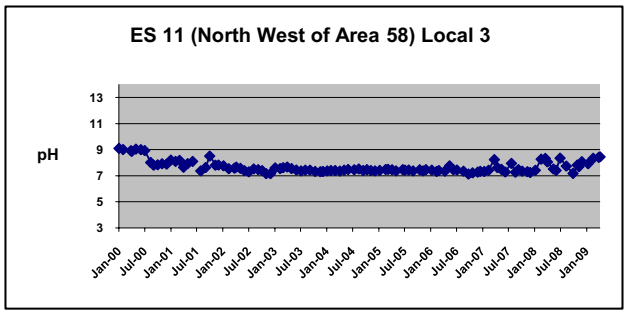


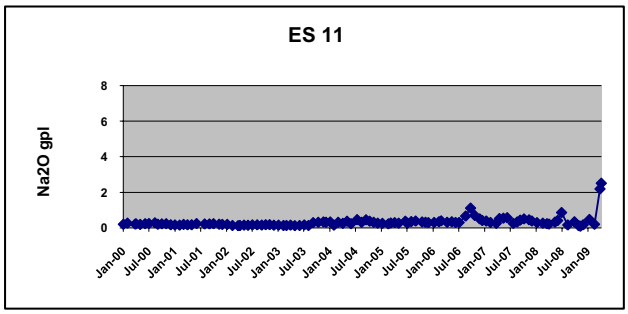


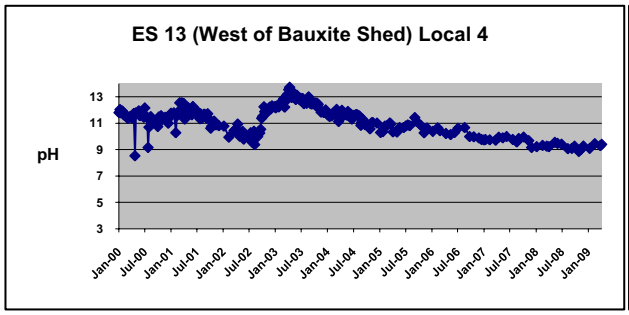


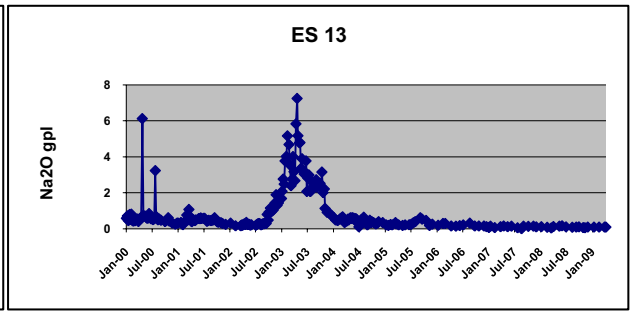


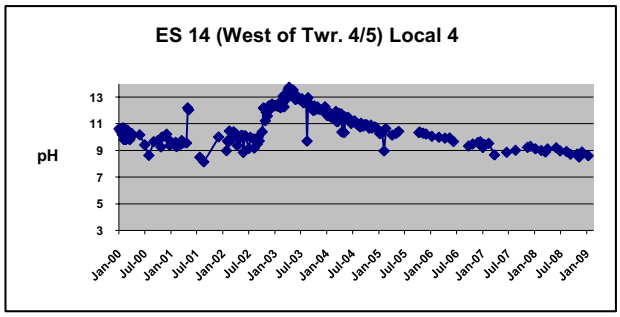


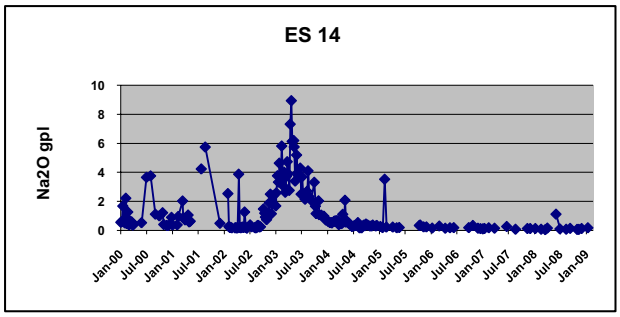




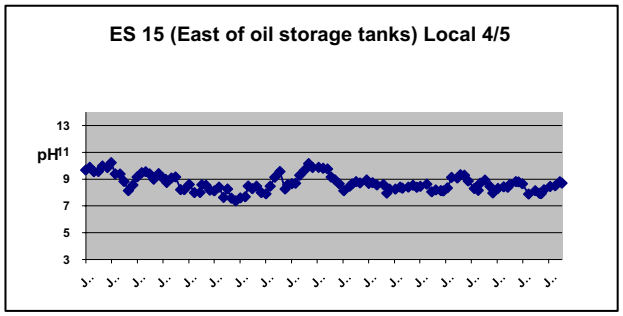


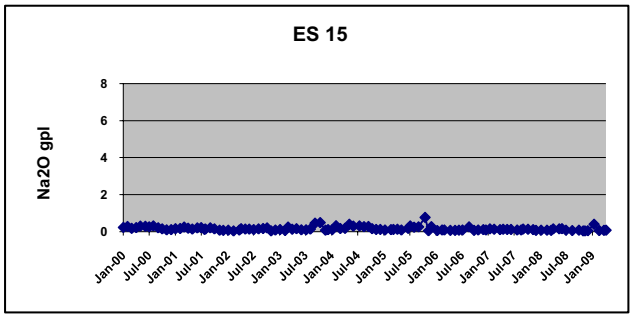


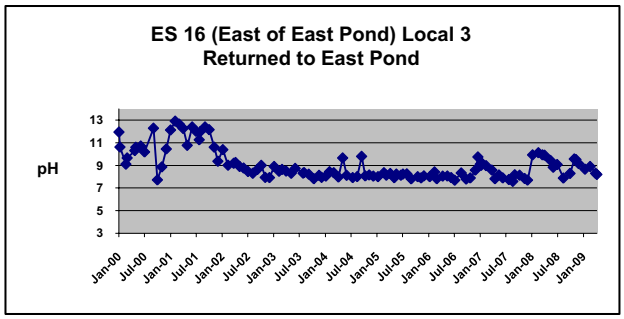


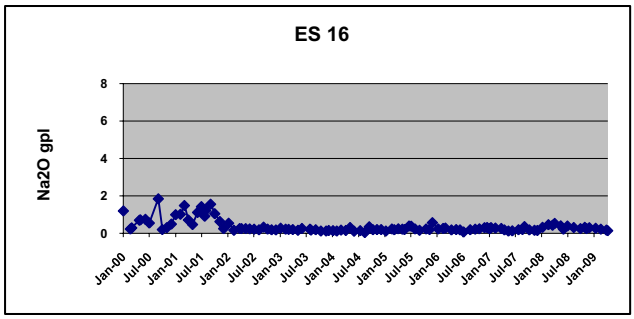


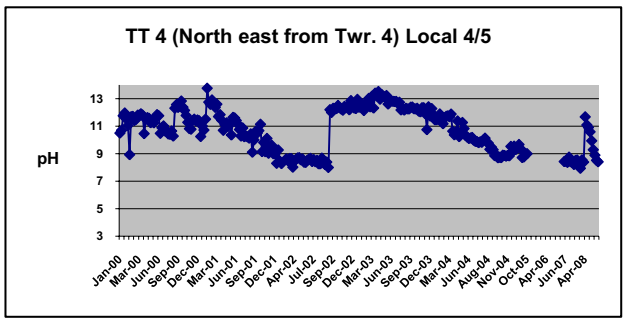
Estuary Streams (ES 1 - 16) Profiles

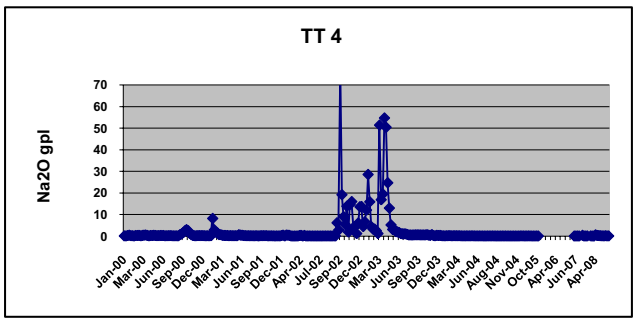


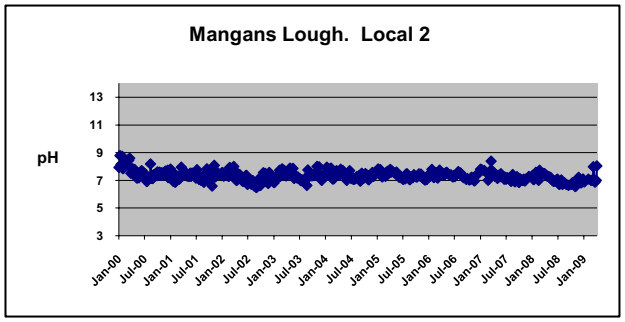


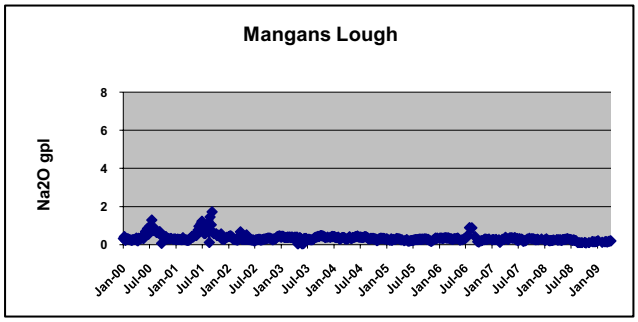


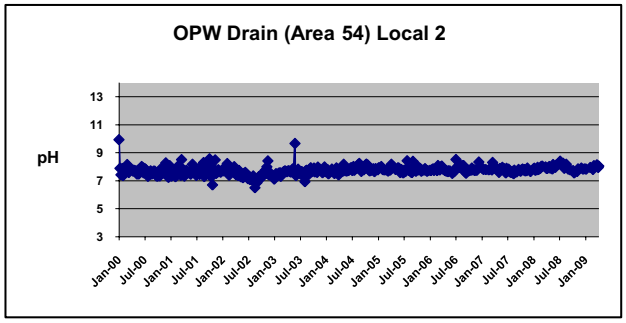


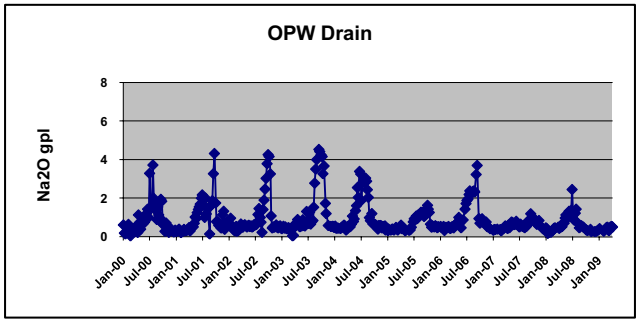


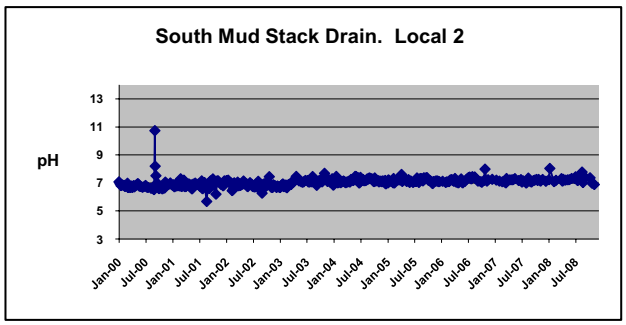


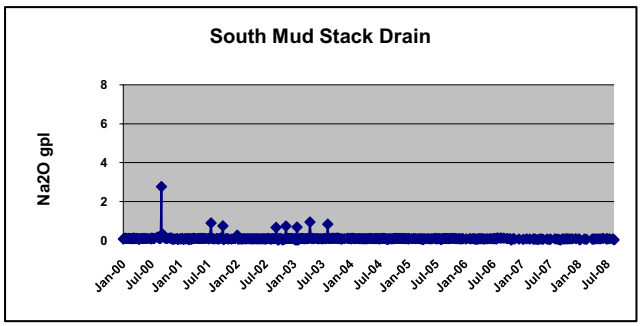




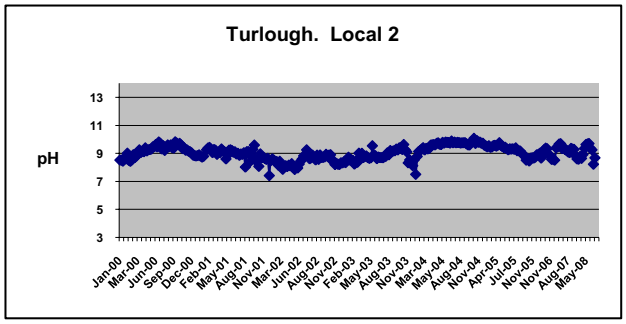


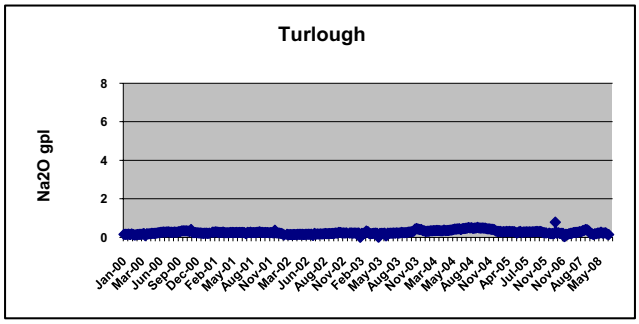


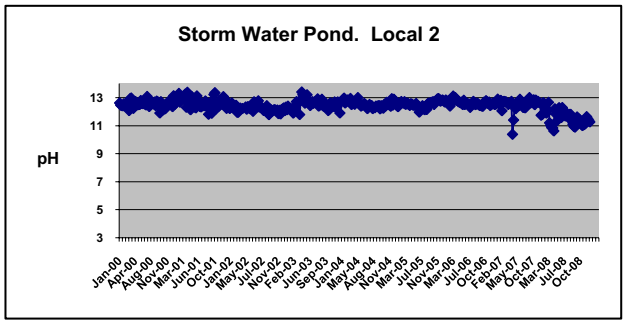


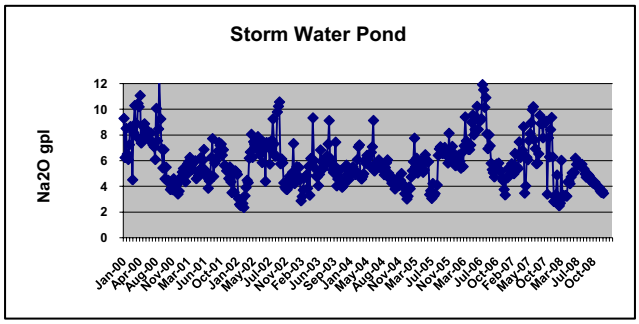


Estuary Streams (ES 1 - 16) Profiles









Attachment 10
Programme for Closure Planning & Re-vegetation of BRDA

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Review of Revegetation Work Conducted on Bauxite Residue Generated at the Aughinish Alumina Ltd. Refinery

1996 – 2008

Dr Ronan Courtney
Dept of Life Sciences
University of Limerick

March 2009

Table of Contents

Summary

The Aughinish Alumina Ltd. Refinery produces approximately 1.05 Mt of bauxite residue per annum. This residue is stored in a 105 ha site adjacent to the refinery. The establishment of a sustaining vegetation cover is the preferred method for post-closure management of residue storage area to control erosion and dusting of the residue and improve its aesthetic impact.

