Rio Tinto

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Environmental Report BC Works 2017

TABLE OF CONTENTS

1. About this report

This Annual Environmental Report is provided to share environmental performance with our stakeholders and meet the reporting requirements under the multi-media permit from the provincial government of British Columbia. It is submitted to the provincial government and made available to the public through our BC Works web site and at our Kitimat Public Advisory Committee (KPAC).

In 1999, Rio Tinto's BC Works became the first industrial facility in British Columbia to obtain a multi-media environmental permit from the provincial government.

The P2-00001 Multi-Media Waste Discharge Permit comprehensively addresses multiple emissions, effluents and solid waste, sets limits and establishes monitoring and reporting requirements. This permit is the key environmental regulatory compliance benchmark for smelter operations.

The permit provides guidelines for a results-oriented environmental management approach.

The 2017 Annual Environmental Report is available online at www.riotinto.com\bcworks.

The website also provides information on key environmental performance indicators. Questions or comments are welcome and may be made through the contact page on the website.

BC Works uses the permit guidelines with other proactive strategies to facilitate vigilant compliance monitoring and regular communications with internal and external stakeholders.

The multi-media permit requires annual reporting to measure performance against established permit standards. In addition to the permit reporting for BC Works, a summary report for compliance of the Kemano Operations environmental permits is provided. This annual environmental report presents a summary of the permit required monitoring and reporting.

Stabilizing the new smelter

2017 was the first full calendar year of operation for the modernised smelter. Process stabilization continued in 2017 with key successes in process stabilization and improvements made at the anode baking furnace's fume treatement centre (FT). Bypasses of the FTC were decreased by 56% bringing the FTC's operations to best practice levels.

In 2017, BC Works reported 27 non-compliances. A discussion of the non-compliances, their impacts and Rio Tinto responses are highlighted in Chapter 11 of this report. Overflow events at F-Lagoon continued to be a challenge in 2017, however, a capacity improvement project for F-Lagoon was implemented in 2017 which has reduced the risk of future overflow events and associated permit non-compliances.

2. Operational overview

Rio Tinto operates a multi-faceted industrial complex in northern British Columbia, which is one of the largest industrial sites in the province. The operational footprint includes the Kitimat smelter, the power house at Kemano and the Nechako reservoir.

On December 1, 2011, Rio Tinto authorized the modernisation of the BC Operations with a total investment of US $4.8 billion. In 2015, the new smelter was fully built and substantively commissioned. By the end of the second quarter of 2016, all of the new pots were fully operational and in process stabilization mode. Process stabilization continued successfully into 2017. The operation of the new AP4X technology has resulted in a remarkable step change in environmental performance compared to the old VSS aluminium smelting technology that was in operation for over 60 years.

The main raw material used at the smelter is alumina ore; large volumes of which are imported from international suppliers and delivered by ship. Alumina is composed of bonded atoms of aluminium and oxygen. An electrolytic reduction process is used to break the bond and produce aluminium.

The electrolytic reduction process takes place in the potroom buildings. These buildings house specially designed steel structures called pots. The pots function as electrolytic cells. They contain a molten bath or electrolyte made up mainly of highly conductive cryolite bath in which alumina ore is dissolved. Electricity flows through the electrolyte from an anode to a cathode. The electricity breaks the aluminium-oxygen bond. The heavier aluminium molecules sink to the bottom of the pot in the form of molten aluminium. Oxygen is combined with carbon from the anode to form carbon dioxide.

Our modernised smelter

The old VSS technology used a carbon anode that is baked in-situ. Electrical current was passed through the anode and into the molten bath to produce metallic aluminium. Fluoridised alumina ore was placed along the outer edge of the pot that would form a crust. This “sealed” the pot against a gas skirt where process gases were collected and taken to a dry scrubber to remove particulates and fluoride.

The new leading-edge AP40 technology in the modernised smelter.

The Söderberg technology from the old Kitimat smelter, which opened in 1954.

The old process had significant fugitive emissions through inefficiencies of gas collection and also the emissions of the baking anode. On a scheduled routine basis, the crust would be broken to "feed" the pot alumina or tap the pot to remove the aluminium. Whenever the crust would be broken, fugitive emissions would be generated.

The new AP4X technology is a modern clean technology that is considered to be the best available technology for emission control (Figure 2.1).

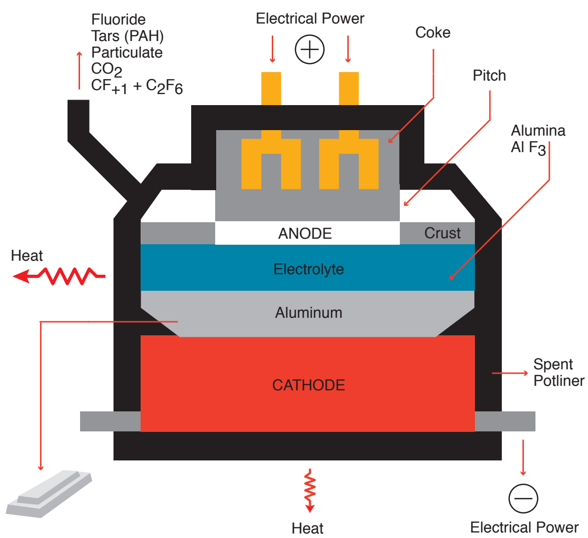


Figure 2.1 Aluminium manufacturing process of the APX technology.

The AP4X technology uses anodes that are pre-baked in an Anode Baking Furnace before they are used in the reduction process. This is how the modernised smelter is able to reduce polycyclic aromatic hydrocarbon emissions by 98%. The new AP4X pots are under strong suction by the Gas Treatment Centres (GTCs) that continuously draw process gas from each pot and filters the gas to remove particulates and fluorides. Each AP4X pot is enclosed by a series of hood cover plates that minimize the generation of fugitive emissions. Pot tending, feeding fresh alumina and tapping metal from the pots are all done under strong gas collection from the GTCs. Gaseous fluorides emission intensity have been reduced by 84% in 2017 over the old VSS smelter due to the modern gas collection and treatment system. The modernised smelter will reduce total air emissions discharge by nearly 50%. This overall reduction in air emissions is the difference between the contaminant loadings (PAH, fluoride, particulates, GHG & SO_2) produced by the old smelter annually and the forecasted loadings that will be generated by the new smelter over the years.

The molten aluminium that is extracted from the pots is transported to the two casting centres (B & C) located within the smelter, where it is temporarily stored in holding furnaces. Various alloying materials (such as magnesium, copper, silicon and iron) are added to produce specific characteristics such as improved strength or corrosion resistance. The new "C" Casthouse has a state-of-the-art water cooling and recycling system.

The aluminium is then poured into moulds and chilled, forming solid ingots of specified shapes and sizes. BC Works produces three types of aluminium ingots: value added sheets, remelt ingots, and sows which are sold to customers in North America and Asia resulting in a variety of end-use applications.

The smelter site also includes facilities that produce materials required for aluminium production including the on-site Anode Paste Plant, Anode Rodding Shop, Coke Calciner, Carbon Recycling and Anode Baking Furnace, which produce materials used in the manufacturing and recycling of anodes. The new process also includes a Bath Treatment and Storage Facility for the recycling of bath materials.

The electrolyte reduction process requires the use of large amounts of electricity. Electricity for BC Works is generated at the Kemano Operations' powerhouse, a 1,000 megawatt hydroelectric generating station located 75 kilometres southeast of Kitimat. This generating station uses water impounded in the 91,000 ha Nechako Reservoir in north-central British Columbia.

In addition to the process related facilities, there are a number of environmental facilities for waste management, storm water management and managed sites. These environmental facilities are shown in Figure 2.2.

56%

Bypass hours of the fume treatment centre (FTC) for the anode baking furnace were reduced by 56% in 2017 .

