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BIOGAS

LIQUIDBIOFUELS

WOODENERGY

Difficult Fuels Technical Guide

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Technical Guide for Solid Biofuels and Resource Consents

The purpose of this guide is to provide guidance for applying and approving Air Discharge and other Resource Consents for difficult solid biofuels. Difficult covers fuels that are not commonly used, such as agricultural by-products and demolition timbers.

- The Guide takes us through a number of fuel types, their characteristics and what particular technical difficulties might be encountered for their use.
- It outlines the regulatory environment in which we operate and provides a rational way to navigate through the regulations which might apply.
- It provides a brief overview of what will likely be required for the continuous monitoring of the combustion processes to meet the likely resource consent conditions.
- And finishes with a look at four brief practical examples of difficult fuel use.

Types of Biomass for Combustion

Herbaceous Biomass:

- Non-woody plants with specific combustion considerations
- Examples: oat husks, miscanthus, straw

High Moisture Biomass:

- Biomass with moisture content above 35%
- Examples: wet wood chips, non-standard wet fuels like sludge or manure

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Types of Biomass for Combustion

Chemically Contaminated Biomass:

- Biomass containing harmful chemicals
- Commonly found in treated wood or wood with paint or resin adhesive
- Examples: boron, copper chrome arsenate, LOSP, painted wood, MDF

Physically Contaminated Biomass:

- Biomass with physical contaminants potentially removable by sorting or mechanical processes
- Examples: metal, plastic, textiles, rubber, construction or demolition waste

Types of Biomass for Combustion

Novel Fuels:

- Diverse materials suitable for combustion under specific circumstances
- Examples: dry municipal sewage sludge, animal litter, oil-impregnated wood chip, forestry wastes, grape and other prunings.

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Air Quality Management and Guidelines

- New Zealand, the Resource Management Act (RMA) and National Environmental Standards for Air Quality (NESAQ) Regulations dictate permitted emissions.
- Regional councils are responsible for managing air quality.
- A major barrier to combusting different fuels is the differences in the Rules set out in each Regional Air Plan
- It is understanding the regulatory environment which is often the key to using a “difficult” fuel.

The airborne contaminant monitoring station, Garlands Road, Woolston, Christchurch

Except from the Canterbury Regional Airplan

Part A

1. Wood painted with lead-based paint or treated with CCA timber preservative;
2. Wire that is coated with any material;
3. Materials containing asbestos;
4. All rubber;
5. Medical waste, pathological wastes, quarantine waste;
6. Batteries, chemicals, paint and other surface coating materials;
7. Tar or bitumen;
8. Used and waste oil, excluding *re-refined oil*;
9. Sludge from industrial processes;
10. Any container that has been used for the purpose of storing *hazardous substances*.

Part B

1. Wood treated or processed with preservatives (except for wood treated with CCA timber preservative), gluing agents, or impregnated with chemicals;
2. Wood which is painted, stained or oiled (except for wood painted with lead based paint)
3. Metals and materials containing metals;
4. All plastic;
5. Animal waste;
6. Synthetic material including, but not limited to, motor vehicle parts, foams and fibreglass.

7.8 Except where prohibited under Regulations 7 to 12 of the Resource Management (Nationa Environmental Standards for Air Quality) Regulations 2004, the discharge of contaminants intc air from burning in a *large scale fuel burning device* or incinerator or as part of an industrial o trade process of any material listed in Part A or Part B of Rule 7.7 is a discretionary activity.