Although revegetation of bauxite residue has been demonstrated elsewhere it is recognised that the process is not straightforward. A research programme was initiated at AAL in 1996 develop methods to develop a system whereby indigenous vegetation can be successfully established on the residue. Following a series of greenhouse screening exercises a series of field trials were established directly on the residue in 1997 and 1999. Performance monitoring and establishing of further field trials has continued. Findings to date are summarised;

- Chemical and physical limitations of the refinery residues must be addressed prior to revegetation
- Process sand, gypsum and organic matter are essential components of the revegetation prescription
- Several indigenous species are capable of growing in amended bauxite residue
- Effective amendment of the residue results in lower plant content of Na, Fe and Al
- Nutrient cycling in the residue is seen a critical parameter to demonstrate that the vegetation cover is self-sustaining cover

1.0 Background

Alumina is extracted from bauxite ore with sodium hydroxide under high temperature and pressure (Bayer process). The waste remaining after alumina extraction is termed bauxite residue and consists mainly of iron-, aluminium-, and titanium-oxides, as well as reactive silica (clay minerals) that forms a sodium alumino-silicate, also termed desilication product (DSP).

An estimated 70 million metric dry tons of residue is produced globally per year and is disposed on land in large residue disposal areas (tailings dams), either as wet slurry or de-watered and dry-stacked.

Several uses for bauxite refinery residue have been investigated. However, quantities of residue currently produced vastly exceed demand, requiring that refinery disposal areas be revegetated when decommissioned to minimize environmental impact and improve visual amenity.

Although plant establishment is seen as a desirable means to achieve landscaping and stabilizing of the residues it is not a straightforward process. Bauxite residue is characterised by high pH (pH >10), high electrical conductivity (EC > 30 dS $m^{-}1$), and high exchangeable sodium percentage (>70%). Also, concentrations of plant nutrients such as calcium, magnesium, manganese, and phosphorus are low and the fine texture impedes penetration of plant roots. Consequently, the chemical and physical limitations of the refinery residues must be addressed prior to revegetation if the refinery residues are to form part of the plant growth medium.

The Aughinish Alumina Ltd. (AAL) refinery at Askeaton, Co. Limerick produces approximately 1.05 Mt of bauxite residue per annum, which is pumped to and stored in a bauxite residue disposal area (BRDA) of 104 ha.

Residues are separated at the clarification stage and can be differentiated into two fractions, the fine ‘red mud’ and a coarser fraction ‘process sand’. At AAL red mud is the principal fraction and accounts for ~ 95% of residue.

The mud fraction is dewatered by vacuum filtration to a solids concentration of 63 wt% before being slightly diluted and transported, by a 2km pipeline, to BRDA where it is discharged and spread and allowed to consolidate and dry in layers. The deposited mud is retained by a series of 2m high rockfill dykes underlain by separation/filter layer of process sand.

Revegetation of bauxite residues has been demonstrated at several sites globally. Since 1996 AAL have conducted revegetation trial work on residue in the BRDA. Laboratory investigation of residue and greenhouse growth trials followed by field trials has developed a revegetation prescription for use on the BRDA at AAL.

Plant growth in unamended bauxite residue is limited or fails (Figure 1) and amendment of residue is carried out prior to revegetation.

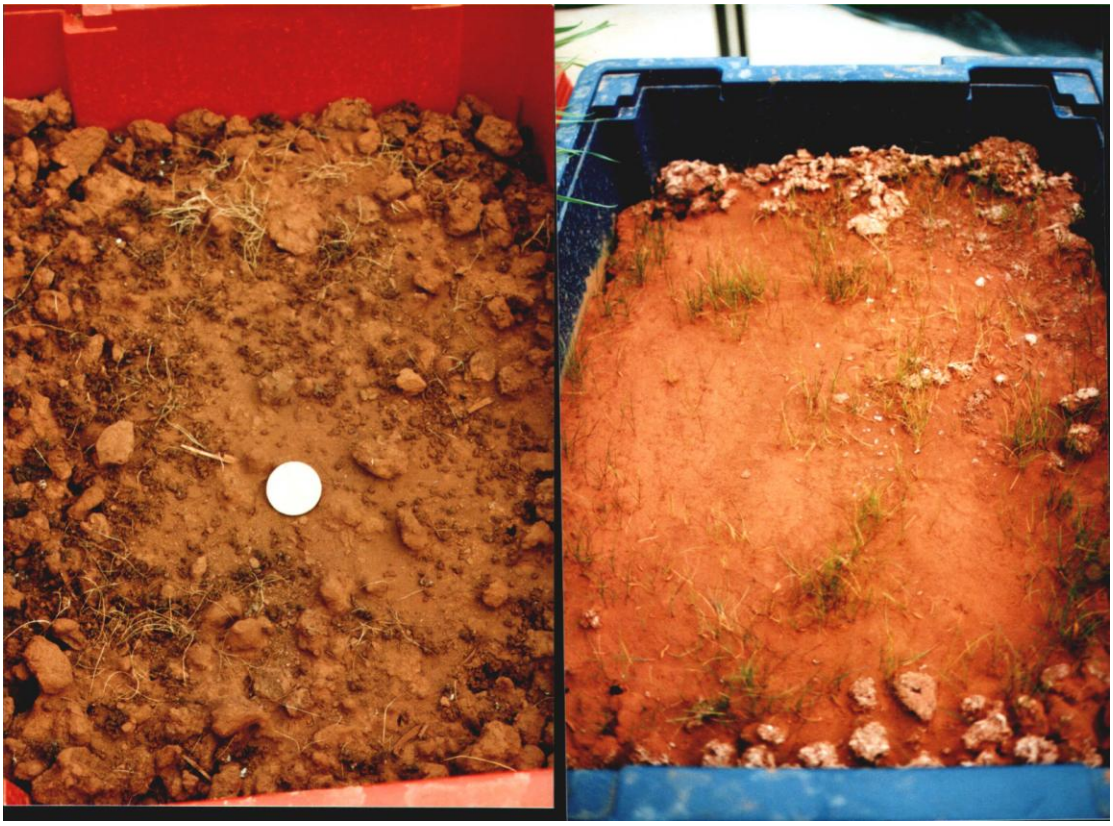

Figure 1. Greenhouse screening on residue amendment and suitable species for revegetation at Aughinish

2.0 Methodology Approach

A series of trials have been conducted on the residue produced at AAL both at laboratory and field level to develop revegetation programme for the management of residue in the BRDA.

The revegetation prescription used at AAL was developed following a series of laboratory and greenhouse trials followed by application of the method in the field at small scale level ($2m^2$).

2.1 Greenhouse trials on bauxite residue and amended bauxite residue (1998 & 1999)

Study Areas

- Residue physical and chemical properties.
- Use of amendments on residue properties.
- Screening of suitable species for revegetation.

2.2 Field trials, c. 210 m^2 (1997 – 1999)

Study Areas

- Methods for spreading and incorporation of amendments
- Leaching and monitoring period
- Application of organic amendments and incorporation into amended residue
- Seeding with selected species

2.3 Field trials, c. 250 m^2 (1999 – 2000)

Study Areas

- Effect of amendments on residue properties
- Plant uptake in revegetated residue

2.4 Field investigations (2005)

Study Areas

- Survey site areas 2.2 and 2.3.
- Characterisation of residue in revegetated areas
- Elemental content of vegetation in revegetated areas
- Flora diversity of revegetated areas
- Invertebrate activity in revegetated areas

2.5 Field trials, c. 4,500 m^2 (2006 – 2008)

Study Areas

- Investigating variations of the procedure to optimise conditions for preparing residue prior to seeding
- Use of gypsum at 0, 40 and 90 t/ha
- Use of organic amendment at 0, 60, 80 and 120 t/ha
- Use of inorganic fertiliser (NPK and superphosphate) on plant growth
- Seeding regime (seed composition and seeding rate)

- Field experiments (2006) investigating suitability of described method on recently deposited (fresh) residue at large scale level

2.6 Greenhouse trials (2007)

Study Areas

- Seed germination and root growth bioassays for assessing properties of Aughinish residue inhibitory to plant growth

2.7 Trial cell (0.6 ha) revegetation area (2007-ongoing)

Study Areas

- Revegetation prescription is effective on residue typical of a closure scenario
- Sustainability of vegetation cover system
- Performance monitoring of residue and vegetation properties for c. 5 years

3.0 Discussion of Results

3.1 Residue Amendment

3.1.1 Use of gypsum and process sand

Laboratory characterisation showed the residue to be

- alkaline (pH 9.7 – 10.9)
- sodic (exchangeable sodium percentage 62 – 86%)
- saline (electrical conductivity 0.5 – 2.6 mS/cm)
- high exchangeable aluminium (KCl extractable 20 –40 mg/kg)

Use of gypsum for amending bauxite residue has been frequently used. Examples of worldwide revegetation programmes using gypsum is summarised in Table 1.

Table 1. Use of gypsum in bauxite residue revegetation

Refinery	Gypsum Used	Species Used	Source
Kwinana (Alcoa) Australia	0, 2, 5 & 8 % w/w	Agropyron elongatum Cynodon dactylon	Wong and Ho, 1993
Pinjarra (Alcoa) Australia	50 t/ha	Medicago sativa	Gheradi&Rengel, 2003
		Secale cereale Lolium rigidum	Eastham et al., 2006
Worsley (Australia)	80 & 160 t/ha		Worsley Alumina Environmental Report, 1997
Kirkvine, Jamaica	10, 20, 40 & 60 t/ha		O'Callaghan, 1998
Mobile, Alabama Alcoa (USA)	40, 50 & 60 t/ha	Agropyron elongatum Distichlis spicata	Bucher, 1985

Reductions in residue pH, Al, EC and ESP following use of gypsum have been reported.

The coarse fraction of the residues presents fewer difficulties in establishing vegetation because of the higher hydraulic conductivity, which increases leaching and thereby reduces the salinity and alkalinity (Meecham and Bell, 1977). Wong and Ho(1994) cited 'the predominance of the fine fraction' as a major constraint limiting red mud reclamation efforts.

Conversely, sand fractions have a low water-holding capacity which provides conditions where availability of nutrients is markedly diminished and the surface layers tend to dry out easily, this can be a significant disadvantage for rehabilitation to take place (Williamson *et al.*, 1982; Gheradi and Rengel, 2003).

At AAL the revegetation prescription employs a mix of gypsum and process sand to amend the fine fraction residue (red mud). Field trials were established employing the revegetation prescription in 1997 and 1999 (Figure 1). Optimization of the prescription rates is currently being examined in field trials established in 2006 (Figure 1).

Typical improvements that have been achieved in residue at AAL are listed.

	Before Amendment	After Amendment
pH	11-12	8.6 – 9.5
EC (mS/cm)	2.6	0.5-0.8
ESP (%)	67-82	12-31
Al (mg/kg)	43	<1 - 1.8

3.1.2 Organic Amendment

Lack of organic matter and nutrient deficiency is recognised as a limiting factor in establishing vegetation on the residue. Incorporation of organic matter into the rooting medium is a critical component of the revegetation prescription. Several organic amendments have been investigated in greenhouse and field trials.

- Spent Mushroom Compost
- Thermally Dried Sewage Sludge
- Topsoil
- Farmyard Manure
- Agro-industrial Sludge

Continuing work on organic matter application is investigating

- Optimum application rates of organic matter (OM)
- Role of OM in addressing nutrient deficiencies
- Role of OM in promoting soil development
- Use of biosolids as a source of organic matter with and without the supplemental use of fertilisers
- Effect of management of revegetated areas (e.g. mowing, fertiliser application)

Figure 2. Improving the physical and chemical properties of bauxite residue prior to revegetation

Figure 3. Effects of different amendments on grass growth

Figure 4. Trials using different amendments for revegetation

Nutrient status of revegetated residue (c. 5 yrs previously) was investigated. Amended residue exhibited

- Organic matter content strongly influences organic carbon, total kjeldahl nitrogen (TKN) and available phosphorous
- Nitrogen and organic carbon values have increased significantly compared to values for unamended residue
- Much of the P remains locked up in the residue matrix with low levels of phosphorous available
- Calcium does not appear to be deficient but excess exchangeable Ca may limit Mg availability
- Application of fertiliser appears to have influenced K nutrition. Long term effect of fertiliser management needs to be assessed
- Mn nutrition remains deficient

A concern with vegetation growing on bauxite residue is that excessive levels of Na or elevated pH may reoccur due to flooding with process water or sodium release from within desilication products (DSP) in the residue. Such conditions may cause established vegetation to regress or die-back. Areas of the BRDA that had vegetation were revegetated in 1997 and 1999 were sampled in 2005 to investigate chemical properties of the residue. Properties are summarised below.

pH	8.02 – 8.14
EC (mS/cm)	0.28 – 0.52
Na (mg/kg)	305 – 432
Al (mg/kg)	< 1

Residue in revegetated area is not exhibiting excessive pH, Al or ESP.