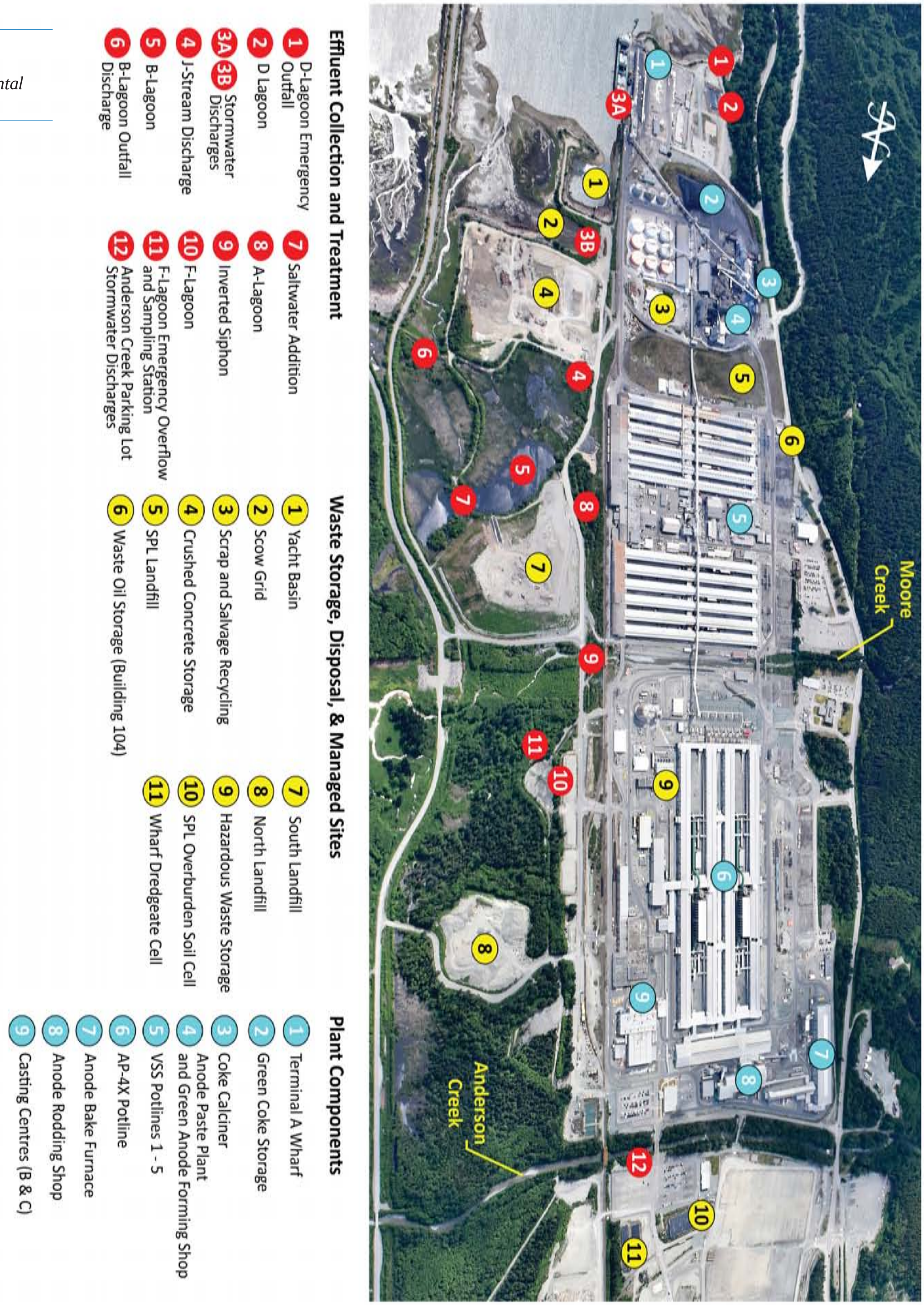


Figure 2.2 Kitimat Environmental operations.

3. Environmental management and certification

The foundation for environmental management throughout Rio Tinto's global operations is the Health, Safety and Environment (HSE) Policy. HSE directives establish corporate-wide standards on major environmental, health and safety topics.

The HSE Policy and the more specific requirements of the Rio Tinto Health, Safety, Environment and Quality (HSEQ) standards are put into practice at BC Works through a comprehensive, operation specific Risk Management System. The system is maintained through adherence to the HSEQ Management System's 17 elements encompassing the continuous improvement cycle of Plan, Do, Check and Review (PDCR).

Independent certification

Since 2001, BC Works has been successfully certified under the requirements of ISO 14001 (2005) environmental program. ISO 14001 provides independent conformance verification that BC Works; evaluates its environmental impacts, has procedures in place to address practice, and works continually to lighten or eliminate its environmental footprint.

In keeping with a corporate- wide commitment to a sustainable management approach, BC Works attains certification of ISO 14001 standards (Environment) and the ISO 9001 standards for Product Quality. For Environment, this covers all Rio Tinto BC Works activities and locations where risks of our business are managed. For Quality, the scope is for the processes of manufacturing of aluminium ingot and shipping.

Audit program

Independent ISO compliance and conformance audits are conducted as a condition of certification. The internal and external Environment and Quality Management System surveillance audits took place in 2017 as planned. BC Works' integrated certification was successfully maintained.

Compliance with all environmental laws and regulations is the foundation of our environmental performance standards.

RioTinto

Health, Safety, Environment and Communities

Our commitment to health, safety, environment and communities is fundamental to how we do business at Rio Tinto. It applies wherever and whenever we operate, from exploration, to closure.

Safety	Teamwork	Respect	Integrity	Excellence
Caring for human life and wellbeing above everything else	Collaborating for success	Fostering inclusion and embracing diversity	Having the courage and commitment to do the right thing	Being the best we can be for superior performance

Delivering world class health, safety, environment and communities performance is essential to our business success. Meeting our commitments in these areas contributes to sustainable development and underpins our continued access to resources, capital and engaged people. Our focus on continuous improvement ensures regular renewal and relevance of our policies, procedures and activities.

We make the safety and wellbeing of our employees, contractors and communities our number one goal. Always. Where everyone goes home safe and healthy every day.

Equally critical, is maintaining stakeholder confidence through accountable and effective management of our risks and our impacts. Safely looking after the environment is an essential part of our care for future generations.

We approach each social, environmental or economic challenge as an opportunity to create safer, more valuable and more responsible ways to run our business. Wherever possible we prevent, or otherwise minimise, mitigate and remediate the effects of our business' operations. We assess the impact of our activities and products in advance, and we work with local communities and agencies to manage and monitor these impacts.

Our approach starts with compliance with relevant laws and regulations. We have the courage and commitment to doing what is right, not what is easiest. We maintain our focus on ethics, transparency and building mutual trust. We support and encourage further action by helping to identify, develop and implement world class practices through the application of our Group wide standards.

We make the safety and wellbeing of our employees, contractors and communities our number one goal.

4. Effluents

Surface runoff from the smelter site, originating as snowmelt and rain, accounts for most of the water discharge. Seasonal precipitation varies significantly and total discharges can be over 100,000 m^3 per day during fall and winter storms.

Sources and infrastructure

Whether water is in use at the smelter or accumulating through surface runoff, it collects contaminants from various sources. It is directed through underground drains and surface channels to one of six inflows into B-Lagoon that discharges into the Douglas Channel.

B-Lagoon consists of a primary and a secondary pond: Upper and Lower B-Lagoons. It is designed to remove contaminants by sedimentation, phytoremediation, along with salt water addition to smooth fluctuations of inflows and contaminant levels. B-Lagoon discharges effluent continuously into the Douglas Channel. In 2017, the average discharge rate was 22,995 m^3 per day.

The retention time for water in the lagoon is usually more than ten hours (confirmed by measurements conducted in 2005), but is reduced to about five hours during runoff events and heavy rainfall.

In addition to the B-Lagoon outfall, there is an emergency outfall that can accommodate significant inflow surges. F-Lagoon and D-Lagoon are also designed with emergency overflows in case of significant surge. In 2017 there were six overflow events at F-Lagoon. Overflow events that were outside permit limits and will be discussed in Chapter 11.

Discharge measurements related to permit requirements and additional monitoring are described below in the following 2017 performance section.