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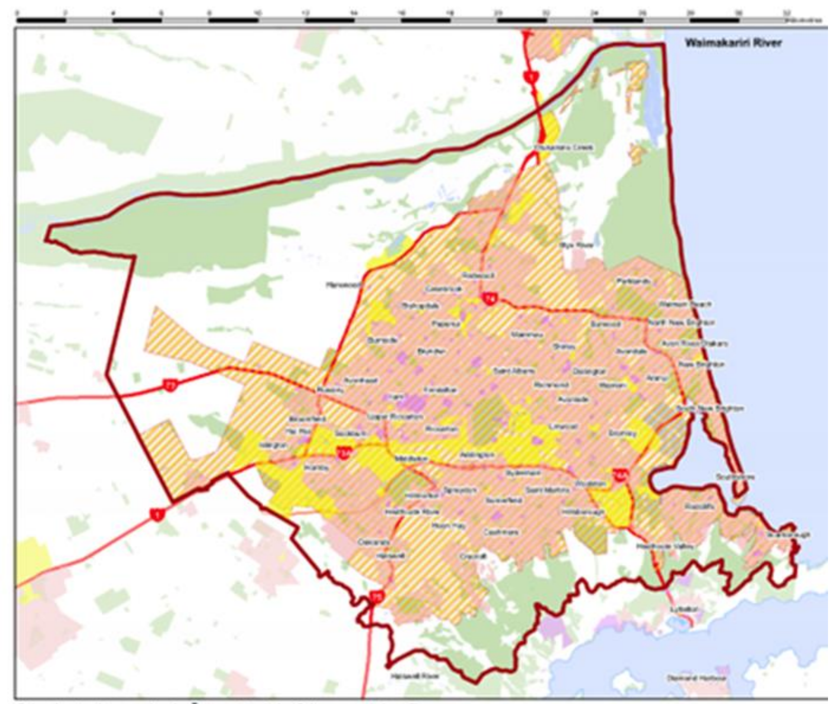
Airsheds

- An “Airshed” is a boundary on a map which encloses a physical area where a Regional Authority, via its Regional Airplan, imposes particular emission limits beyond the general rules of the RMA and NESAQ.

- To the right, the Christchurch Airshed, bounded to the north by the Waimakariri River, to the east by the coast, the south by the ridgeline of the Port Hills, and the West by roadlines.



Christchurch / Ōtautahi Clean Air Zone
Canterbury Air Regional Plan

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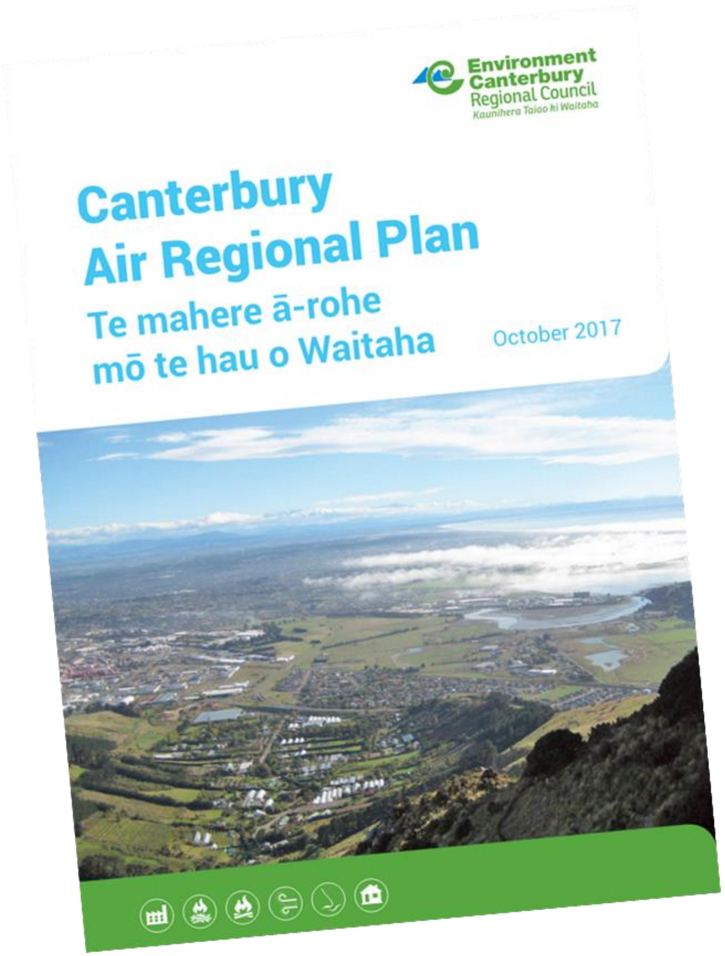
Airplan Examples



Two examples of Regional Airplans. Airplans for each Regional Council can be found on their website.