3.2 Suitable Species for the Revegetation of Bauxite Residue at Aughinish

A selection of grass species and cultivars were selected for screening trials in the greenhouse. Choice of species and cultivars were determined by literature review of species growing on similar residues and mine wastes, identification of volunteer species on areas of the BRDA and commercial availability.

Findings of screening trials on residue and residue amended with gypsum and organic matter are summarised.

- Poor germination and initial seedling growth limited by both poor chemical conditions and physical conditions in the residue
- Physical and chemical amendment of residue is necessary before seeding
- Amending with process sand and gypsum followed by a period of leaching greatly improves germination and growth of tested species
- Several indigenous species are capable of growing amended bauxite residue at AAL (see below)
- Organic matter alone is not a sufficient amendment if residue exhibits excessive pH, ESP
- Amendment with gypsum, process sand and organic matter produces optimum growth in residue

Species capable of growing in amended bauxite residue at AAL.

Avena sativa	Oats
Agrostis stolonifera	Creeping Bent
Agrostis capillaris	Common bent
Cynosurus cristatus	Crested Dog's Tail
Festuca ovina	Sheep's Fescue
Festuca rubra	Red Fescue
Holcus lanatus	Yorkshire Fog
Hordeum vulgare	Barley
Triticum aestivum	Wheat
Lolium perenne	Perennial Ryegrass
Puccinellia distans	Salt marsh grass
Rumex acetosa	Common Sorrel
Rumex crispus	Curled Dock
Trifolium pratense	Red Clover
Trifolium repens	White Clover

Composition of seed mixture will be affected by what is commercially available at time of seeding. Colonisation by further species occurs on areas once vegetation is established.

Residue that had previously been revegetated, 1997 and 1999, was surveyed in 2005. Species diversity was recorded and compared to the initial seed mixture of 6 species. Species identified on revegetated areas are listed in Appendix 1.

- There were 50 species belonging to 40 genera and 16 families
- Asteraceae and Poaceae were the dominant families
- Seven leguminous species were recorded growing
- Dominant grass species were *Holcus lanatus* with *Festuca rubra* and *Agrostis stolonifera*
- Although useful as a nurse crop, *Lolium perenne* may not persist long-term
- Woody species *Betula*, *Salix* and *Alnus* have established on the revegetated areas
- Patches of hay, previously used to suppress dust, acted as a seed source

Figure 5. Selection of Species growing on revegetated residue

Figure 6. Selection of Species growing on revegetated residue

Figure 7. Vegetation established on residue with invertebrate activity

3.3 Plant Elemental Content

Trials have demonstrated that addition of process sand and gypsum is effective in lowering uptake of Na, Al and Fe in plants. Findings at AAL are in keeping with those reported at other refineries. Long-term monitoring is necessary to evaluate effect of low P and Mn in vegetation growing on amended bauxite residue.

Effect of gypsum and process sand on the growth of *Trifolium pratense* in amended residue at AAL was evaluated in a series of field trials (1999). Findings are summarized:

- *Trifolium pratense* grown in gypsum-amended treatments had significantly lower aluminium concentration than those in non-gypsum treatments and levels are not considered excessive.
- This trend was also found for plant iron concentration
- Gypsum amendment produced lower Na concentration in herbage, concentrations were markedly decreased with greater process sand addition
- Higher manganese concentrations were observed for *Trifolium* grown in treatments with gypsum addition.
- Sodium levels in the substrate were not high enough to affect calcium in the plant cells. Calcium levels were in the range deemed adequate for the growth
- Marginal Mg, P and K deficiency was found
- Mn nutrition may be a limiting factor in achieving long-term growth
- Nitrogen nutrition is not adversely affected in organically amended residue

Performance of and elemental uptake for two grass species (*Holcus lanatus* and *Lolium perenne*) was evaluated over a two-year growing period (2000 and 2001) on amended residue. Findings are summarized:

Herbage Nutrient Analysis – Year 1

- Herbage sodium concentrations were above the Irish national mean. However, they were much lower than levels cited as high for *L. perenne*
- Sodium toxicity is not considered an issue in the present study
- Calcium levels were within the range typical for Irish grasses and not considered deficient
- Potassium and Magnesium are marginally deficient but are not considered to be an inhibitory factor in vegetative growth for year one
- Phosphorous nutrition is not limiting in the amended bauxite residue
- Grass Mn values were less than the critical value and also lower than the Irish mean values. Manganese deficiency may be a limiting factor in achieving longterm growth of the native species on amended residue.
- Nitrogen levels determined for the two grasses can be considered marginally deficient. Even with organic amendment and inorganic fertiliser application, nitrogen levels were low.
- Incorporation of legumes in seeding mixture is recommended.

Herbage Nutrient Analysis – Year 2

- Significantly lower biomass was recorded for the second years growth
- Levels of sodium recorded were significantly lower than for the previous years
- although levels are still high, the decrease in sodium content for all treatments indicates that sodium uptake and toxicity in not a contributing factor for the decrease in dry weight biomass recorded
- Calcium, nitrogen and phosphorous herbage concentrations decreased and may reflect a decrease in levels of available Ca, N and P in the amended residue
- Magnesium levels decreased to below the critical threshold for deficiency symptoms
- Mn levels were significantly lower in herbage. Mn nutrition in amended residue needs further investigation
- Lower biomass production is attributed to nutrient deficiencies rather than alkalinity or high ESP

Revegetation trials established on amended residue at AAL in 1999 were examined again in 2005. Chemical composition of the two dominant species (*Holcus lanatus* and *Trifolium pratense*) is summarised below,

- Nitrogen levels in *H. lanatus* are close to Irish grassland mean values. *Trifolium pratense* nitrogen is adequate
- Foliar P is only marginally deficient; application of inorganic P fertiliser may be effective in increasing foliar P concentrations. Role of organic matter in P nutrition in the residue needs further investigation
- Adequate levels of foliar Ca for both *T. pratense* and *H. lanatus* indicate that Na soil concentrations are not affecting plant uptake
- levels of *T. pratense* foliar K are adequate and levels for *H. lanatus* are greater than average critical range for temperate grasses
- gypsum amendment of residue can cause lower Mg concentration in plants
- Mn is low and reflects the low levels of extractable Mn in the amended residue
- Role of fertilizer application and gypsum amendment on plant composition should be further investigated

3.4 Residue Amendment and Plant Screening – Greenhouse Trial

The major constraints and suitable plant species for revegetation of bauxite residues will vary with each site. In order to further identify residue properties that are inhibitory to seed germination and seedling development in Aughinish bauxite residue and establish critical levels, a series of germination and root growth bioassays were used on bauxite residue from Aughinish were performed

Unamended residue was characterized as having high pH (11.3), sodicity (ESP 92%), and salinity (EC 14 mS cm^{-1}).

Gypsum amendment at rates of ≥45 t/ha reduced pH, soluble Al and ESP of the residue and increased Ca and Mg content. High rate gypsum amendment of the residue can result in a higher EC and further leaching may be required.

All test species failed to germinate in fresh residue that had not been amended or leached. Amendment of the residue improved chemical properties and greatly increased seedling performance in four test species.

Relative seed germination had significant negative correlations with residue pH, EC, Na, Exchangeable sodium percentage (ESP).

Relative root growth had significant negative correlations with residue pH, EC, Al, Na and ESP. Ca and Mg content of the amended residue were significantly correlated with relative root growth. Ca content in gypsum-amended treatments had a growth stimulating effect on plant growth. Germination index values of >80% in amended residues indicated disappearance of phytotoxicity.

Lolium perenne and *Trifolium pratense* were identified as useful species for revegetation of amended bauxite residue.

3.5 Residue Amendment - Field Trials with Gypsum and organic matter

In order to optimise the amendment procedure for revegetation at Aughinish, a field experiment was conducted to evaluate the use of organic matter [spent mushroom compost (SMC)[with gypsum as amendments for promoting vegetation cover on bauxite residue. Residue was amended at varying rates of SMC (0, 60, 80 and 120 t/ha) and gypsum (0, 40 and 90 t/ha) and sown with *Holcus lanatus*. Following a one-year growing period, residue properties and plant performance.

Treatment	SMC (t/ha)	Gypsum (t/ha)	Biomass (kg/2m^2)
1	0	0	0
2	0	40	0
3	0	90	0
4	60	0	1.8±0.025
5	60	40	2.6±0.080
6	60	90	2.8±0.100
7	80	0	3.6±0.033
8	80	40	3.7±0.13
9	80	90	4.2±0.22
10	120	0	3.8±0.073
11	120	40	4.9±0.059
12	120	90	4.9±0.16

Table 2. Residue treatments showing variation of organic and gypsum amendment with first year biomass values

Figure 8. Vegetation grown in amended bauxite residue with organic amendment (right) and without (left)

Physical Properties

The principal fraction of bauxite residue produced, fine fraction (red mud), consisted mainly of silt (44%), clay (37%) and sand (19%). Fine fraction residue (red mud) has a silt-clay-loam texture and lacked aggregation. Typical red mud gradings show up to 20-30% clay sized particles, with the majority of particles in the silt range.

Unless amended and vegetation established, the massive structure and lack of aggregation of the residue is likely to pose erosion problems

Physical properties of the substrate were significantly affected by organic (SMC) application rate to the residue.

- SMC significantly reduced the bulk density and particle density of the residue

- Organic carbon content increased with SMC application rates, with significant increases for each application rate
- pH was significantly reduced when amended with gypsum
- SMC amendment without gypsum was also effective in lowering pH of residue but only significantly at higher rates.
- EC values significantly increased with increasing gypsum application rates due to the formation of salts
- Application of gypsum was the principal mechanism in reducing residue pH and ESP
- Gypsum application promoted flocculation of clay sized particles thereby reducing clay dispersion in the residue

Chemical Properties

Amendment of the bauxite residue to create a growth medium suitable for plant establishment is critical for successful revegetation. Unamended bauxite residue is nutrient poor with no nitrogen detected in treatments without organic application. Micronutrient status was also lowest in this treatment. Furthermore, no sward development persisted in treatments without SMC application for biomass yield to be determined.

Substrate levels of nutrient N, P, K, Mg, Cu, and Mn were increased with SMC application.
Residue cation imbalance, namely ESP, was greatly improved through gypsum application.

Dry weight biomass increased with each application rate of SMC reflecting the improvement in residue nutrient properties.
Plant performance was further enhanced through increased application of gypsum reducing substrate sodicity.

Plant performance (measured by dry weight biomass) was positively correlated with substrate levels of K, C, Mn, Zn, Mg, Cu, and N.
Levels of ESP in the amended residue was negatively correlated with biomass

3.6 Large Scale Field Trial Implementation

Previous field trial work conducted on the bauxite residue at Aughinish has focused on small level ($2m^2$) plots. Amendment and management practices within these smaller plots can be performed manually. However, transfer of this methodology to a closure scenario will necessitate adaptation in areas such as amendment spreading and incorporation. A series of large-scale trials (400 m^2) were implemented in 2007 to develop practices for residue amendment and seedbed preparation at large-scale level.

Figure 9 indicates some of the stages in residue amendment for seedbed preparation. Findings from this work shows that the key stages in the revegetation programme can be achieved at a large-scale level. These include the ability for the residue to support movement of traffic. Methodologies have been developed for spreading large volumes of amendment (chemical, physical and organic). A successful seedbed can be established in the residue using conventional agronomic procedures.

Figure 9. Various stages of residue amendment at large scale level

Figure 10a. Successful amendment and vegetation establishment in large scale plots

A range of grassland species can be used in the seeding once the inhibitory properties of the residue are overcome and a seedbed with adequate nutrients and organic matter is established. Grassland species successfully established in this work include

Cynosurus cristatus	Crested Dogtail
Holcus lanatus	Yorkshire Fog
Festuca rubra	Red Fescue
Dactylis glomerata	Cocksfoot
Lolium perenne	Perennial Ryegrass
Agrostis.capillaris	Common Bent Grass
Trifolium pratense	Red Clover
Trifolium repens	White Clover
Agrostis stolonifera	Creeping Bent

Also of note is the importance for sufficient spreading and incorporation of the various amendments and an adequate period of leaching is observed before seeding.. Figure 10b illustrates poor germination and seedling development in areas where amendment has not been sufficient and the bauxite residue cannot support plant growth.

Figure 10b. Different areas of residue from large scale amendment where sufficient amendments were not applied

4.0 Ongoing Research

A large-scale (0.6 ha) dedicated research trial area has been created within the BRDA. This trial area has received residue and is currently undergoing amendment and leaching. It is anticipated that this trial area will be revegetated in Spring/Summer 2009.

It is recognised that the establishment of plant cover on residue is only part of the re-vegetation objective. The main aim of any restoration process is to create sustainable plant communities representative of the composition and diversity of the surrounding natural plant communities. To adequately monitor and manage this ecosystem development a programme has been developed and will be enacted once the vegetation cover is established.

A bi-annual monitoring and sampling programme will be carried out on the emerging plant/residue soil system and functioning ability of this system. By achieving completion criteria as detailed it is proposed that this system can be proven to be sustainable/ self-regulating.