2017 performance

Effluent water quality monitoring

Effluent water quality is monitored annually for the following parameters: flow variability, dissolved fluoride, dissolved aluminum, TSS, cyanide, temperature, conductivity, hardness, toxicity, acidity and Total PAH. Of these parameters, dissolved fluoride, dissolved aluminum, and TSS are monitored for long term trends.

Flow variability

Variability in the flow from B-Lagoon into the Douglas Channel is mainly a function of precipitation. As shown in Figure 4.1, peak rain events and flows occurred in January to March and in September through December. The total amount of rainfall in 2017 (2375 mm) was very similar comparing to 2016 (2328 mm).

Long-term trends

Dissolved fluoride, dissolved aluminum, and total suspended solids are the most meaningful performance indicators of plant effluent water quality. Average annual performance for these have been consistently maintained below permit levels (10 mg/L, 3 mg/L and 50 mg/L respectively) in recent years. Figure 4.2 illustrates the long-term trend performance.

In 2017 dissolved fluoride, and total suspended solids loads slightly decreased over a 10 year trend. The most significant change has been the reduction of dissolved aluminum in the lagoon system over the 10 years that can be attributed to the shutdown of the old smelter.

Dissolved fluoride

Dissolved fluoride originates mainly from the leaching of a landfill formerly used to dispose of spent pot lining. Information on the spent pot lining landfill is reported in Chapter 9, Groundwater monitoring. Other sources of fluoride are raw material losses around the smelter.

Dissolved fluoride is monitored continuously through daily composite sampling and monthly grab sampling. Daily composite and grab samples are sent to an outside laboratory for analysis (refer to Chapter 12, Glossary for sample method definitions).

The permit specifies a maximum concentration of 10 mg/L of dissolved fluoride in effluent; this level was not exceeded in 2017. Average dissolved fluoride concentration for the year derived from composite sampling was 3.75 mg/L. The long-term trend is illustrated in Figure 4.2. The 2017 composite and grab sampling results (Figure 4.3) profile the higher concentrations that occurred during the higher precipitation and surface run-off events during the year.

Dissolved aluminium

Aluminum metal at BC Works, such as finished products stored outside at the wharf, have a very low solubility and contribute little to the discharge of dissolved aluminum.

In addition to its use as a raw material, alumina is also used in the scrubbing process to remove fluoride from smelter emissions. Some scrubbed alumina is released through the potroom gases collection centres. In this form, scrubbed alumina has a higher solubility and is a contributor to both dissolved aluminum and dissolved fluoride.

In 2017, concentrations of dissolved aluminum did not exceed the maximum permit limit of 3.0 mg/L. The annual average of dissolved aluminum concentration was 0.184mg/L (Figure 4.4).

B-Lagoon is a large and well-vegetated area that is highly efficient in absorbing and processing effluent compounds.

Total suspended solids (TSS)

Solids that remain suspended in discharge from B-Lagoon include small amounts of materials used in industrial processes at the smelter and other naturally occurring substances like dust, pollen and silt. There is a proportional relationship between TSS levels and concentrations of both dissolved aluminium and polycyclic aromatic hydrocarbons (PAHs) because these contaminants are usually bound to suspended solids in water when entering the B-Lagoon system.

B-Lagoon is a large and well-vegetated area that is highly efficient in absorbing and processing effluent compounds. The permit specifies a concentration maximum of 50 mg/L of TSS in effluent.

Concentrations in 2017 were much lower than the permit level. The annual average concentration for the composite samples was 2.6 mg/L (Figure 4.5) which is consistent with previous years.

Cyanide

Cyanide is formed during the electrolytic reduction process and retained in the cathode lining material known as spent pot lining (SPL). In the past, material in the cathode was deposited on-site at the SPL landfill. Today, all generated SPL is shipped off-site to a secure landfill. Groundwater and the bottom of the SPL landfill lining interact, generating a leachate containing cyanide. The source of the cyanide in B-Lagoon is from the J-Stream outlet.

The permit specifies a maximum concentration of 0.5 mg/L of strong acid dissociable cyanide (the more abundant, although less toxic form) in B-Lagoon. Concentrations are determined from the monthly grab samples. The permit level was not exceeded in 2017. Weak acid dissociable cyanide is also monitored, although there is no permit requirement (Figure 4.6). The results for the September cyanide sample are missing as a results of a lost sample at our third party lab.

Temperature

Water used for cooling is the major source of effluent at BC Works. B-Lagoon is designed to retain effluent long enough to ensure water temperatures are not elevated when discharged. The permit requires that the temperature of the lagoon discharge does not exceed 30°C. Temperatures were within permit requirements during 2017 (Figure 4.7).

Conductivity, hardness, salt water addition and toxicity

Since 1997, salt water has been pumped into B-Lagoon at the connection between the primary and secondary ponds. As per permit requirements, the addition of salt water is monitored and managed to maintain non-toxic discharges.

In 2008, an independent consulting firm conducted a review to examine the correlation between seawater addition rates, conductivity, hardness, and toxicity. The review was in fulfillment of section 8.2.5 of the multi-media permit requirement. Results confirmed that the addition of sea water was successful at reducing the toxicity of the B-Lagoon effluent.

The data also confirmed the best way to predict toxicity is via aluminium concentration, conductivity and pH. Conductivity and hardness are monitored on a continuous and daily composite basis respectively, even though there are no permit limits for either parameter (Figure 4.8). These measures provide information that ensures the salt water addition system is contributing to the reduction of toxicity at the B-Lagoon outfall.

Water toxicity is determined through the application of a bioassay test. The toxicity of water discharged from B-Lagoon is tested by exposing juvenile rainbow trout to the effluent in a certified laboratory under controlled conditions (96LC50 bioassay test). The permit requires quarterly monitoring with a survival rate of at least 50% for trout tested. All effluent discharge bioassay tests at B-Lagoon passed during 2017.

Acidity

A variety of contaminants can influence the acidity of effluent, by either increasing or decreasing the pH levels. A pH level of 7.0 is neutral, and water sources found adjacent to BC Works (Anderson Creek and the Kitimat River) usually have a pH level slightly below neutral (i.e. acidic, rather than alkaline).

Acidity is monitored using a variety of methods (continuous, daily composite and monthly grab samples). Daily composite samples are provided to an external laboratory for analysis. The permit requires that the pH of the effluent is maintained between 6.0 and 8.5. The 2017 annual pH composite sample average was 7.5. All sample measurements were within the permit limits during 2017 (Figure 4.9).

Polycyclic aromatic hydrocarbons (PAHs)

Polycyclic Aromatic Hydrocarbons (PAHs) are a large family of chemical compounds (more than 4,000 have been identified) generated by the incomplete combustion of organic material. Various operations at the smelter generate PAH in both particulate and gaseous forms.

Other sources include raw materials (green coke and pitch) handling. PAHs are monitored using two methods: weekly analysis of composite and monthly grab samples. PAHs are also analyzed from grab samples taken during special events. B-Lagoon discharges are monitored and analyzed for 15 of the most common PAH compounds (Figure 4.10). In 2017 the overall trend PAHs appear to be less than previous years which may highlight some of the benefits of the new smelter technology.

All PAH results from 2017 were within permit limits set at 10 ug/L. The average reading for 2017 was 0.7ug/L.