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Airsheds (continued)

- Within an Airshed there are three types of activities.
- Permitted, (for which no resource consent is required, provided the rules are met)
- Digressionary, where the Regional Council may, if it is satisfied that its various rules and guidelines can safely be met, may permit an activity.
- Prohibited. Don’t even think of it!!!!
- Whilst all of the Regional Airplans operate within the realm of the RMA and NESAQ, each Council is responsible for drafting its own airplan to meet its own needs. What is permitted or digressionary in one region may be quite different in another.

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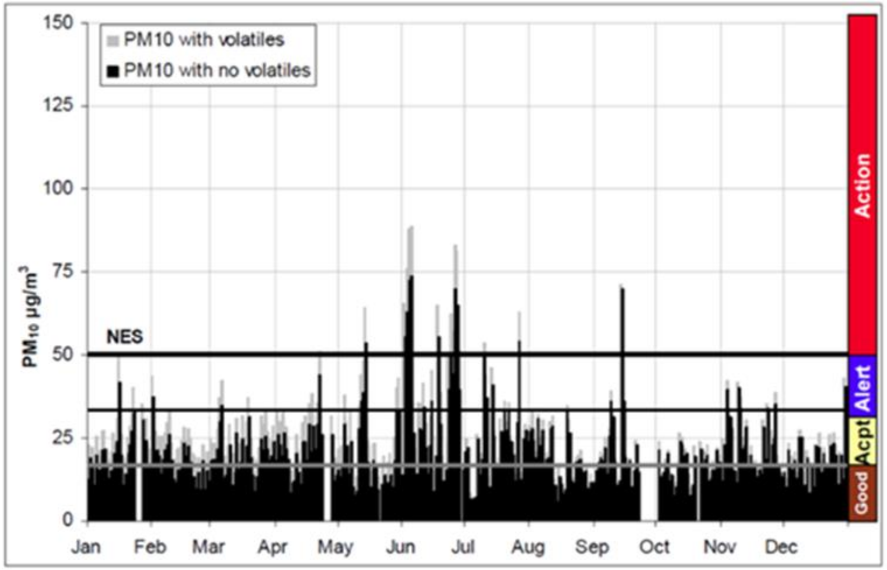
Methodology of Compliance

- Councils monitor air quality in their airsheds.
- The predominant concern in NZ is particulate emissions, in particular the sub-10 micron limit (PM10) for 24 hour ambient air quality. An airshed may only exceed an average of 50µg/m^3 of the ambient air once per year.

Example of the output from a monitoring station.



NZ Emission Regulations vs Overseas

- NZ, Australia, Europe, UK, and USA air emission regulations primarily align with WHO guidelines
- Relatively similar emissions regulations between the EU and NZ
- EU practices can provide insights into achievable goals for NZ

World Health Organization

Pollutant	Averaging Time	2005 AQGs	2021 AQGs
$PM_{2.5}$, µg/m^3	Annual	10	5
	24-hour[a]	25	15
PM_{10}, µg/m^3	Annual	20	15
	24-hour[a]	50	45
O_3, µg/m^3	Peak season[b]	-	60
	8-hour[a]	100	100
NO_2, µg/m^3	Annual	40	10
	24-hour[a]	-	25
SO_2, µg/m^3	24-hour[a]	20	40
CO, mg/m^3	24-hour[a]	-	4

World Health Organization air quality guidelines.