It is proposed that through delivery of 'Completion criteria' sustainability of the vegetation cover system can be demonstrated. Key components of the monitoring programme will contain;

- Vegetation establishment, survival and succession
- Vegetation productivity, sustained growth and structure development;
- Fauna colonisation and habitat development;
- Ecosystem processes such as soil development and nutrient cycling,
- Colonisation of specific fauna groups that are involved in these processes
- Microbiological studies e.g. colonisation by mycorrhizal fungi and microbial biomass
- Ecosystem recovery e.g. resilience of vegetation to disease or drought.

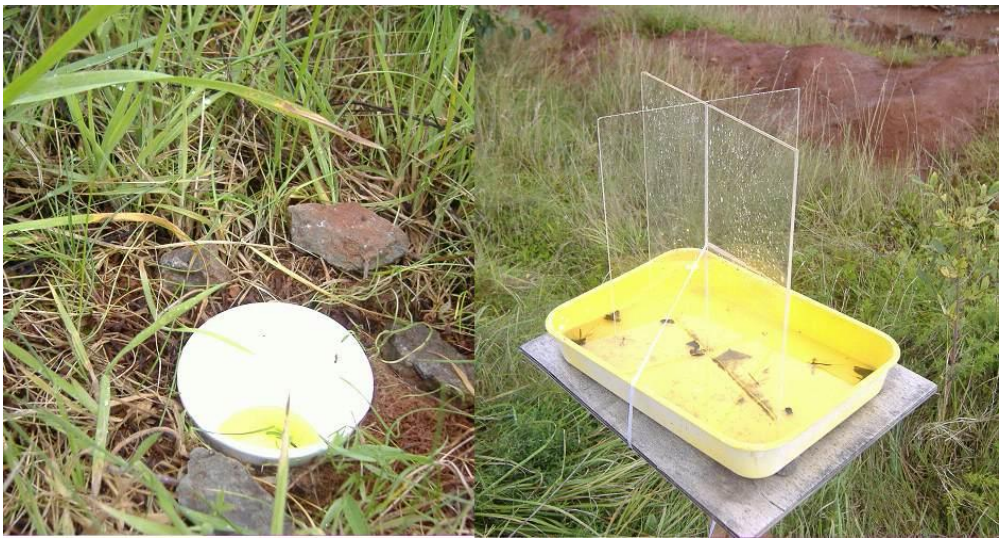

Figure 11. Example of invertebrate sampling on revegetated residue

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Wong, J. W. C. and G. E. Ho (1993) Use of waste gypsum in the revegetation on red mud deposits: A greenhouse study. Waste Management & Research 11: 249-256.

Worsley Alumina Environmental Report (1997) Development of a bauxite residue disposal area rehabilitation prescription: Residue Preparation Trial 1994 - 1997

Appendix 1. Species identified growing in amended bauxite residue at AAL (Families in bold)

Apiaceae /Umbelliferae
Angelica sylvatica
Daucus carota
Asteraceae/Compositae
Achillea millefolium
Centaurea nigra
Chrysanthemum leucanthemum
Circium arvense
Cirsium vulgare
Hypochoeris radicata
Lapsana communis
Leontedon autumnales
Leontodon hispidus
Leontodon taraxacoides
Senecio jacobea
Sonchus arvensis
Taraxacum sp.
Tussilago farfara
Betulaceae
Betula
Cyperaceae
Carex flacca
Caryophyllaceae
Cerastium fontanum
Fabaceae/ Leguminosae
Lathyrus pratensis
Lotus corniculatus
Medicago lupulina
Medicago nigra
Trifolium pratense
Trifolium repens
Vicia sepium
Gentianaceae
Blackstonia perfoliata
Hypericaceae(Clusiaceae)
Hypericum perforatum
Onagraceae
Epilobium angustifolium
Epilobium hirsutum
Epilobium parviflorum
Orchidaceae
Anacamptis morio
Dactyloriza fuchsii
Gymnadenia conopsea
Poaceae
Agrostis stolonifera
Anthoxanthum odoratum
Arhenatherum elatius
Dactylis glomerata
Elymus repens
Festuca rubra
Holcus lanatus
Lolium perenne
Phleum pratense
Polygonaceae
Rumex acetosa
Rumex crispus
Ranunculaceae
Ranunculus acris
Ranuculus repens
Rubiaceae
Galium palustre
Salicaceae
Salix sp.
Urticanceae
Urtica dioica

Appendix 2. Publications and Presentations Arising from Work

Courtney, R. (2002) The development of a rehabilitation system for the red mud residue generated at the Aughinish Alumina Bayer Plant, PhD Thesis, Institute of Technology, Sligo

Courtney, R.; Timpson, J. and Grennan, E. (2003) Growth of *Trifolium pratense* in red mud amended with process sand, gypsum and thermally dried sewage sludge. *International Journal of Surface Mining, Reclamation and Environment*, 17:4: 227-233

Courtney, R. and Timpson (2005) Nutrient status of vegetation grown in alkaline bauxite processing residue amended with gypsum and thermally dried sewage sludge - A two-year field study. *Plant and Soil*, 266:1:187-194

Courtney, R. and Timpson (2005) Reclamation of fine fraction bauxite processing residue (red mud) amended with coarse fraction residue and gypsum. *Water, Air and Soil Pollution*, 164:1: 91-102

Courtney, R. and Mullen, G. (2009) Use of germination and seedling performance bioassays for assessing revegetation strategies on bauxite residues. *Water, Air and Soil Pollution*, 197: 15-22

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Attachment 11

BRDA Operational Plan

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Bauxite Residue Disposal Area

Operational Manual

March 2009

Bauxite Residue Disposal Area (BRDA)

Operational Manual

Contents

Attachments

Attachment A Drawings

1.0 Introduction

The Bauxite Residue Disposal Area (BRDA) is a dedicated facility, owned, developed and operated by Rusal Aughinish Ltd as the landfill/tailings storage area for the permanent deposition of specific bauxite and process residues generated within the alumina extraction plant.

This Operational Plan includes all relevant data for the effective operation, monitoring long-term planning and aftercare of the mud stack. It is intended to demonstrate that the BRDA operations are in accordance with best management practices, the environmental policies of Rusal Aughinish Ltd and the existing IPPCL conditions.

1.1 Specific IPPCL Conditions

The development, management and placement of Bayer process residues within the bauxite residue disposal area is covered under Condition 8.3 of the IPPC licence as follows:

8.3 Waste disposal in the on-site landfill (BRDA):

8.3.1 Only those waste materials identified in *Schedule A Limitations* of this licence shall be disposed of in the BRDA. No other waste materials shall be disposed of to the BRDA without the prior written agreement of the Agency.

8.3.2 The licensee shall have regard to all current and any future guidelines issued by the Agency with regard to landfill sites for waste disposal.

8.3.3 No new cell or operational phase of the BRDA may be developed without the prior written agreement of the Agency.

8.3.4 Salt cake waste shall be placed into a specially designated and operated area of the BRDA.

8.3.5 Design and construction details for all basal, side and capping containment engineering works proposed for any part of the BRDA must be as agreed in writing by the Agency prior to construction.

8.3.6 All basal, side and capping containment engineering works proposed for any part of the BRDA, must be carried out under an Agency agreed Construction Quality Assurance (QA) Plan.

8.3.7 No remedial pollution control/monitoring works or installations other than those necessary in an emergency shall be effected on any part of the BRDA without the prior written agreement of the Agency.

8.3.8 The BRDA shall be operated in accordance with a comprehensive and detailed Operational Plan as agreed with the Agency. This plan shall be reviewed annually and any amendments notified to the Agency as part of the Annual BRDA Status Report (Condition 8.3.12), for agreement. The Plan and any reviews shall, as a minimum, comprise the following elements:

(i) Site management & responsibilities.

(ii) Operational principles.

(iii) Waste analysis.

(iv) Waste handling & placement.

(v) Design, operation and closure of the hazardous waste disposal cell.

(vi) Emergency procedures.

(vii) Dust control.

(viii) Surface water management and protection.

(ix) Groundwater management and protection.

(x) Leachate management and disposal.

(xi) Life expectancy.

(xii) Development programme.

(xiii) Restoration.

(xiv) Aftercare management.

(xv) Environmental Monitoring Programme (scope, frequency, instrumentation, locations, design and maintenance of monitoring points, quality control, recording, protocols, assessment, reporting, procedures for non-compliance) for;

- Surface water monitoring.
- Groundwater monitoring.
- Leachate monitoring.
- Mud stability, levels and void monitoring.
- Estuarine soils stability (adjacent to landfill).
- Meteorological monitoring.
- Dust monitoring.
- Vegetation cover.

The licensee shall, when preparing the environmental programme, have regard to the Landfill Monitoring manual published by the Agency.

8.3.9 The Operational Plan shall apply to closed and currently active areas of the BRDA as well as any new cells developed with the agreement of the Agency.

8.3.10 Leachate generated by the BRDA shall be monitored as set out in *Schedule C.4 Waste Monitoring* of this licence.

8.3.11 Leachate generated by the BRDA shall not result in environmental pollution as a consequence of uncontrolled migration or discharge.

8.3.12 The licensee shall submit on an annual basis a BRDA status report. This report shall contain as a minimum the elements detailed in *Schedule D: Annual BRDA Status Report* of this licence.

8.3.13 The licensee shall implement the recommendations of the Golder Associates report (ref 05515445) received on 27 April 2006 as part of the review application for licence register P0035-04. The implementation of the individual recommendations of the report (ref 05515445) shall be undertaken on a timescale agreed by the Agency that is commensurate with risk reduction and based on an assessment by a competent person, with this assessment to be submitted to the Agency within 3 months of the date of grant of this licence. Progress reports shall be submitted as part of the Annual Environmental Report.

8.3.14 The licensee shall implement the recommendations in subsections titled Closure Planning; Closure Revegetation; Post-Closure; and, Alternative Uses of Residue, in Section 8 of the Residues Solutions Report (ref 220-1-001 Final, dated July 2007) received on 4 July 2007 as part of the review application for licence register P0035-04. A written confirmation of implementation or commencement of the recommendations shall be submitted to the Agency within 12 months of date of grant of this licence, with progress reports submitted thereafter as part of the AER.

8.3.15 By 1 January 2012 the mud and sand residues deposited in Phase 2 shall be subject to a neutralization step (soluble alkalinity as a minimum). Sand residues may be exempted from neutralization with agreement by the Agency, where it can be demonstrated that it would be of limited environmental benefit. Any request for the exemption of sand residues from the requirement for neutralization shall be supported by an environmental impact and cost benefit analysis report, with the scope of this report to be agreed in advance by the Agency.

8.3.16 The licensee shall report annually on progress towards the achievement of neutralization of mud residues.

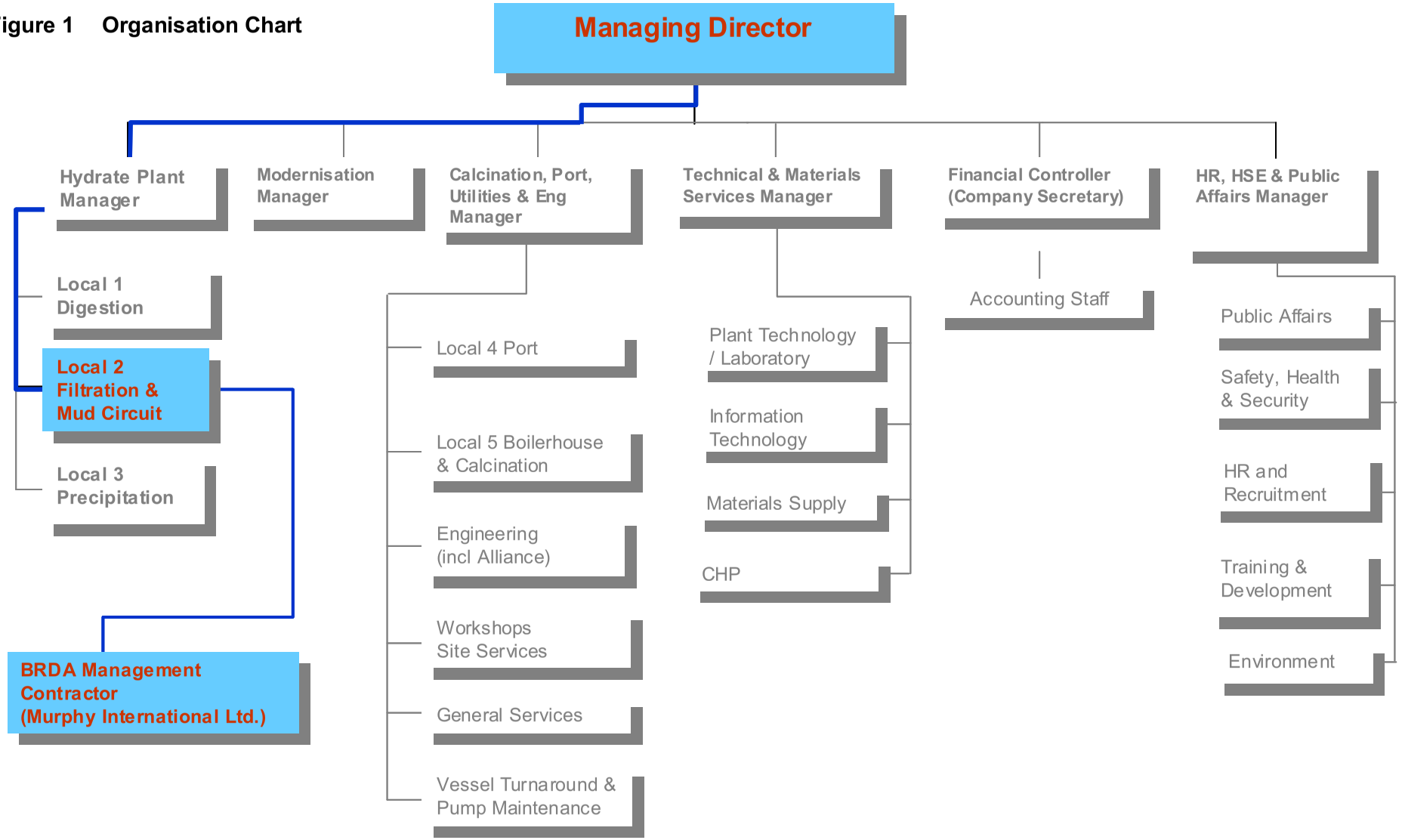
8.3.17 Unless otherwise agreed in writing the neutralization referred to in Condition 8.3.15 shall be by the Carbonation process. Any request for variation in this specified technology shall be supported by a comprehensive feasibility/unfeasibility statement having regard to the principles of BAT.