Figure 4.1
Flow variability, B-Lagoon 2017

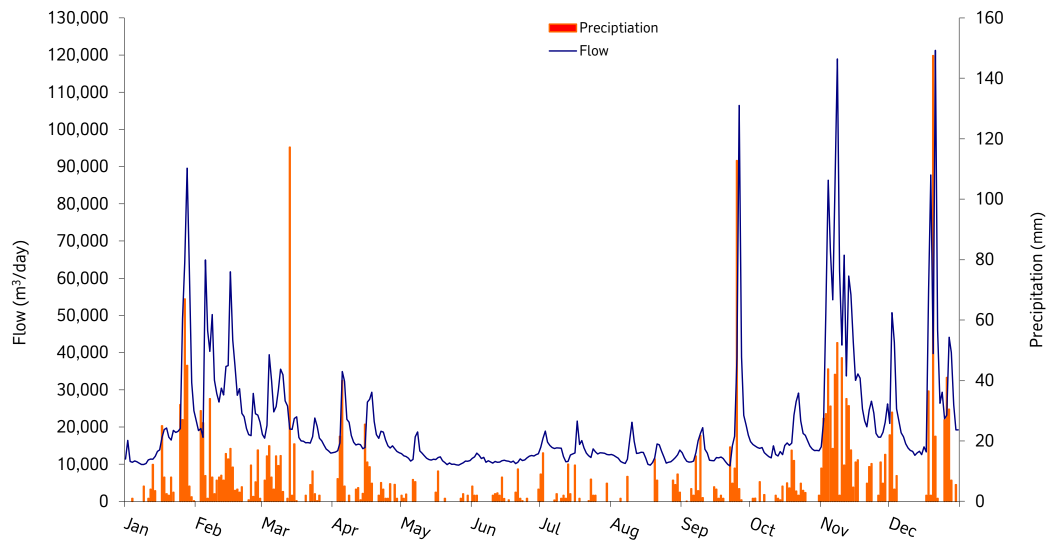


Figure 4.2
Dissolved Fluoride, Dissolved Aluminium and Total Suspended Solids, B-lagoon 2017