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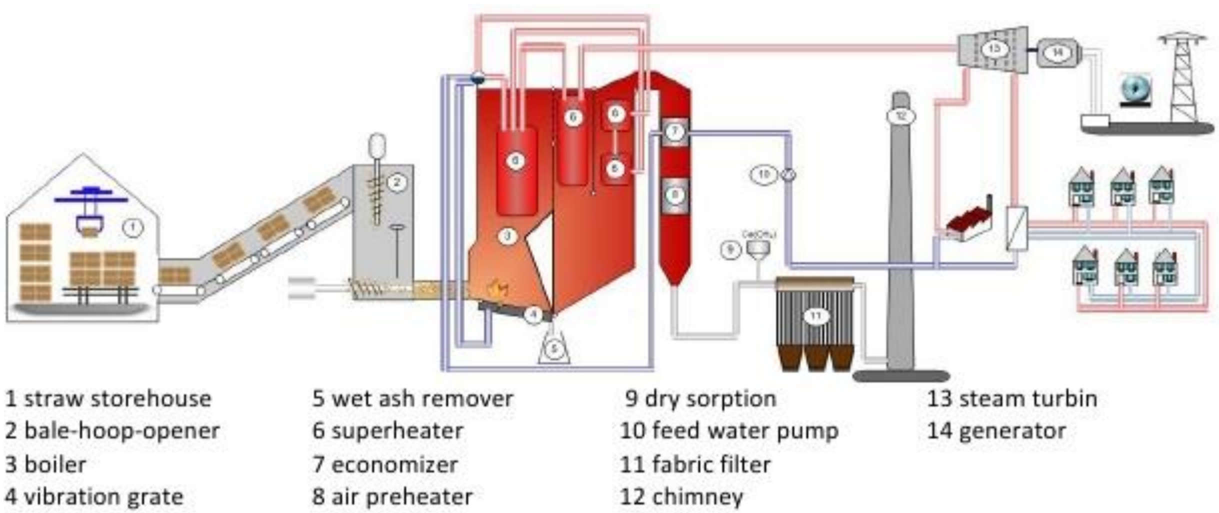
NZ Emission Regulations vs Overseas

Example 1: Herbaceous Biomass

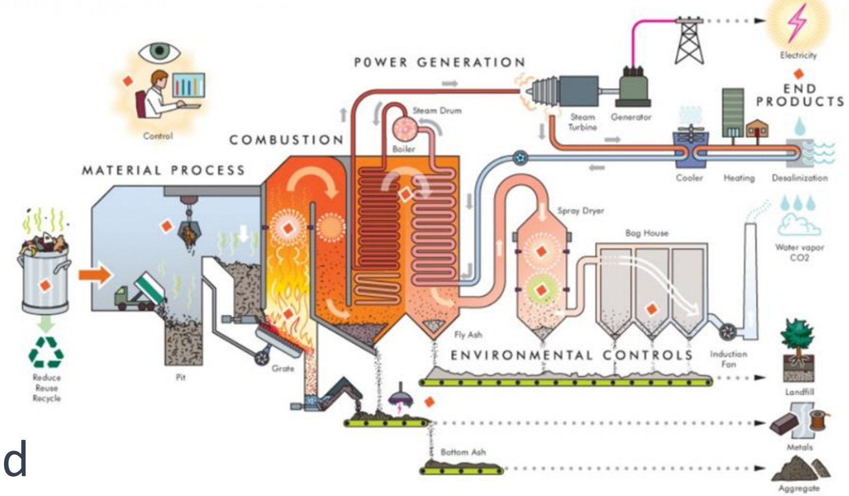
- Denmark's biomass target encourages the use of herbaceous biomass as an alternative to fossil fuels
- Denmark, an EU member, follows EU emission regulations



NZ Emission Regulations vs Overseas

Example 2: Sweden’s High Temperature Boilers

- Sweden permits incineration of physically and chemically contaminated waste wood
- Incinerators operate at high temperatures for pollutant breakdown
- Significant reduction in SOx, NOx, and heavy metal emissions through post combustion control methods



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Novel Fuels

- By definition, they are unusual “one-off” types of fuel. So how to go about using them?
  - What is it?
  - How much?
  - Seasonal or steady in quantity and composition?
  - Its calorific value
  - Moisture content
  - Elemental analysis
  - Nature of the ash

What do you want to do with it?

- What is the peak heat load?
- How does it vary through the day, the week, the year?
- How fast does a load change? In seconds, in hours?

- Working backwards from the projected heat loads, how to they relate to the available fuel? Enough? Too much? Too little?

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Next Step

- Assuming that there is a sufficient load and sufficient fuel, the next step is to commission an environmental consultant who will provide guidance on the maximum emissions to air (peak, average and total over a period), which a plant must achieve to have a reasonable chance of being granted a resource consent.
- Those emission limits are used with potential equipment suppliers as part of the specifications when going out for equipment proposals.
- Assuming that a plant can economically be constructed which can meet the likely environmental emission limits, one is then in a position to apply for a resource consent.