8.3.18 The final 1m of all exposed red muds deposited in Phases 1 and 2 of the BRDA shall comprise 'amended mud'. This 'amended' layer shall include a proven composite of neutralized process residues, sand, gypsum and organic material. The amendment layer shall be underlain by a capillary break layer of process sands or equivalent approved. The licensee shall in advance of preparation and deployment of this amendment layer submit for Agency approval the specifications and rationale for the proposed composition of this cover layer.

8.3.19 Unless otherwise agreed with the Agency the licensee shall continue to operate a dedicated trial research area for closure/revegetation research. Annual progress reports on research findings, and operational decisions flowing therefrom, shall be reported as part of the AER.

This Operational Plan has been structured in order to facilitate a clear presentation of relevant information as required by Condition 8.3.

Figure 1 Organisation Chart



2.0 Site Management and Responsibilities

The Hydrate Plant Manager has overall responsibility operation of the bauxite residue disposal area (BRDA).

The BRDA is referred to as Area 54 (A54) and is within the functional area of Local 2 - Filtration and Mud Circuit. Local 2 is involved in the separation of bayer process residues (red mud, sand) from process liquor. The separated residues are placed in the BRDA, while process liquor is passed via filtration onto precipitation (Local 3).

The Local 2 Co-ordinator has functional and administrative responsibility for the management of the bauxite residue disposal area.

Placement of waste material within the mudstack is undertaken by Murphy International Ltd. under a Site Process Materials Management Contract.

The Local 2 Operations Facilitator has overall responsibility for day-to-day operations.

The Local 2 Operations Engineer has overall responsibility for technical developments in the residue production and effluent treatment operations.

The Engineering Dept. Principal Engineer has functional responsibility for all technical developments within the BRDA area and advises the Operations Engineer.

The BRDA Operations Contractor is responsible for all landfill operations and maintenance as per contract.

All queries from members of the public are managed by the Public Affairs Manager.

All liaison with and queries from the EPA are managed by the Environmental Co-ordinator

The following describes the personnel and their roles associated with the BRDA area.

Operation of the BRDA

The day-to-day operation of the BRDA is carried out under the Site Process Materials (SPM) Management Contract. Under this contract, Murphy International Ltd. (the Contractor) has responsibility for the following:

- *Collection, transport and placement of all process plant residues at the BRDA.*
- *Maintenance and organization of red mud placement operations*
- *Reporting of waste quantities deposited to the BRDA to Local 2.*
- *Organisation and development of all landfill operations and maintenance, including construction of internal access roads.*
- *Organisation and implementation of all internal storage developments within the mudstack, including perimeter rockfill construction.*
- *Organisation, implementation and maintenance of environmental protection measures*

The Process Operators (PO), working as a team with the Site Process Materials Management Contractor, are responsible for the day to day running of the BRDA area.

Their responsibilities include:

1. Patrolling and liaising with Contractor on discharge points to be operated. Assessing the vulnerability of dusting and liaising with contractor on appropriate measures to suppress it.
2. Priming the dust suppression sprinkler system with water when advised by the contractor.
3. Submitting job-tickets for any maintenance work required.
4. Participating in the formulation of longer-term strategies in conjunction with the Local 2 Coordinator and his team.

The Local 2 Coordinator with support from the Central Engineering Dept manages the construction of rockfill embankments on the periphery of the mud-stacking areas.

Control of Mud Quality

The Control Room Operator (CRO) is responsible for monitoring mud throughput and mud line pressure.

The Process Operator (PO) is responsible for sampling, field patrols, filter checks, pump checks, filter washing and mud line pressure control. The PO has responsibility for bringing on and off line filters, washing filter cloths and flushing of vents when washing (1A, 1B, 2A, 2B, 3A, 3B and 50A/50B).

The Process Engineer is responsible for monitoring and achieving all long-term trends and process targets.

Mud Washing

The Control Room Operator (CRO) is responsible for, monitoring wash flow and filter speed.

The Process Operator (PO) is responsible for, sampling, field patrols, wash distribution and cloth repairs.

Management of runoff from the BRDA – (Water Management)

The Control Room Operator (CRO) is responsible for monitoring pond levels and stream distribution. The CRO records any non-compliance in the L2 Day Log and reports these to the Shift Plant Facilitator. (SPF). The SPF reports any non-compliances in the shiftlog.

The Process Operator (PO) is responsible for sampling, field valve set up and field patrols.

The Environment Coordinator is responsible for formal notification of the Environmental Protection Agency (EPA) as soon as practicable regarding IPPC licence non-compliances.

Pond Clean Outs and Inspection

The Local 2 process engineer and facilitator are responsible for deciding when a clean out may commence and where the clean out sludge should be disposed of.

The Environmental Engineer is responsible for reviewing clean out operations and to advise on environmental control measures as necessary.

The control room operator (CRO) is responsible for monitoring any condensate dumps to the West pond or its trenches.

The process operator (PO) is responsible for monitoring the pump off of the liquid waste pond, during a normal clean out.

The Local 2 Environmental Facilitator is responsible for inspection of ponds.

The civil engineering department is responsible for monitoring any repairs to the pond liners or concrete.

Dust Emissions Control

The SPM Contractor is responsible for ensuring that no dusting occurs on the mud stack and to take the necessary measures to prevent dusting. These measures include ensuring the BRDA is appropriately sprinklered to damp down potential fugitive dust emissions at all times.

The responsibility for prevention of fugitive dust emissions includes maintenance, filling and operation of all mobile water sprayers and permanently installed sprinkler systems.

The contractor maintains a watching brief for the meteorological conditions which favour dusting and is responsible for communicating this to the Equipment Facilitator on a daily basis.

Emergency Response

In the event of a dusting emergency, the Contractor is responsible for directly notifying the SPF and Local 2 CRO. Depending on the response required, the Contractor has responsibility for requesting assistance, organizing all dust suppression resources and ensuring that the Emergency Response procedure (SWM 2021) is implemented.

Dusting is categorized a plant emergency. The plant emergency number (4444) is used to contact security at A79.

3.0 Operational Principles

The following summarises key the operating principles for the Bauxite Residue Disposal Area (BRDA):

1. The BRDA accepts only those residues described in the Licence.

2. The red mud is pumped to the BRDA at optimum solids and deposited in layers to maximise maturing by drying and consolidation and to optimize overall storage capacity of the mud stack.

3. The approach to the placement of red mud is based on “field stacking”. Field stacking involves the placement of mud in a thin layer over a short period of time at a series of locations. This technique allows the mud to mature rapidly, thereby allowing a higher stacking angle and easier movement on the surface by equipment.

4. Storage capacity is developed within the BRDA by construction of rockfill embankments around the mud stack using the upstream terracing method where the underlying red mud supports the upper rockfill embankment.

5. The overall stability of the upstream rockfill core mud retention terraces around the BRDA perimeter is determined by routine monitoring and assessment of the undrained shear strength of the red mud and underlying estuarine soil

6. The soda content of the red mud and other residues being deposited is minimised to optimize soda recovery in the plant and to minimise environmental liabilities within the mud stack

7. The integrity of all HDPE geomembranes for environmental protection is maintained. No mobile equipment is permitted direct contact with the geomembrane

8. The runoff and leachate is collected in the perimeter drain and pumped back to the plant.

9. The surface water inventories in the perimeter drain and adjacent storm water pond are minimised and pumping capacities are maximised as practicably as possible to ensure that there is sufficient operational freeboard for major rainfall events.

10. A water sprinkler Dust Suppression System is used over the entire red mud and process sand surfaces to prevent dusting.

11. The downstream toe drains, external watercourses and groundwater observation wells are routinely inspected to monitor for any migration of liquids from the mud stack.

12. All incidents, whether of an environmental or health and safety nature are reported and investigated to ensure that any necessary remedial action is taken and to prevent any re-occurrence of the incident.

4.0 Waste Analysis

4.1 Sources of Waste

All bauxite derived solid and sludge residues arising from alumina production at the plant are directed to the red mud stack in accordance with the licence. Almost all the solid residue material arises from the initial caustic digestion of the bauxite ore. After exiting the bauxite digesters, the residue is segregated into two fractions, the fine red mud fraction, representing 90% of the total and the coarse fraction, known as process sand, representing the other 10%.

Together these represent about 97% of the total bauxite residue from the plant. The remaining proportion comprises salt cake, from a salting-out liquor purification process and other process wastes including scale, construction and demolition waste and sand. Table 1 below lists the waste types approved by the Agency for placement within the BRDA.

Table 1 Approved Waste Types

Waste Types

- *Red Mud*
- *Process Sand*
- *Salt Cake*
- *Process Scale*
- *Lime Grits*
- *Pond Cleanout Sludge (LWP, SWP, North Pond, South Pond, East Pond, West Pond)*
- *Miscellaneous non hazardous refractory material*
- *Building rubble (For roadway/embankment construction within mudstack)*
- *Sludge from the Sanitary treatment plant (Emergency)*
- *A34 effluent clarifier underflow sludge (Discontinued)*

The red mud is subject to counter-current washing to reduce the concentration of entrained caustic before being de-watered in a vacuum drum filter and pumped as slurry to the mud stack.

The coarser “process sand” fraction is delivered to the storage area in dumper trucks. Salt cake, lime grits, refractory and scale that are trucked to the mud stack, are confined to specific areas within the existing mud stack.

In addition sludge’s from the process effluent treatment plant and from the other process ponds are deposited within the mud stack area.

4.2 Waste quantities

Waste analysis in 2003 is shown in Table 2 and accumulated waste quantities are shown on Table 3.

Table 2 Waste Composition & Tonnage (2008)

Waste Stream	EWC Code	Jan – Dec '08 Total (t)	As % of total waste land filled
Fluestack Residues (dry)	16 11 04	110	0.01%
Lime Grits (wet)	01 03 99	7,509	0.61%
Process Waste (wet)	01 03 99	71,750	5.78%
Red Mud (dry)	01 03 09	1,148,738	92.59%
Salt Cake (wet)	01 03 07	12,558	1.01%
Total Waste		**1,240,695**	**100%**

Table 3 Accumulated Quantities Of Waste (1983 To Dec 2008)

Waste Stream	EWC Code	1983 – Dec.'08 Total (t)	As % of total waste landfilled
Effluent Sludge A34 Clarifier (dry) *	06 05 03	4,380	0.02%
Fluestack Residues (dry)	16 11 04	4,396	0.02%
Lime Grits (wet)	01 03 99	101,130	0.52%
Process Waste (wet)	01 03 99	1,843,390	9.83%
Red Mud (dry)	01 03 09	17,016,737	88.04%
Salt Cake (wet)	01 03 07	293,587	1.56%
Total Waste		**19,263,651**	**100%**

(Note1: The data for all residues for 1983 - 1997 other than red mud are estimated based on pro-rata tonnages for the period 1997 to 2000.

* Material no longer generated at plant.

4.3 Physical properties

The red mud residue is pumped from the mud separation area (Local 2) to the storage area as slurry with a solids content of between 55% and 60%.

Once the mud has been discharged it begins to dry, with water being lost through surface evaporation and "bleeding" due to consolidating pressures. It has been found that after an average 'maturing period' of 3 to 9 months for a mud layer of 0.3 to 0.6m thick a solids content of around 68% to 70% is achieved.

Particle size analyses of red mud indicate that the material is largely silt size, with 90% of the particles smaller than 35 microns and 35% finer than 2 microns. The permeability of the mud is correspondingly very low and has been assessed to be in

the range 1 x 10^{-8} to 1 x 10^{-9}m/sec. The average specific gravity of the dry mud solids is 3.3.

The process sand is poorly graded medium sand having 90% and 10% of the particles smaller than 500 and 100 microns respectively. The permeability of the process sand is estimated to be about 1000 times greater than the permeability of the red mud.

Salt cake is deposited as a 70% solids cake.

4.4 Chemical Properties

The principal constituents of the red mud solids (expressed as the oxides) are iron oxide (Fe_2O_3), aluminium oxide (Al_2O_3) and titanium dioxide (TiO_2).

The aqueous solution entrained within the red mud contains a small amount of residual dissolved caustic (sodium hydroxide) and alumina in spite of the repeated washing in the plant. It is this residual dissolved caustic that gives the red mud its elevated pH characteristics. Most of this caustic converts to sodium carbonate and sodium bicarbonate on the stack.

The salt cake consists of the organic degradation products from humates in the bauxite, including sodium carbonate, sodium sulphate and sodium oxalate. Results of monthly analysis of waste (as required by the IPPC licence) is tabulated on Table 4 over.