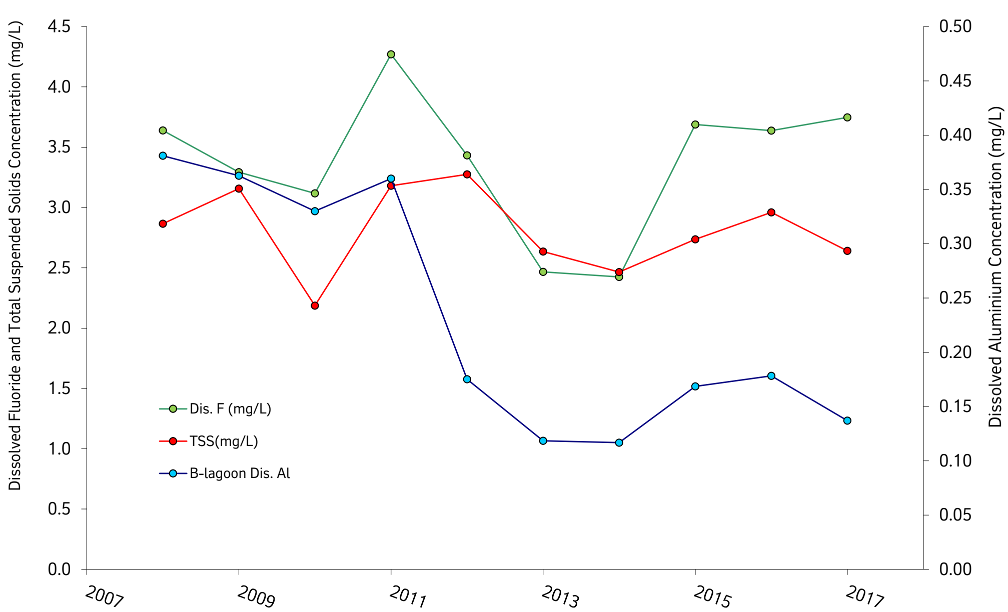


Figure 4.3 Dissolved fluoride, B-lagoon 2017

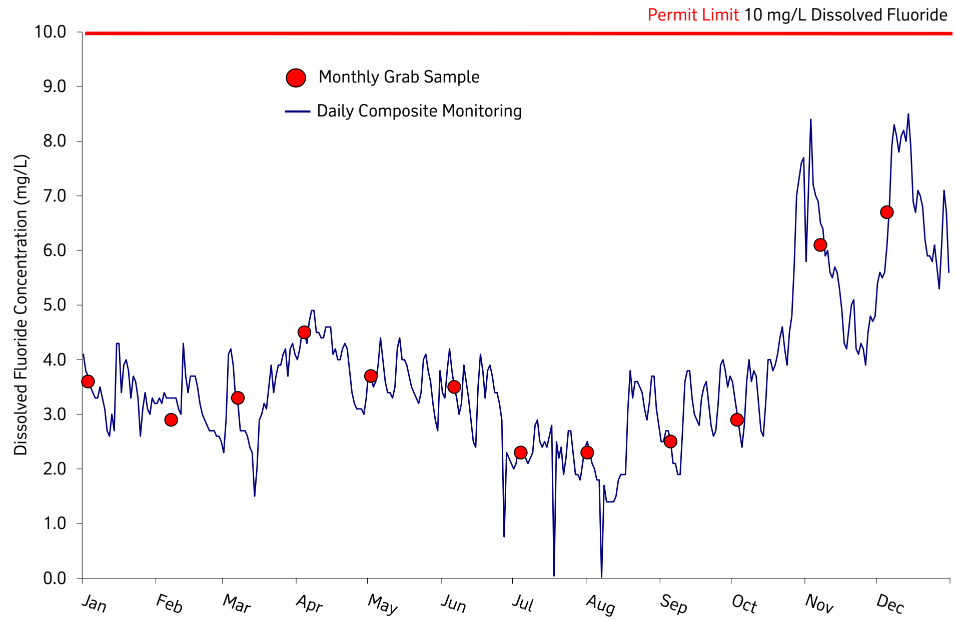


Figure 4.4 Dissolved Aluminium, B-lagoon 2017

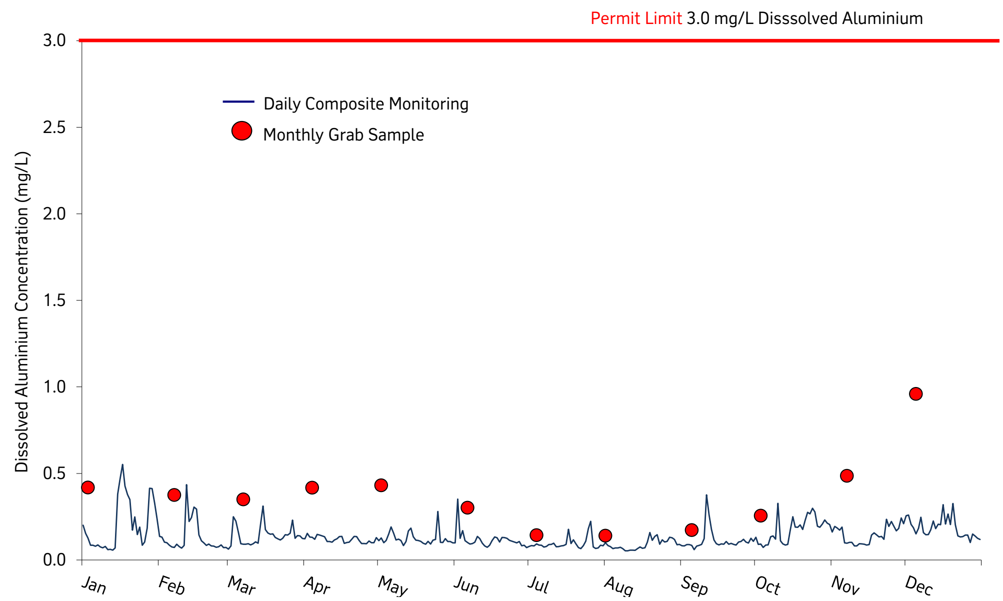


Figure 4.5 Total Suspended Solids, B-lagoon 2017

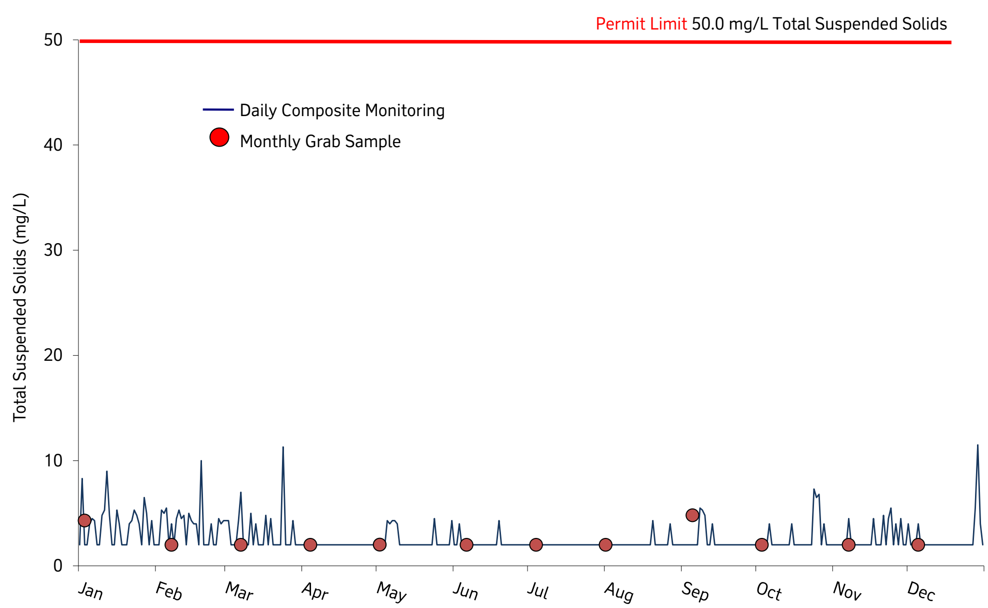


Figure 4.6
Cyanide, B-lagoon 2017

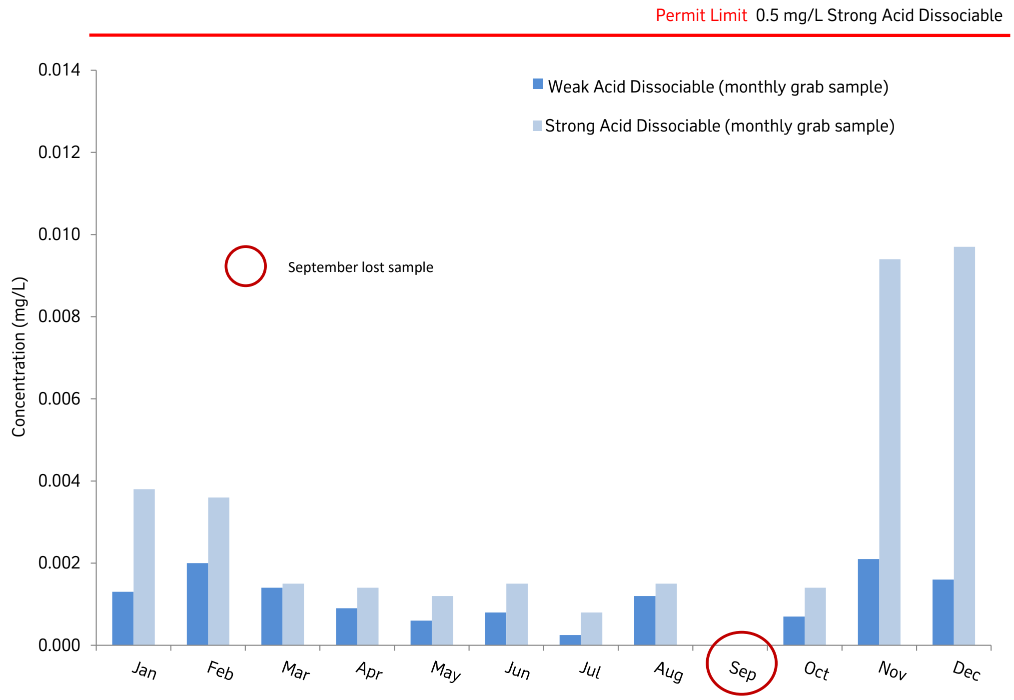


Figure 4.7
Temperature B-lagoon 2017

Figure 4.8
Conductivity and hardness, B-lagoon 2017

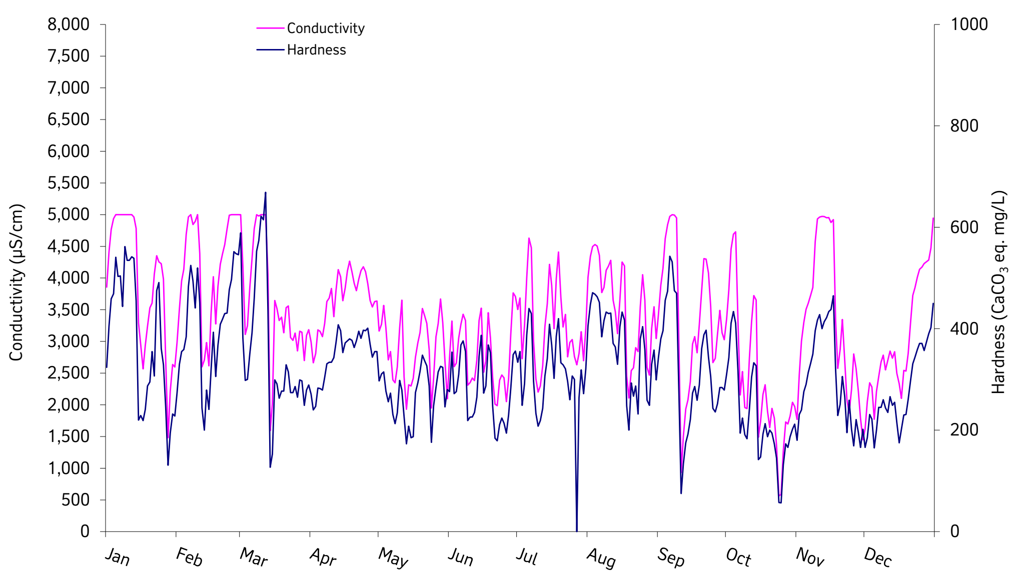


Figure 4.9
Acidity, B-lagoon 2017

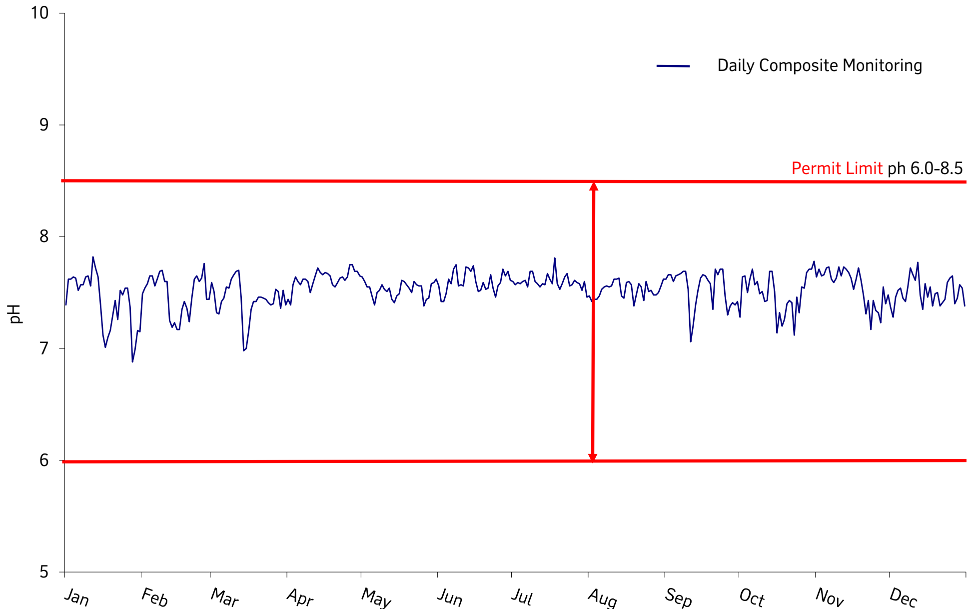
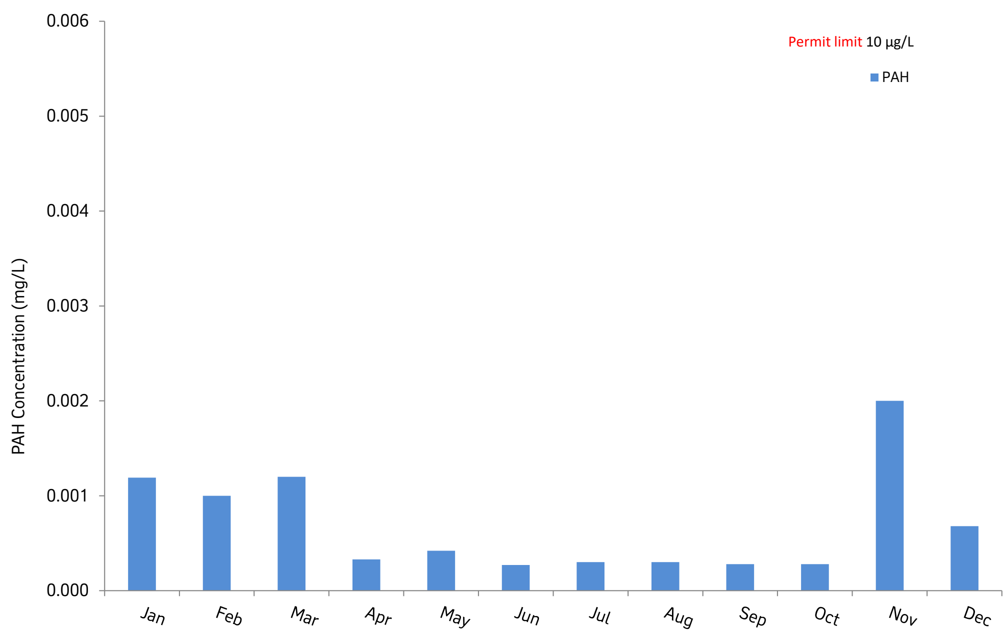