The Resource Consent and Compliance

- When a resource consent is granted, it will be so for a period of time and with certain conditions attached. Typically it will cover matters such as:
  - Maximum fuel burn, hourly, daily, annually.
  - Type of fuel and limitations on its composition
  - Plant operating hours
  - Required records, logging and record keeping.
  - Emission monitoring intervals.
  - Reporting
- The conditions will be defined in the draft resource consent. If any are unreasonable or unworkable, this is the time to discuss it.

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Case study: CCA Treated Timber Combustion

- Different hazard classes for CCA-treated timber based on its intended use
- Hazard classes H1.2, H3.2, and H4 are commonly used in construction and demolition waste – the higher the number, the more CCA there is.
- CCA solution contains copper, chromium, and arsenic in specific percentages

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Case study: CCA Treated Timber Combustion

- Arsenic is the main pollutant of concern in flue gases
- Study shows 11-14% of arsenic emitted into the air during combustion of CCA-treated wood
- Majority of copper and chromium remains in the bottom ash

Contaminant	Emission factor (mg/kg wood)	Ash (mg/kg)
Arsenic	188–237	84 260
Chromium	8.4–14.9	158 740
Copper	8.7–13.4	91 620
PCDD/Fs	1.4–2.4 ng TEQ/kg wood	0.07 ng TEQ/kg wood

Indicative Emission Factors for CCA Timber and Ash Levels (Wasson, 2005)

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Case study: CCA Treated Timber Combustion

- Electrostatic precipitators (ESP) and wet limestone flue gas desulfurization (WFGD) can help remove arsenic in fly ash particles.
- Co-firing CCA timber with other fuels can reduce emissions

- Example: Co-firing H1 timber with untreated wood, and control methods of ESO and WFGD, H1 could make up 3.5% of the overall fuel. For a 20 MW site, this could save 1,000 T of CCA timber from the landfill per year.

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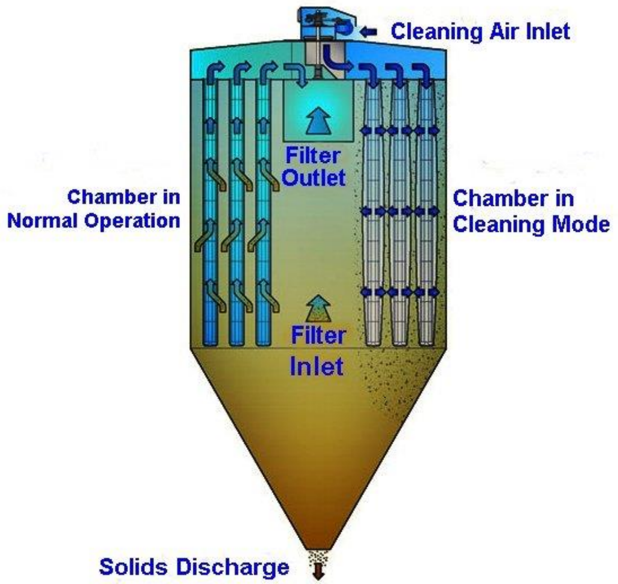
Case study: Oat Husks

- Oat hulls (husks) are the main by-product from oat milling operations, posing disposal challenges.
- Existing equipment was adapted for burning husks for process heat.
- Changes were made to the feed system, burners, firebox, and air flow for effective combustion.
- PM10 emissions were successfully limited to <250 mg/dsm³, complying with consent conditions.

Case study: Oat Husks

- At reconsent, stricter discharge limits required reducing particulate emissions.
- A bag house filter system was installed to improve air quality and reduce emissions.
- PM10 emissions were reduced to 16 mg/dsm³, achieving over a 90% reduction.



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Case Studies - MDF

- Trial by a NZ manufacturer on a standard boiler originally designed for coal. (Example of the details in the back of the Guide).
- Running on hogged MDF & joinery shop waste.
- Emissions monitored in detail
- Details then used for consent applications in Australia
- Several joinery operations in Australia now using the NZ boiler successfully as a means of MDF disposal and to recover heat for space heating.