Table 4 Results of Monthly Red Mud, Sand & Salt Cake Analysis (2008)

Parameter	Units	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec
pH		12.3	12.3	12.2	12.3	11.9	11.9	12.0	12.0	11.9	12.2	12.3	12.1
Dry matter	% w/w	56.7	58.3	57.7	59.5	58.5	58.1	58.7	57.0	55.8	57.2	56.6	59.0
Total alkalinity	mg/Kg $CaCO_3$	9,229	7,485	7,554	6,934	6,191	7,787	6,366	7,072	7,600	6,903	8,533	8,758
Chloride	mg/Kg	66.2	44.1	44.5	42.1	40.9	62.3	52.0	39.4	40.8	31.8	44.4	49.8
Fluoride	mg/Kg	57.4	50.9	43.7	38.7	32.6	36.8	36.5	37.2	33.0	27.9	36.0	30.7
Soda	mg/Kg	5,700	4,689	4,293	4,573	3,487	4,764	3,921	4,015	4,589	3,933	5,252	5,439

Description	*pH	Dry matter	*Chloride	*Fluoride	*Soda	*Total Alkalinity	Al	As	Cd	Cr	Cu	Fe	Pb	Mg	Hg	Ni	Ti	Zn
		%	mg/Kg	mg/Kg	mg/Kg	mg/Kg $CaCO_3$	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
Red Mud	12.4	60	30	50	6234	9669	14880	2.051	0.048	312.2	7.12	12160	15.55	27	0.0075	2.97	5603	3.41
Sand	12.4	80	6	59	6588	11004	13650	0.857	0.073	284.70	5.92	33560	19.53	438	0.019	3.85	3915	7.83
Salt Cake	13.0	55	1279	1436	218830	300277	34712	48.03	4.68	0.612	1.62	25.34	<.001	9	<.0025	0.616	1.73	1.89

5.0 Waste Handling & Placement

The bauxite residue disposal area is a dedicated and engineered facility for the placement of specific process residues as detailed below

Red mud
The majority of red mud slurry is pumped from the Mud Filtration Building to the red mud disposal area at generally above 58% solids. A small proportion of red mud low solids slurry collected from the maintenance turnaround cleaning of the mud settling and washing tanks is trucked to the red mud stack area and deposited on the existing red mud surfaces from the process sand landfill areas within the red mud stack area.

The method of placing mud o the BRDA is known as 'Field stacking'. This involves allowing mud to stand for a short period of time in one location to facilitate the maturing process. This necessitates the availability of a number of mud points for the incoming mud to be deposited. This process allows the mud to mature more quickly, which in turn enables the mud to be stacked at a higher angle in the longer term and also enables earlier trespass onto the stack surface.

The placement of red mud within the mudstack is controlled by procedure – SWM 2009 and SWM 2022. The plant Waste Management Manual (WM001) covers the placement of Red Mud (Section 4.3.2.9)

Process Sand: Process Sand is the quartsite fraction of the bauxite residue. This is washed as effectively as possible to remove all leachable soda and in particular to extract all leachable sodium aluminate which is potential product (SWM 2006).

The process sand is trucked under contract to the mud stack from the process plant. The disposal of sand is specified under Section 4.3.1.8 of the plant Waste Management Manual (WM001).

Salt cake
The salt cake is produced in the liquor purification process called the Organics and Causticity Control plant. The liquor is purified through the precipitation of impurities that occur when the caustic liquor is concentrated. These impurities are removed as a filter cake, consisting principally of sodium compounds with carbonate, sulphate, oxalate, fluoride and chloride.

The salt cake is deposited within a process sand bunded area on the interior red mud surfaces the mud stack.

The disposal of salt cake is specified under Section 4.3.1.8 of the plant Waste Management Manual (WM001).

Lime Grits
These are the insoluble clinker cores of the burnt limestone cobbles dissolved in the lime slaking plant within the process. These are trucked from the process plant by contract to the red mud stack area and are used as landfill road surfacing materials in the immediate area around the salt cake.

The disposal of lime grits is covered under Section 4.3.2.6 of the plant Waste Management Manual (WM001)

Scale

The process scale, which consists of hydrated sodium aluminium silicate sometimes combined with bauxite residues, removed from the interiors of process tanks, vessels and pipes during routine and turnaround maintenance activities in the process plant. All such scales are trucked by contract to the red mud stack area and deposited on the existing red mud surfaces from the process sand landfill areas with the red mud stack area.

The disposal of scale is covered under Section 4.3.2.6 of the plant Waste Management Manual (WM001).

Transport and placement of wastes

The BRDA is operated under contract to Murphy International Ltd. who have overall responsibility to the collection, transportation, and placement of waste. The contract extends to maintenance and resourcing of all equipment, including vehicles, which operate within the BRDA, including environmental control equipment for dust suppression.

All residues are either pumped or trucked in specified skips or dumpers to the BRDA area. All drivers are trained on checking that only wastes designated for disposal at the BRDA should be contained in the designated skips. If other waste streams are contained in the skips the skips will not be removed for disposal. Drivers are also trained on checking and handling of leachate which may arise.

All trucked residues are transported onto the BRDA area on a network of internal access roads constructed to engineering standards.

Trucked residues must be deposited on a layer of matured red mud. Process sand may be deposited directly onto red mud surfaces provided mechanical plant is confined to adjacent engineered designed and supervised access roads or the mobile plant is moving on a layer of compacted process sand.

Relevant Standard Operational Procedures

In addition to the sections of the Site Materials Management Contract and the Waste Management Manual listed above, the following standard operating procedures deal with the operation of the BRDA –

Procedure Number	Purpose
SWM 2006	Area 27A Operation
SWM 2009	Provide Stackable Mud and maintain mud removal capacity
SWM 2010	Mud Washing Operating Guidelines
SWM 2005	Wash Circuit Control
SWM 2022	Mud Stacking

6.0 Emergency Procedures

The management of emergencies at Rusal Aughinish Ltd is co-ordinated by a fully resourced and trained plant security team who are on site 24 hours per day, 365 days per annum.

Owing to the organization for safety and emergency response centrally at the security gatehouse, the overall plant emergency response plan and procedure covers the activities at the mudstack.

Environmental Emergency Response procedure (P007.075.001) details specific measures to be taken in the event of a significant environmental incident at the plant in addition to defining roles and responsibilities in an emergency.

The overall Rusal Aughinish Emergency Response Plan deals with emergency preparedness, planning, response and co-ordination in the case of significant emergencies or incidents at the plant. The defined categories of emergency include environmental emergencies and emergencies which may have to potential to lead to environmental damage.

Dusting is classified as an emergency and is subject to a formulised emergency response procedure (SWM2021 - Dust Emission Control and Frost Procedures – Local 2). Under the SPM Contract, the Contractor has defined responsibilities in the event of dusting. These responsibilities extend from prevention to response through:

- Review of meteorological conditions.
- Preventative damping of mudstack.
- Maintenance of equipment.
- Operation of sprinklers, bowzers.
- Resourcing emergency response.
- Communication with Rusal Aughinish personnel in an emergency response.
- Ensuring that SWM 2021 is followed.

7.0 Dust Control

Historical evidence shows that incidents of fugitive dust generation occur under the effects of the following:

- Wind speeds in excess of 5 m/sec.
- Freezing or very warm temperatures
- Dry air-conditions i.e. low humidity

The primary objective in management of placement operations at the BRDA is to prevent the formation of conditions where fugitive dust generation can occur.

7.1 Dusting Prevention and Response Measures

The following fugitive dusting prevention and response measures are implemented at the BRDA.

1. Minimise mud flat area exposed to dusting risk.

2. Keep mud flats in service as long as possible to limit areas of potential dusting.

3. Switch points regularly to cover drying mud with wet mud.

4. Maximise mud solids to the stack to get best stacking angle.

5. Switching mud points regularly to aid stacking angle lift.

6. Water spray sprinkler (Dust suppression sprinkler system) installed to 100% coverage over red mud areas.

7. Five bowzer units are available to transport and discharge water from the Liquid Waste Pond (LWP).

8. RUSAL AUGHINISH Bowzers left at LWP outside of normal business hours and where significant potential for dusting exists. If taken to be used elsewhere on site, must be returned cleaned to LWP and filled with water.

9. Open individual valves on sprinklers for approximately five minutes at a time and rotate as required.

The procedure to be followed in the event of requiring dust suppression is SWM 2021.

8.0 Surface Water Management & Protection

BRDA is bounded by the River Shannon, the Robertstown River and Poulaweala Creek. The River Shannon is tidal at Rusal Aughinish with a range of over 5.0m (Spring tides).

Surface water runoff due to rainfall from the BRDA discharges to a perimeter dyke, which runs along the entire northern, western and southern perimeter up to the East Ridge.

This perimeter dyke returns all runoff from the BRDA to the storm water pond, located in the northeastern corner of the BRDA (adjacent to LWP).

Average annual rainfall from this area is of the order 927mm with evapotranspiration accounting for of the order 450mm per annum. Nett effective rainfall on the BRDA equates to an estimated 477mm per annum.

Surface water runoff is recycled to the plant by pumping and ultimately discharged to the River Shannon post treatment.

The BRDA water inventory is carefully managed in order to ensure that peak surface water volumes generated during short term heavy rainfall events can be accommodated within the system while allowing treated waste water discharges to remain within daily flow limits as specified in the IPPC licence (Schedule 2(ii))

9.0 Groundwater Management and Protection

Aughinish Island is hydrogeologically isolated from the mainland and can be regarded as an independent groundwater body.

Groundwater Seepage Controls

The BRDA is underlain by two geologically dissimilar components. The northern part of the BRDA is generally underlain by low conductivity estuarine deposits, which are subject to saline intrusion (with the water table). The original plant BRDA was developed directly on this material.

The southern BRDA is underlain by limestone bedrock. This section of the BRDA is sealed within 1.0mm and 2.0mm thick HDPE sheets, set out above variable subgrade mineral layers.

Seepage control measures in the BRDA consist of the following.

The original northern part of the BRDA was developed over an extensive deposit of low hydraulic conductivity estuarine soil. In addition, the upstream slope of the Main Dike around the stack and the SWP was sealed with a composite liner consisting of a 750 mm thick compacted glacial till fill covered with a 2.0 mm thick HDPE liner anchored in the estuarine soil along the toe of the Main Dike. In addition, all areas along the toes of the Main Dikes where the estuarine soil thickness is less than 4.0 m (applies to the mud stack) or where glacial till or rock outcrop (applies to the SWP) was encountered, were sealed with 2mm thick smooth HDPE liner. All runoff reporting to the open drainage ditch is stored between the Main Dike and the Rockfill Starter Dike (RFSD).

The extended southern area is sealed with 1.0 and 2.0 mm thick smooth and double textured HDPE sheets. Beneath the HDPE sheets, the subgrade consists of a series of mineral varying from 300mm to 600mm thick depending the subgrade.

Seepage/Leakage Control Systems

The following seepage and leakage control systems are in place:

(1) Collection and pumping back to the open perimeter drains all localised concentrated seepage sources around the north west corner of the original mud stack.

(2) A leak collector toe drain along the entire length of the existing Main Dike, which forms the western edge of the extended mud stack. Leachate intercepted by the leak collector ditch is routed to a sealed concrete sump from where it is pumped out into the SWP or into the open drainage ditch.

Landfill Gas

There is no landfill gas generated by the placement of the in-organic bauxite residues.

10.0 Leachate Management and Disposal

The BRDA does not generate leachate in the conventional sense of the term (as applied to waste disposal) due to:

a) The bauxite process residues placed within the BRDA do not degrade and are inorganic.

b) The red mud on placement and maturation has hydraulic conductivity values of the order of 1x10-9 m/sec. Accordingly, recharge and downward movement of liquid into the waste (through precipitation) does not occur.

Although there is no positive leachate collection system in place, washout our bleed water from the red mud is collected in the perimeter dyke and returned to the plant for treatment and licensed discharge.

11.0 Life Expectancy

The life expectancy of the current Bauxite Residue Disposal Area is approximately 2009, based on current production levels and waste generation as tabulated below. This will be reviewed each year as part of the Annual Environmental Review.

Table 5 Determination of Remaining Capacity

Period	MOM*	Waste during period (t)	Accumulated waste (t)	Remaining capacity of BRDA (t)
'83 to '00	R	9,952,703	9,952,703	9,762,404
2001	R	1,110,916	11,063,619	8,651,488
2002	R	1,111,886	12,175,505	7,539,602
2003	R	1,053,818	13,229,323	6,485,784
2004	R	1,077,940	14,307,263	5,407,844
2005	R	1,224,053	15,531,316	4,183,791
2006	R	1,270,270	16,801,586	2,913,520
2007	R	1,221,369	18,022,955	1,692,151
2008	R	1,240,695	19,263,651	451,455
2009	E	855,200	20,118,851	3,108,591**
2010	E	855,200	20,974,051	2,253,391
2011	E	855,200	21,829,251	1,398,191
2012	E	855,200	22,684,451	542,991

*Note: MOM – Method of Measurement; R = Recorded (Measured); E = Engineering Estimate
**Note: Increased in capacity of BRDA with increase in height to 32 meters (going from Stage 7 perimeter lift to Stage 10 perimeter lift) following issue of IPPC P0035-04 in 2008.

The original design capacity of the extended BRDA is 23.2 mt, which, at current disposal rates, will be achieved by early 2013.

As the rate of placement is a direct function of production activity, the life expectancy of the BRDA will be reduced with increasing levels of production.

12.0 Development Programme

As the future of the RUSAL Rusal Aughinish production facility is dependant on available residue storage capacity it is planned to develop the Bauxite Residue Disposal Area to facilitate the continuation of the production process beyond 2013.

The Rusal Aughinish plant is currently involved in two major projects which will underwrite the continuity visibility of the activity into the future. These are:

- Construction of 150MW gas fired CHP plant
- Plant modernisation to increase production to 1.95mt per annum.

As part of plant modernisation, the company has commenced the development of an extend BRDA through the provision of an additional 78ha.

An application for a revised IPPC Licence will be made to the Agency in order to take account of the extended Bauxite Residue Disposal Area.

13.0 Restoration

The restoration plan for the BRDA was developed by SRK (UK) Ltd. in 1999 as part of the Plant Decommissioning & Closure Plan (DCP). The DCP was submitted to the Agency as part of the first plant AER in 1999.

Success in providing for revegetation of the mudstack has been demonstrated by field trials (IPPCL Application documentation: Hartney and Courtney, 1998; Enviroplan Services Ltd, 1998).