Figure 4.10
Polycyclic Aromatic Hydrocarbons, B-lagoon 2017



5. Emissions

This chapter describes the results of ongoing monitoring of various gaseous and particulate-matter in air emissions from BC Works. Performance results relate to type and source of emissions.

Emission types

The primary types of emissions monitored are total fluoride (Ft), sulphur dioxide (SO_2), polycyclic aromatic hydrocarbons (PAHs), nitrogen oxides (NOx), total particulates, and greenhouse gases (GHGs). As per the permit requirements for the AP4X smelter, the compliance monitoring for the pre-bake emission points started in September of 2016.

Sources

Major sources of air emissions at BC Works include the reduction roof vents, Gas Treatment Centres (GTCs), Calcined Coke Plant, Anode Paste Plant, Anode Baking Furnace (ABF) and the exhaust stacks. Wind-blown or fugitive dust (picked up from raw material storage piles, process ventilation systems and during raw material transportation) is another contributor to air emissions.

Pollution control equipment, situated at various locations in and around BC Works, includes the reduction GTC's, the coke calciner pyroscrubber, the Fume Treatment Centre (FTC) at the ABF, and the dust collectors. Air emissions are collected and processed via these pieces of equipment to remove airborne pollutants.

Air quality monitoring

In addition to monitoring emissions, regular and extensive air quality and vegetation monitoring is conducted in the Kitimat valley. Information on these monitoring programs is detailed in Chapters 6 and 7.

2017 performance

Total fluoride (F_t)

Four major sources contribute to fluoride emissions: the reduction roof vents, the Gas Treatment Centres, the Fume Treatment Centre and the Pallet Storage Building where anode butts are cooled before being recycled. In reduction, the molten bath dissolves the alumina ore by an electrolytic reduction process through which aluminium is produced. The bath is composed primarily of sodium fluoride and aluminium fluoride and is the main source of fluoride emissions at BC Works. The modern AP4X technology has strong gas suction and hoods on the pots, so the collection and recycling of emissions has improved in comparison to the old Söderberg technology. Gas collection efficiency for the new smelter is greater than 98%.

The first pot of the modern AP4X prebake smelter began producing metal in June 2015 and all 384 pots were started sequentially with the last pot started at the end of March 2016. Compliance monitoring and reporting of the reduction roof emissions (fluoride and particulate) started in September 2016 when the process stabilized (refer to the yellow dots on the potroom roof sampling locations on Figure 5.1). Fluoride emissions are monitored at roof top locations inside the reduction buildings A, B, C and D (Figure 5.2).

In preparation for the idling of the VSS potlines, in 2008, the gaseous fluoride permit limit (including both reduction and dry scrubber emissions) was set by the Ministry at 50 tonnes of gaseous fluoride loading per month and replaced the rate measurement of gaseous fluoride per tonne of aluminium. The fluoride permit limit has transitioned to 33.3 tonnes per month of total fluoride for the new AP4X smelter (Figure 5.3). This limit will further transition to 0.9 kg/t Al at the start of 2018. The total fluoride emissions rate is tracked internally.

Total fluoride includes the gaseous fluoride plus the fluoride particulate. During 2017, there were no monthly loading exceedances of the total fluoride emissions limit (Figure 5.3).

Sulphur dioxide (SO_2)

Sources of sulphur dioxide at BC Works include petroleum coke (green and imported calcined) and coal tar pitch. Both are raw materials used to manufacture anodes. Coke calcination is a process used to change green coke into a usable form. Sulphur dioxide emissions occur during calcination, baking of the anodes at the Anode Baking Furnace and the electrolytic reduction process through which aluminium is produced.

From 1993 to 1999, the permitted sulphur dioxide emission was set at 20.7 tonnes per day on an annual average. In 2000 the permitted sulphur dioxide emission was set at 27 tonne per day on annual average to reflect the quality challenges observed in the global coke market. In April 2013 the operation permit was updated to reflect the new SO_2 emission permit limit of 42.0 tonnes per day on annual average in preparation to the modernised smelter production increase. The average SO_2 emissions have increased since 2015 which can be attributed to the smelter reaching full metal production in 2016 and continuing to produce approximately 50% more tonnes of aluminium. In 2017, the SO_2 emission levels remained well below the permit limit (Figure 5.4). Monthly average performance was also consistently below the permit limit (Figure 5.5). Small quantities (approximately 3.0% of the total anodes consumed) were low sulphur imported anodes from China that contributed to the low monthly SO_2 emissions.

In addition to monitoring emissions, BC Works carries out every year extensive monitoring activities under the SO_2 Environmental Effects Monitoring program (SO_2 EEM). The EEM studies four different lines of evidence; water, human health, soil and vegetation. Results and information about the SO_2 EEM can be found online at www.riotinto.com\bcworks.

Polycyclic aromatic hydrocarbons (PAHs)

PAH are produced by both industrial processes and various forms of combustion such as wood-burning stoves and forest fires. Since the anodes for the AP4X technology are baked before being placed in the pot, the PAH emissions are greatly reduced as compared to the Söderberg technology.

A measurement campaign will be done in the potrooms once the pots are stable to confirm the low levels of PAH emissions. A 98% reduction in PAH emissions from the anode baking and consumption is forecasted for the modernized smelter.

98%

PAH emissions from the AP4X potrooms are expected to be reduced by over 98% due to the anode pre-bake process.

Nitrogen oxides (NO_X)

Nitrogen oxides are a minor emission from the Smelter. NO_x emissions are generated plant wide from three main sources: natural gas consumption, coke calcination and open burning of wood. Nitrogen oxides are relevant to smog and other potential air quality concerns.

NO_x emissions are estimated using a combination of actual measurements and US-EPA emission factors. In 2013 the method of calculation of NO_x emissions for the annual environmental report changed to reflect the same calculation used for the National Pollutant Release Inventory (NPRI). Smelter-wide NO_x emissions for 2017 was estimated at 292 tonnes per year (Figure 5.6).

Reduction Gas Treatment Centres (GTCs)

The annual average for reduction particulate samples including both GTCs was 0.48 kg/tonne of Al which is under the permit limit of 1.3 kg/tonne of Al (Figure 5.7).

The decrease in measured particulate emissions in 2016 & 2017 is a result of the modernised smelter coming on-line and the full shutdown of the old VSS operation (Figure 5.8).

Particulate emissions from the reduction roof vents accounted for 73% of total particulate emissions for BC Works in 2016 (Figure 5.9).

Total particulate emissions

The plant-wide total particulate emissions for 2017 was 277.9 tonnes which is an 11 percent decrease from 2016's 310.7 tonnes of particulate emissions. This plant wide total includes reduction roof vents, GTCs, Coke calcination (pyroscrubber & Cooler), Casting and the Anode Bake Furnace (FTC). (Figure 5.9).