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Case Study, Process Residue

- Forest owner and timber producer looking to extract specialist chemicals from forestry waste.
- Benchtop study proved the viability
- Designed an extraction plant to recover the specialist materials.
- During design, it was realised that the processing waste was possibly the fuel also, rather than chipping slash.
- Trials during commissioning proved that the waste was indeed a good fuel, both saving on the need to generate chip and usefully disposing of the process waste.

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Case Study, Sewage Waste

- Similar to the process residue study.
- During design of a system to provide supplementary heating for drying sewage sludge, it became apparent that the dried sludge itself was potentially the fuel.
- To the right is the first page of a detailed analysis of the biosolids we wanted to burn.

Report of Analysis

Report Number: 23/339
Issue: 1
Date: 20 April 2023

Order No: 195286

Attention

Sample : 23/339-01
Description : 01 Non routine
Customer Ref. : Biowaste Front End

Date Received: 11/04/2023
Weight Received: 7 kg

Test Code	Analysis - as received	Result	

Test Code	Non routine	Result	
701	Total Moisture (ISO 18134)	17.3	%
705r	Ash (ISO 18122)	18.2	%
706r	Volatile Matter (ISO18123)	53.3	%
707r	Fixed Carbon	11.2	%
712r	Gross Calorific Value (ISO 18125)	14.87	MJ/kg

Test Code	Analysis - dry basis	Result	
705d	Ash (ISO 18122)	22.0	%
706d	Volatile Matter (ISO18123)	64.4	%
707d	Fixed Carbon	13.5	%
712d	Gross Calorific Value (ISO 18125)	17.98	MJ/kg

Test Code	Ash Constituents using XRF - ignited basis#	Result	
1101	SiO2	25.69	%
1102	Al2O3	5.99	%
1103	Fe2O3	2.58	%
1104	CaO	7.58	%
1105	MgO	7.27	%
1106	Na2O	1.39	%
1107	K2O	7.48	%
1108	TiO2	0.99	%
1109	Mn3O4	0.09	%
1110	SO3	0.13	%
1111	P2O5	39.01	%

Test Code	Ash Fusion Temperature - oxidising (ISO 540)	Result	
535	Deformation -oxidising	> 1,560	°C
536	Spherical-oxidising	> 1,560	°C
537	Hemispherical-oxidising	> 1,560	°C
538	Flow-oxidising	> 1,560	°C

Sample : 23/339-02
Description : 01 Non routine
Customer Ref. : Biowaste Middle

Date Received: 11/04/2023
Weight Received: 7 kg

Test Code	Analysis - as received	Result	

Test Code	Non routine	Result	
701	Total Moisture (ISO 18134)	15.8	%

Report No: 23/339-1 (BStdBM)
20 April 2023 15:04:57

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Case Study, Sewage Waste (cont.)

- Worked through a dispersion modelling process to establish that the fuel was indeed useable, consentable, and to create a requirements document for potential suppliers.
- And this is a small part of what came in yesterday morning.

	RATE	M. Flow	M. Flow	Concentr.
PROJECTED EMISSIONS	(lb/mmBtu)	lbs / hr	kg/ hr	mg/m^3
PM -10 with Multicyclone (by AP-42)	0.27	0.81	0.37	207
PM-2.5 with Multicyclone (by AP-42)	0.16	0.48	0.22	123
Total PM with Multicyclone (by AP-4	0.3	0.90	0.41	230
PM-10 with ESP (by AP-42)	0.04	0.12	0.05	31
PM-2.5 with ESP (by AP-42)	0.035	0.10	0.05	27
Total PM with ESP (by AP-42)	0.054	0.16	0.07	41
Nox (by AP-42)	0.22	0.66	0.30	169
CO (by AP-42)	0.3	0.90	0.41	230
SO2	0.57	1.70	0.77	434
VOC (by AP-42)	0.017	0.05	0.02	13
TOC (by AP-42)	0.039	0.12	0.05	30

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