Considerable attention has been focused on the testing and measures that can be used to ensure appropriate surface soil conditions are present which will promote successful vegetation establishment and surface rehabilitation of the mudstack while controlling costs.

However, the original DCP was prepared in 1999 prior to the introduction of the current sprinkler dust suppression system. Accordingly the Restoration Plan will be updated as part of the proposed extension.

Closure actions for the mudstack

Closure will involve utilisation of those techniques that have been proven in operations, or demonstrated in field trials, which have the greatest potential to achieve the performance criteria for air, soil, surface water and groundwater. A key element of this closure plan will be the rehabilitation cover for the mudstack. Because of the variety of wastes within the mudstack, there are several different surface treatments which will be necessary in order to ensure that performance criteria are achieved following closure.

The mudstack will be rehabilitated to ensure physical and chemical stabilisation of the red mud. To ensure dust control a final surface layer will be put in place to provide a substrate that will be seeded with a grassland seed mixture, and fertiliser applied by broadcast spreader.

In hot spots of higher pH, it may be necessary to sow a crop of oats before seeding to grassland, to lower pH by acid root exudates and root decomposition. Engineered surface water drainage berms will be created to allow for stormwater drainage from the mudstack.

Aftercare of established vegetation cover may also involve scrub planting, topsoil importation to augment earthworm and soil decomposer communities, and also further limited organic matter, nutrient and trace element application where necessary. Colonisation by rabbits and other burrowing mammals in suitably dry areas may result in localised disturbance of the surface and a potential dust source. This will be reduced to a minimum by covering the process sand areas with a low permeability cover which is resistant to damage by burrowing animals.

Steps will be taken to ensure that a suitable drainage system is established on the rehabilitated mudstack. Infiltration through the buried and more permeable process

wastes (salt cake, process sand, sludges, process solid wastes) will be minimised, by covering all such areas, and in particular the process sand haulway, with a low permeability synthetic cover. Surface disturbance by erosion will be reduced by the installation and long-term maintenance of a lined surface drainage system designed to intercept storm runoff and direct it to optimum discharge.

The maintenance of efficient surface water drainage from the mudstack, avoiding as far as possible soil erosion into the peripheral drain, will contribute to the improvement of water quality after closure. With time, it is expected that rainwater flushing, and wet-dry cycles in the surface layers of the mudstack, will improve water quality so that runoff and seepage can be discharged without treatment.

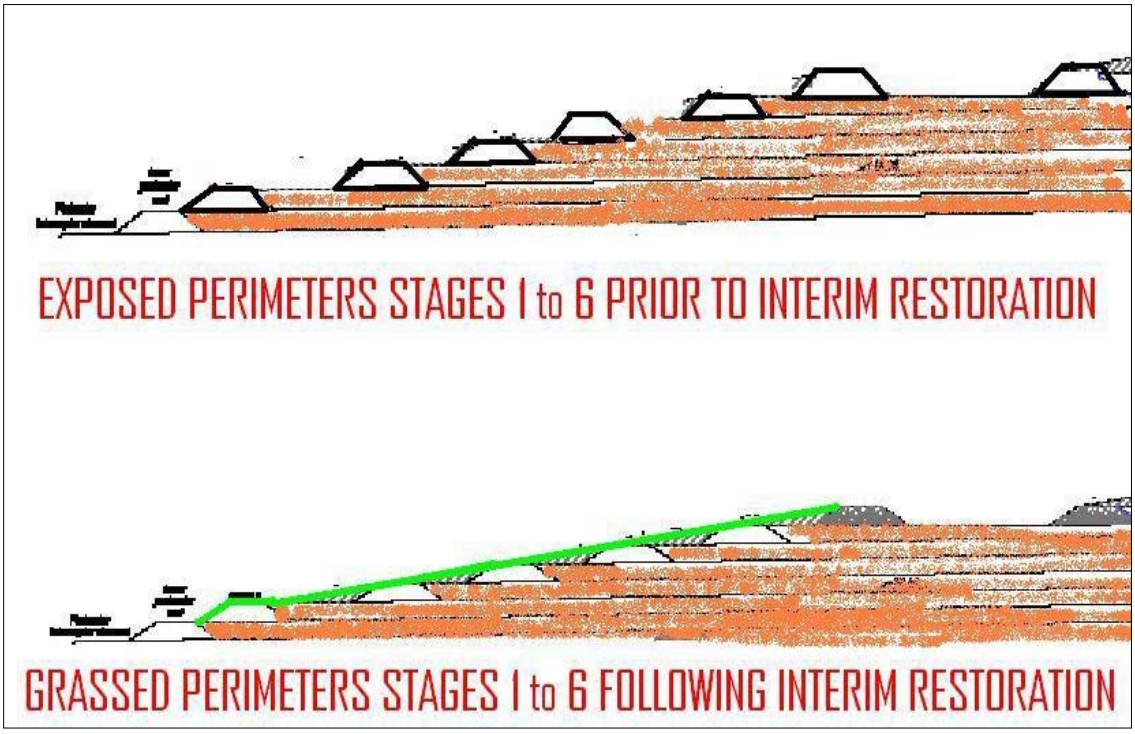
Interim Restoration

As part of the extension of the BRDA, an interim restoration plan will be put in place to provide for intermediate cover of the embankment slopes as the height of the area is increased. This will be achieved in two phases as follows.

Interim restoration will involve the stepping back of the seventh lift (Stage 7) into the BRDA to create a level area between Stage 6 and 7.

The area from the embankment at the existing perimeter dike to the top of Stage 6 embankment will be filled and grassed (See Figure 1 below).

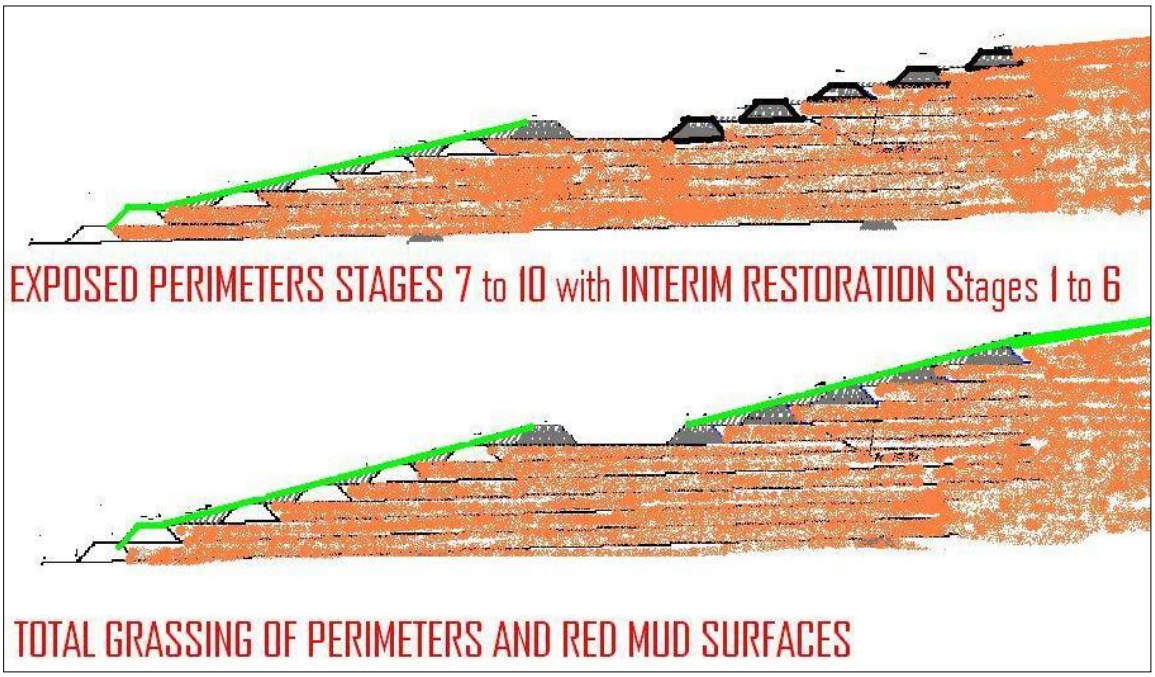
Figure 1 BRDA Cross Section showing pre and post interim restoration Phases



A series of drainage channels will be installed to traverse (perpendicularly) the grassed perimeter stages to provide for formalized surface water runoff from Stage 7 onwards to the main perimeter dike.

As the BRDA is developed, the perimeter embankments between Stage 7 to 10 will be exposed pending completion of the restoration, which will involve grassing of the remaining perimeter embankments and the BRDA surface (Figure 2).

Figure 2 BRDA Cross Section showing post interim- and total-restoration Phases



The detailed design and specification for implementation of Phase 1 and 2 of the extended BRDA restoration plan will be submitted to the Agency as part of the Application for Review of the IPPC Licence in 2005.

This Plan will supercede the section of the original Decommissioning and Closure Plan (DCP) prepared in 1999.

14.0 Aftercare Management

Nature Conservation

The existing Bird & Butterfly sanctuary is adjacent to the north side of the existing BRDA. The bird sanctuary management has been featured and reported on by organisations such as the Irish Wildbird Conservancy since it's development in 1981. Accordingly, there is an existing nature conservation focus in the vicinity of the BRDA.

The ongoing management, and possible enhancement, of the existing bird sanctuary will be examined in the after use policy for the restored BRDA.

Amenity Restoration

The eastern sides of the BRDA have a network of nature trails starting from the Rusal Aughinish Ltd sports centre complex. Joggers, walkers and sightseers use these amenity features. The ecological features viewed from these trails include some woodland, fernland, and the tidal Poulaweala Creek that includes a bird hide to observe the intertidal bird environment.

15.0 Environmental Monitoring Programme

RUSAL AUGHINISH undertake extensive monitoring of environmental quality (air, water, groundwater, dust and noise) in the vicinity of both the plant and Bauxite Residue Disposal Area (BRDA).

This monitoring, which is undertaken by qualified and experienced Environmental Technicians is detailed in SWM0003_IPPCL Compliance Monitoring.

SWM0003 deals with the BRDA specifically through measurement of:

Table 6 Environmental Monitoring

Environmental Media	Monitoring Location	Analysis Undertaken	Frequency
Surface Water	OPW Channel Mangans Lough South Drain	pH, Conductivity, Soda	Monthly
Groundwater	BRDA Observation Wells (OW's) (19 No)	pH, Conductivity, Total Alkalinity, F, Cl, Cu, Ni, Pb, Hq, Zn, Cd, Co, Ca, Mg, Na, Ag, Al, Fe, SO^4, T?s	Monthly
Air – Fugitive Dust	7 No. Gauges at perimeter of BRDA	Dust Deposition	Monthly
Air – Noise	North Shore (B5), East of East Ridge (B4)	Sound Pressure Level, L_{AEQ}, L_{A10}, L_{A90}	Annually
Waste	Red Mud, Sand, Salt Cake, Leachate	pH, Dry Matter, Alkalinity, Cl, F_1, Soda	Monthly

In addition to the above, RUSAL AUGHINISH maintain a weather station between the plant and the BRDA for measurement of wind speed, direction and temperature. This data is fed back to the plant Process Information (PI) System. Recorded data is used for historical look back purposes and in incident investigation.

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Attachment 12
AER/PRTR Emissions Data Information

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Environmental Protection Agency

AER Returns Worksheet

Version 1.1.03

REFERENCE YEAR	2008

1. FACILITY IDENTIFICATION

Parent Company Name	Aughinish Alumina Limited
Facility Name	Aughinish Alumina Limited
PRTR Identification Number	P0035
Licence Number	P0035-04

Waste or IPPC Classes of Activity

No.	class_name
5.13.0	The production of basic inorganic chemicals, such as:(a) gases, such as ammonia, chlorine or hydrogen chloride, fluorine, or hydrogen fluoride, carbon oxides, sulphur compounds, nitrogen oxides, hydrogen, suphur dioxide, carbonyl chloride,(b) acids, ...
2.1.0	The operation of combustion installations with a rated thermal input equal to or greater than 50MW

Address 1	Aughinish Island
Address 2	Askeaton
Address 3	County Limerick
Address 4	
Country	Ireland
Coordinates of Location	12751520
River Basin District	
NACE Code	2442
Main Economic Activity	Aluminium production
AER Returns Contact Name	Liam Fleming
AER Returns Contact Email Address	trevor.montgomery@augh.com
AER Returns Contact Position	Environmental Co-ordinator
AER Returns Contact Telephone Number	061-604000 / 604232 (Direct)
AER Returns Contact Mobile Phone Number	
AER Returns Contact Fax Number	061604074
Production Volume	0.0
Production Volume Units	
Number of Installations	0
Number of Operating Hours in Year	0
Number of Employees	0
User Feedback/Comments	
Web Address	

2. PRTR CLASS ACTIVITIES

Activity Number	Activity Name
4bv	Non-metals, metal oxides or other inorganic compounds such as calcium carbide, silicon, silicon carbide
1c	Thermal power stations and other combustion installations
5d	Landfills

3. SOLVENTS REGULATIONS (S.I. No. 543 of 2002)

Is it applicable?	No
Have you been granted an exemption ?	
If applicable which activity class applies (as per Schedule 2 of the regulations) ?	
Is the reduction scheme compliance route being used ?	