Calcined Coke Plant

The two emission sources at the Calcined Coke Plant (the pyroscrubber and the cooler) are monitored relative to permit limits for particulate content. In 2017, the pyroscrubber and the cooler were tested and all results were compliant (Table 5.3).

Anode Paste Plant

Various emission sources at the Anode Paste Plant are controlled using dust collectors and two pitch incinerators. The dust collector discharge stacks are monitored relative to permit levels for total particulate content (Table 5.4). As part of the modernization, a new dust collector was added to the Pitch Fume Treatment Centre (PFTC). PAHs are also tested there and are monitored relative to a permit limit. The pitch incinerator discharges are monitored relative to permit levels for total particulate and PAH content. There were no exceedances for PAHs at the Anode Paste Plant in 2017 (Table 5.5).

Anode Baking Furnace - Fume Treatment Centre (FTC)

The emission source at the Anode Baking Furnace is monitored relative to permit limits for total particulate and PAH. In 2017 there were no exceedances of the permit limit (Table 5.6). The SO_2, Fluoride and NO_x emissions at the anode baking furnace are included in the plant wide limits. The FTC is designed to allow the bypass of emissions from the ABF direct to the FTC stack without treatment under emergency conditions or exceptional major maintenance restarts and operations. FTC bypass Table 5.7 lists the bypass mode occurrences for 2017. FTC bypasses in 2017 were reduced by 56% in comparison to 2016's total bypass hours from January to December and were close to best practice levels.

Bath Treatment and Storage Facility

The two major dust collectors at the bath treatment and storage facility are monitored relative to permit levels for total particulate. There were no exceedances of the permit limits in 2017 (Table 5.8).

Natural gas consumption

Natural gas is widely used at BC Works in various applications where heat is required. Variables affecting usage levels include production levels and the availability of energy generated by the hydroelectric facility at Kemano Operations.

BC Works consumption rates and associated emissions are calculated using standards developed by the US Environmental Protection Agency (US-EPA). Plant-wide natural gas consumption can be seen in Table 5.9.

Chlorine and sulphur hexafluoride (SF_6) consumption

Gaseous chlorine was not used during the process of casting aluminium ingots in 2017. The permit limit for chlorine consumption is 300 kg per day. This limit has not been exceeded since 1999. Over the past years, the use of chlorine was reduced and finally eliminated in April 2014.

There was no SF6 consumption in 2016 during the process of casting aluminium ingots. In 2013, the casting centres that used the SF6 gas were shut down.

Other stack tests were completed in 2017 for casting operations (Table 5.10).

Greenhouse gas emissions

There are a number of sources of greenhouse gas (GHG) emissions at BC Works (Figure 5.10). Most emissions occur during the smelting process, and most smelting-related emissions are attributable to anode consumption (Figure 5.11).

BC Works GHG 2017 emissions have been steadily decreasing since 2015 (Figure 5.13) emitting on average 1.97 tonnes of CO_2 equivalent, per tonne of aluminium production (Figure 5.12).

Table 5.1
GTC Annual Stack Tests 2017

Performance Measure	GTC East	GTC West
Dates	**Dec 17**	**Dec 17**
Flow (m^3/min) Permit limit: None	51,754	50,342
Total Particulates (mg/m^3) Permit Limit: Included in Plant Wide limit	0.18	0.199
Particulate Fluoride (mg/m^3) Permit Limit: Included in Plant Wide limit	0.027	0.07
Gaseous Fluoride (mg/m^3) Permit Limit: Included in Plant Wide limit	4.42	3.75
Sulphur Dioxide (mg/m^3) Permit Limit: Plant Wide limit	157.3	192.9

* GTC east and west will be retested in 2018

Table 5.2
GTC Upset Conditions 2017

Date	GTC	Upset condition	Duration	Cause
18-Jan-17	East	Fresh Alumina Feed stopped for > 2 hours	7h 38m	Airlift maintenance cleaning
19-Jan-17	West	Fresh Alumina Feed stopped for > 2 hours	6h 22m	Airlift maintenance cleaning
11-Mar-17	West	Fresh Alumina Feed stopped for > 2 hours	6h 31m	Airlift maintenance cleaning
22-Mar-17	East	Fresh Alumina Feed stopped for > 2 hours	7h 5m	Airlift maintenance cleaning
6-Jun-17	West	Zero Exhaust	1h 30m	PLC communication loss
		Fresh Alumina Feed stopped for > 2 hours	2h 45m	
8-Jun-17	East	Fresh Alumina Feed stopped for > 2 hours	9h 30m	Airlift maintenance cleaning
9-Jun-17	West	Fresh Alumina Feed stopped for > 2 hours	5h 34m	Airlift maintenance cleaning
20-Jun-17	East	Zero Exhaust	1h 53m	Power Outage
		Fresh Alumina Feed stopped for > 2 hours	3h 42	
	West	Zero Exhaust	2h 35m	
		Fresh Alumina Feed stopped for > 2 hours	4h 35m	
24-Aug-17	West	Zero Exhaust	10m	Operator Error
		Fresh Alumina Feed stopped for > 2 hours		
		Loss of Air Fluidization		
	East	Zero Exhaust	12m	Automation Error
		Fresh Alumina Feed stopped for > 2 hours	12m	Stop Feed to drain Filters
		Loss of Air Fluidization	1h 7m	
6-Sep-17	West	Fresh Alumina Feed stopped for > 2 hours	7h 30m	Airlift maintenance cleaning
6-Sep-17	East	Fresh Alumina Feed stopped for > 2 hours	5h 30m	Airlift maintenance cleaning
29-Oct-17	West	Fresh Alumina Feed stopped for > 2 hours	4h 50m	Airlift maintenance cleaning
30-Nov-17	East	Zero Exhaust	1h	Power Outage
	West			
	East	Fresh Alumina Feed stopped for > 2 hours	2h	
	West			
6-Dec-17	East	Fresh Alumina Feed stopped for > 2 hours	5h 20m	Airlift maintenance cleaning
7-Dec-17	West	Fresh Alumina Feed stopped for > 2 hours	5h 15m	

Table 5.3
Calcined Coke Plant Biannual Stack Tests 2017

Pyroscrubber		
Parameters	**May-17**	**Dec-17**
Particulates (Kg/hr) Permit Limit: 21.1 (Kg/Hr)	6.2	5.2
SO_2 (Kg/hr)	163.5	227.8
NO_x (Kg/hr)	11.1	17.5

Cooler		
Parameters	**Jul-17**	**Dec-17**
Particulates (Kg/hr) Permit Limit: 21.1 (Kg/Hr)	1.26	1.01
SO_2 (Kg/hr)	1.96	1.38

Table 5.4
Anode Paste Plant Annual Stack Tests 2017

Source	Particulate Permit Limit (mg/m^3)	Particulate Emissions (mg/m^3)
Dust Collector DC10	120	9.8
Dust Collector DC11	120	10.6
Dust Collector DC12	120	11.3
Dust Collector DC13	120	13.3
Dust Collector DC14	120	11.5
FC3 (Day Tank)	120	31.7
Liquid Pitch Incinerator	500	59.2
Dust Collector PFTC	2.4	2.1

Table 5.5
Anode Paste Plant Annual PAH Stack Tests 2017

Source	PAH Emissions
Liquid Pitch Incinerator (mg/m3)	0.0104
FC3 Day Tank (mg/m3)	0.0992
Dust Collector PFTC (Kg/Mg Paste) Permit Limit: 0.3 (Kg/Mg Paste)	0.00373

Table 5.6
FTC Annual Tests 2017

Flume Treatment Centre	
Parameters	**Nov-18**
Particulate (Kg/Mg of baked anode) Permit Limit: 0.3 Kg/ Mg of baked An.	0.006
PAH (Kg/Mg of baked anode) Permit Limit: 0.05 Kg/ Mg of baked An.	0.001