SECTION A : SECTOR SPECIFIC PRTR POLLUTANTS

RELEASES TO AIR																
POLLUTANT		METHOD													QUANTITY	
			Method Used													
No. Annex II	Name	M/C/E	Method Code	Designation or Description	Emission Point 1	Emission Point 2	Emission Point 3	Emission Point 4	Emission Point 5	Emission Point 6	Emission Point 7	Emission Point 8	Emission Point 9	T (Total) KG/Year	A (Accidental) KG/Year	F (Fugitive) KG/Year
08	**Nitrogen oxides (NOx/NO2)**	C	PER	calculation based on fuel usage	521847.0	596367.0	358716.0	0.0	0.0	0.0	0.0	0.0	0.0	1476930.0	0.0	0.0
11	Sulphur oxides (SOx/SO2)	C	PER	calculation based on fuel usage	1456123.0	1047392.0	10000.0	0.0	0.0	0.0	0.0	0.0	0.0	2513515.0	0.0	0.0
86	Particulate matter (PM10)	C	PER	calculation based on fuel usage	32257.0	88149.0	0.0	10198.47					0.0	130604.47	0.0	0.0
03	Carbon dioxide (CO2)	C	ETS	calculation based on fuel usage	259079.0	448214.0	750706.0	0.0	0.0	0.0	0.0	0.0	0.0	1457999.0	0.0	0.0

* Select a row by double-clicking on the Pollutant Name (Column B) then click the delete button

SECTION B : REMAINING PRTR POLLUTANTS

RELEASES TO AIR								
POLLUTANT		METHOD			QUANTITY			
			Method Used					
No. Annex II	Name	M/C/E	Method Code	Designation or Description	Emission Point 1	T (Total) KG/Year	A (Accidental) KG/Year	F (Fugitive) KG/Year
					0.0	0.0	0.0	0.0

* Select a row by double-clicking on the Pollutant Name (Column B) then click the delete button

SECTION C : REMAINING POLLUTANT EMISSIONS (As required in your Licence)

RELEASES TO AIR								
POLLUTANT		METHOD			QUANTITY			
			Method Used					
Pollutant No.	Name	M/C/E	Method Code	Designation or Description	Emission Point 1	T (Total) KG/Year	A (Accidental) KG/Year	F (Fugitive) KG/Year
					0.0	0.0	0.0	0.0

* Select a row by double-clicking on the Pollutant Name (Column B) then click the delete button

Additional Data Requested from Landfill operators

For the purposes of the National Inventory on Greenhouse Gases, landfill operators are requested to provide summary data on landfill gas (Methane) flared or utilised on their facilities to accompany the figures for total methane generated. Operators should only report their Net methane (CH4) emission to the environment under T(total) KG/yr for Section A: Sector specific PRTR pollutants above. Please complete the table below:

Landfill: Aughinish Alumina Limited

Please enter summary data on the quantities of methane flared and / or utilised

	T (Total) kg/Year	M/C/E	Method Used: Method Code	Method Used: Designation or Description	Facility Total Capacity m3 per hour	
Total estimated methane generation (as per site model)	0.0				N/A	
Methane flared	0.0				0.0	(Total Flaring Capacity)
Methane utilised in engine/s	0.0				0.0	(Total Utilising Capacity)
Net methane emission (as reported in Section A above)	0.0				N/A	

4.2 RELEASES TO WATERS

SECTION A : SECTOR SPECIFIC PRTR POLLUTANTS

Data on ambient monitoring of storm/surface water or groundwater, conducted as part of your licence requirements, should NOT be submitted under AER / PRTR Reporting as this only concerns Releases from your facility

RELEASES TO WATERS								
POLLUTANT					QUANTITY			
			Method Used					
No. Annex II	Name	M/C/E	Method Code	Designation or Description	Emission Point 1	T (Total) KG/Year	A (Accidental) KG/Year	F (Fugitive) KG/Year
					0.0	0.0	0.0	0.0

* Select a row by double-clicking on the Pollutant Name (Column B) then click the delete button

SECTION B : REMAINING PRTR POLLUTANTS

RELEASES TO WATERS								
POLLUTANT					QUANTITY			
			Method Used					
No. Annex II	Name	M/C/E	Method Code	Designation or Description	Emission Point 1	T (Total) KG/Year	A (Accidental) KG/Year	F (Fugitive) KG/Year
					0.0	0.0	0.0	0.0

* Select a row by double-clicking on the Pollutant Name (Column B) then click the delete button

SECTION C : REMAINING POLLUTANT EMISSIONS (as required in your Licence)

RELEASES TO WATERS									
POLLUTANT					QUANTITY				
			Method Used						
Pollutant No.	Name	M/C/E	Method Code	Designation or Description	Emission Point 1	Emission Point 2	T (Total) KG/Year	A (Accidental) KG/Year	F (Fugitive) KG/Year
303	BOD	M	PER	APHA	316307.0	127.0	316434.0	0.0	0.0
314	Fats, Oils and Greases	M	PER	APHA	15334.0	0.0	15334.0	0.0	0.0
240	**Suspended Solids**	M	PER	APHA	53062.0	236.0	53298.0	0.0	0.0

* Select a row by double-clicking on the Pollutant Name (Column B) then click the delete button

4.3 RELEASES TO WASTEWATER OR SEWER

SECTION A : PRTR POLLUTANTS

OFFSITE TRANSFER OF POLLUTANTS DESTINED FOR WASTE-WATER TREATMENT OR SEWER								
POLLUTANT		METHOD			QUANTITY			
			Method Used					
No. Annex II	Name	M/C/E	Method Code	Designation or Description	Emission Point 1	T (Total) KG/Year	A (Accidental) KG/Year	F (Fugitive) KG/Year
					0.0	0.0	0.0	0.0

* Select a row by double-clicking on the Pollutant Name (Column B) then click the delete button

SECTION B : REMAINING POLLUTANT EMISSIONS (as required in your Licence)

OFFSITE TRANSFER OF POLLUTANTS DESTINED FOR WASTE-WATER TREATMENT OR SEWER								
POLLUTANT		METHOD			QUANTITY			
			Method Used					
Pollutant No.	Name	M/C/E	Method Code	Designation or Description	Emission Point 1	T (Total) KG/Year	A (Accidental) KG/Year	F (Fugitive) KG/Year
					0.0	0.0	0.0	0.0

* Select a row by double-clicking on the Pollutant Name (Column B) then click the delete button

4.4 RELEASES TO LAND

SECTION A : PRTR POLLUTANTS

RELEASES TO LAND							
POLLUTANT		METHOD			QUANTITY		
			Method Used				
No. Annex II	Name	M/C/E	Method Code	Designation or Description	Emission Point 1	T (Total) KG/Year	A (Accidental) KG/Year
					0.0	0.0	0.0

* Select a row by double-clicking on the Pollutant Name (Column B) then click the delete button

SECTION B : REMAINING POLLUTANT EMISSIONS (as required in your Licence)

RELEASES TO LAND							
POLLUTANT		METHOD			QUANTITY		
			Method Used				
Pollutant No.	Name	M/C/E	Method Code	Designation or Description	Emission Point 1	T (Total) KG/Year	A (Accidental) KG/Year
					0.0	0.0	0.0

* Select a row by double-clicking on the Pollutant Name (Column B) then click the delete button

Transfer Destination	European Waste Code	Hazardous	Quantity T/Year	Description of Waste	Waste Treatment Operation	Method Used		Location of Treatment	Name and Licence / Permit No. of Recoverer / Disposer / Broker	Address of Recoverer / Disposer / Broker	Name and Address of Final Destination i.e. Final Recovery / Disposal Site (HAZARDOUS WASTE ONLY)	Licence / Permit No. of Final Destination i.e. Final Recovery / Disposal Site (HAZARDOUS WASTE ONLY)
						M/C/E	Method Used					
To Other Countries	17 06 01	Yes	9.0	Insulation materials containing asbestos	D1	M	Weighed	Abroad	Rilta Environmental Ltd W0192-03	Block 402, Grant's Drive, Greenogue Business Park, Rathcoole, County Dublin, Dublin		
Within the Country	16 06 01	Yes	0.01	Lead Acid batteries	R4	C	Weighed	Offsite in Ireland	Returnbatt Ltd / P00105	Old Mill Industrial Estate, Kill, Co. Kildare, Kildare	Old Mill Industrial Estate, Kill, Co. Kildare, Kildare	W0105
Within the Country	20 01 21	Yes	0.2	Flourescent & Discharge tubes	R4	C	Volume Calculation	Offsite in Ireland	Irishlamp recycling	Athy, Co. Kildare	Athy, Co. Kildare	WCP/057/0
To Other Countries	13 08 99	Yes	9.4	Oil Dry / Oil Rags	D1	E	Volume Calculation	Offsite in Ireland	Rilta Environmental Ltd W0192-03	Block 402, Grant's Drive, Greenogue Business Park, Rathcoole, County Dublin, Dublin	Block 402, Grant's Drive, Greenogue Business Park, Rathcoole, County Dublin, Dublin	W0192-03
Within the Country	13 08 99	Yes	93.0	Waste Oil (Heavy Gear)	R9	M	Volume Calculation	Offsite in Ireland	Atlas Environmental Ireland Ltd. Portlaoise Co. Laois	EPA Waste Licence 184-1	Clonminam Industrial Estate,Portlaoise Co. Laois	EPA Waste Licence 184-1
Within the Country	20 03 01	No	207.4	Municipal Waste	D1	M	Weighed	Offsite in Ireland	Veolia W0082.2	Ballykeefe Townland, Waste Management Section, Dock Road, Limerick, Limerick		W0082.2
Within the Country	01 04 07	Yes	12559.0	Salt Cake	D1	C	Volume Calculation	Offsite in Ireland	Aughinish Alumina (P0035-04)	Askeaton Co. Limerick	Askeaton Co. Limerick	P0035
Within the Country	20 01 39	No	50.7	plastic containers	R11	C	Volume Calculation	Offsite in Ireland	Rilta Environmental Ltd W0192-03	Block 402, Grant's Drive, Greenogue Business Park, Rathcoole, County Dublin, Dublin		
Within the Country	01 03 99	No	71750.0	Process Waste (scales, sand, etc)	D1	C	Volume Calculation	Onsite in Ireland	Aughinish Alumina (P0035-04)	Askeaton Co. Limerick	Askeaton Co. Limerick	P0035
Within the Country	01 03 09	No	1148738.0	Red Mud	D1	C	Volume Calculation	Onsite in Ireland	Aughinish Alumina (P0035-04)	Askeaton Co. Limerick	Askeaton Co. Limerick	P0035
Within the Country	10 01 99	No	110.0	Refractory	D1	C	Volume Calculation	Onsite in Ireland	Aughinish Alumina (P0035-04)	Askeaton Co. Limerick	Askeaton Co. Limerick	
Within the Country	19 08 05	No	580.0	Sanitary effluent Sludge	D1	C	Volume Calculation	Onsite in Ireland	Aughinish Alumina (P0035-04)	Askeaton Co. Limerick	Askeaton Co. Limerick	
To Other Countries	17 04 07	No	1176.0	Scrap Metal	R4	M	Weighed	Abroad	Hegarty Metals Recycling WP05-04	Ballysimon Road, Limerick	France & Spain	
Within the Country	16 01 03	No	1.4	Used Tyres	R11	C	Volume Calculation	Offsite in Ireland	R Quinn	Clarina, Co Limerick		
Within the Country	20 01 38	No	64.7	Wood (Recycled)	R3	M	Weighed	Offsite in Ireland	Veolia P0082.2	Ballykeefe Townland, Waste Management Section, Dock Road, Limerick, Limerick		
Within the Country	20 01 38	No	53.8	Wood (Landfilled)	D1	M	Weighed	Offsite in Ireland	Veolia P0082.2	Ballykeefe Townland, Waste Management Section, Dock Road, Limerick, Limerick	Gortadroma, Ballyhahill, Co. Limerick, Limerick.	W0017-03
Within the Country	20 01 99	No	48.4	use hosing	R11	M	Weighed	Offsite in Ireland	Veolia P0082.2	Ballykeefe Townland, Waste Management Section, Dock Road, Limerick, Limerick		
Within the Country	15 01 10	Yes	38.8	IBC's	R11	C	Volume Calculation	Offsite in Ireland	Rilta Environmental Ltd W0192-03	Block 402, Grant's Drive, Greenogue Business Park, Rathcoole, County Dublin, Dublin		
Within the Country	20 01 36	No	3.2	WEEE	R4	M	Weighed	Offsite in Ireland	Rilta Environmental Ltd W0192-03	Block 402, Grant's Drive, Greenogue Business Park, Rathcoole, County Dublin, Dublin		
Within the Country	**20 01 01**	**No**	12.6	Papers & document shredding	R5	M	Weighed	Offsite in Ireland	DGD Papers Ltd., WFP/LK/2008/09C	Box No. 337, Bay M1, Raheen Business Park, Limerick		

Transfer Destination	European Waste Code	Hazardous	Quantity T/Year	Description of Waste	Waste Treatment Operation	Method Used		Location of Treatment	Name and Licence / Permit No. of Recoverer / Disposer / Broker	Address of Recoverer / Disposer / Broker	Name and Address of Final Destination i.e. Final Recovery / Disposal Site (HAZARDOUS WASTE ONLY)	Licence / Permit No. of Final Destination i.e. Final Recovery / Disposal Site (HAZARDOUS WASTE ONLY)
						M/C/E	Method Used					
Within the Country	20 01 01	No	12.5	Cardboard	R5	M	Weighed	Offsite in Ireland	Veolia P0082.2	Ballykeefe Townland, Waste Management Section, Dock Road, Limerick, Limerick		
To Other Countries	20 01 23	Yes	1.07	Aerosols	R4	C	Volume Calculation	Abroad	Rilta Environmental Ltd W0192-03	Block 402, Grant's Drive, Greenogue Business Park, Rathcoole, County Dublin, Dublin		
Within the Country	16 07 08	Yes	3.396	Empty Oil Drums	R4	C	Volume Calculation	Offsite in Ireland	Atlas Environmental Ireland Ltd. Portlaoise Co. Laois	EPA Waste Licence 184-1		
Within the Country	16 01 99	No	39.5	Conveyor Belting	R11	C	Volume Calculation	Offsite in Ireland	Mick Walsh, Craystreet, Glin, Co. Limerick	WCP/LK/083/02B		
Within the Country	01 03 99	No	7509.0	Lime Grits	D1	C	Volume Calculation	Onsite in Ireland	Aughinish Alumina (P0035-04)	Askeaton Co. Limerick		

* Select a row by double-clicking the Description of Waste then click the delete button