Table 5.7
FTC Bypass Modes 2017

Date	Bypass Mode	Duration	Cause
4-Jan-17	Mode 2	1h 2m	Process induced due to pressure sensor at cooling tower
12-Jan-17	Mode 2	30m	Process induced due to high temperature at cooling tower
1-Feb-17	Mode 2	1h 30m	Process induced due to high temperature at cooling tower
	Mode 2	45 m	Process induced due to high temperature at cooling tower
4-Feb-17	Mode 2	42 m	Valve failure
6-Feb-17	Mode 3	1h 30m	Process induced due to zero draft
15-Feb-17	Mode 2	14m	Process induced due to low draft
16-Feb-17	Mode 2	17m	Fluidization Fan 2 failed to start
9-Mar-17	Mode 2	14m	Process induced due to low draft
12-Mar-17	Mode 2	1h 27m	Process induced due to a fire move delay
30-Mar-17	Mode 2	5h 12m	Maintenance of Cooling Tower and FTC airlift
3-Apr-17	Mode 2	15m	Process induced due to high temperature at filter
17-Apr-17	Mode 2	12m	Process induced due to high temperature at cooling tower
7-Jun-17	Mode 3	1h 3m	Process induced due to high temperature at cooling tower
7-Jun-17	Mode 3	30m	Process induced due to high temperature at cooling tower
20-Jun-17	Mode 3	2h 30m	Power Outage
11-Jul-17	Mode 4	2h 19m	Communication Loss
12-Jul-17	Mode 2	36m	Process induced due to temperature at cooling tower
19-Jul-17	Mode 2	9m	Faulty equipment and rotary valve off for PM
1-Aug-17	Mode 2	4h 29m	Cooling Tower plugged
17-Aug-17	Mode 2	20m	Operator Error
23-Aug-17	Mode 2	59m	Maintenance of Cooling Tower
7-Sep-17	Mode 2	15m	High Pressure
11-Sep-17	Mode 2	23m	Maintenance on Inlet Damper
		4m	
30-Sep-17	Mode 2	2h 35m	Air Fluidization fan failure
		4h 35m	Gas skid failure
27-Oct-17	Mode 2	16m	Air Fluidization fan failure
2-Nov-17	Mode 2	28m	Plant Air down
3-Nov-17	Mode 2	1h 17m	Replace Fan
22-Nov-17	Mode 2	2h 26m	Cleaning of Cooling Tower
30-Nov-17	Mode 3	50m	Power Outage
14-Dec-17	Mode 2	4h	Cleaning of inlet plenum
15-Dec-17	Mode 2	25m	Failure of fluidization fans
30-Dec-17	Mode 2	1h 20m	High pressure on water pumps

Table 5.8
Bath Treatment and Storage Annual Stack 2017

Source	DCB-001	DCB-003
Particulate Emissions (mg/m3) Permit Limit: 30 (mg/m^3)	10.3	12.1

Table 5.9 Natural Gas Consumption and Associated Emissions 2017

Year	Natural Gas Consumption m^3/yr	Associated Emissions (tonnes/year)			
		Nitrogen Oxides	Total Particulates	Sulphur Dioxide	Carbon Monoxide
2007	25,837,200	41.34	3.14	0.25	34.73
2008	25,931,400	41.49	3.15	0.25	34.85
2009	24,013,100	38.42	2.92	0.23	32.27
2010	23,564,629	37.70	2.87	0.23	31.67
2011	20,864,400	33.38	2.54	0.20	28.04
2012	19,695,700	31.51	2.39	0.19	26.47
2013	19,492,700	31.19	2.37	0.19	26.20
2014	18,048,900	28.88	2.19	0.17	24.26
2015	22,801,400	36.48	2.77	0.22	30.65
2016	32,066,200	51.31	3.90	0.31	43.10
2017	31,360,000	50.18	3.81	0.30	42.15

Table 5.10 Bi-Annual Stack Test Casting 2017

Parameters	B Casting		C Casting			
	DC 4		Furnace 61		Furnace 62-63	
	Nov-17	Aug-17	Aug-17	Dec-17	Aug-17	Dec-17
NO_x (Kg/hr)	0.77	0.07	0.24	0.11	0.24	0.091
Chloride (Kg/hr)	0.8	0.41				
Chlorine (Kg/hr)	0.012	0.0119				
Particulate (Kg/hr)	0.50	0.58	1.11	1.16	1.48	1.55

Figure 5.1
Potroom roof sampling locations

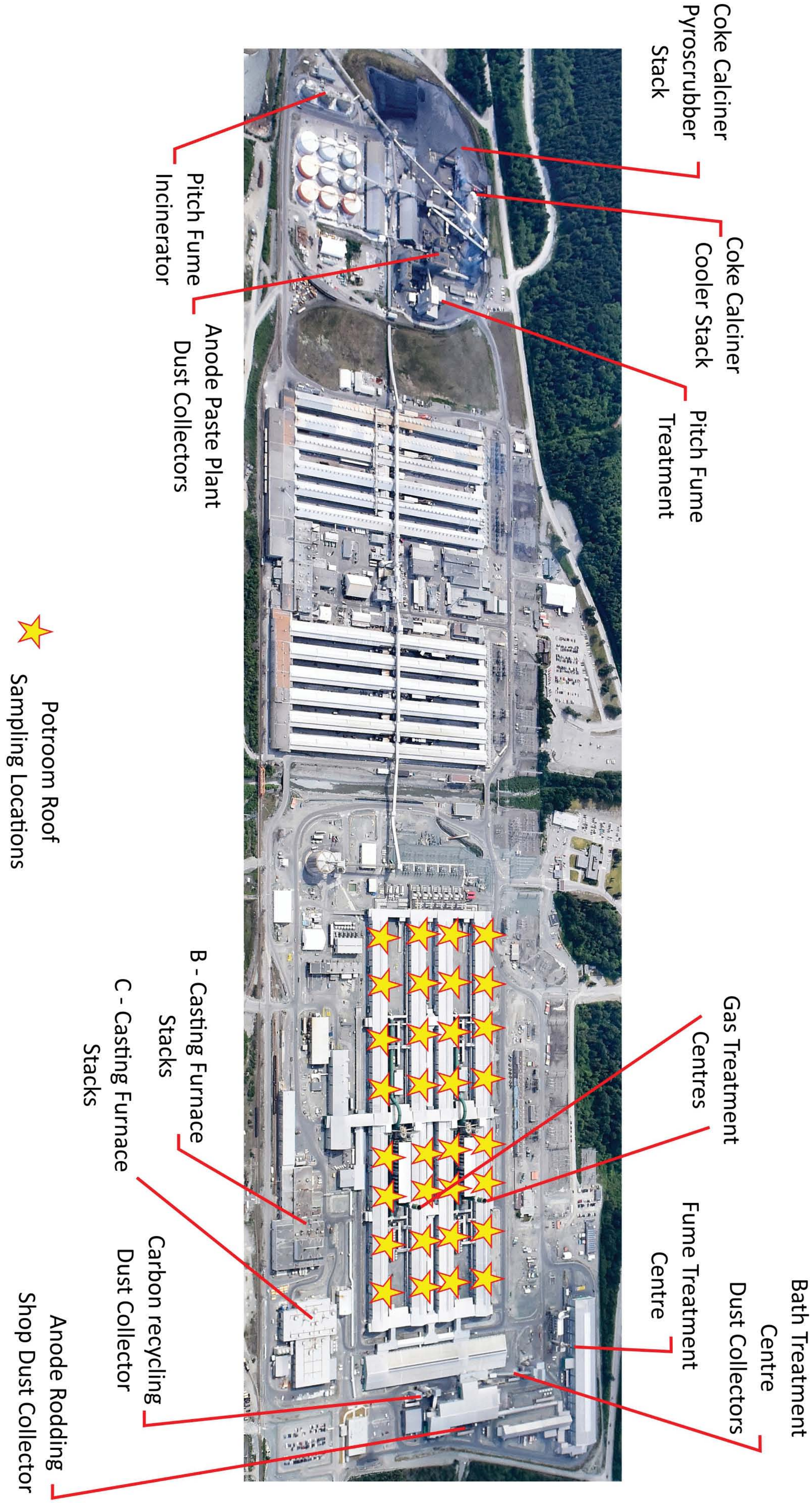


Figure 5.2
Potroom total fluoride emissions rate, 2017

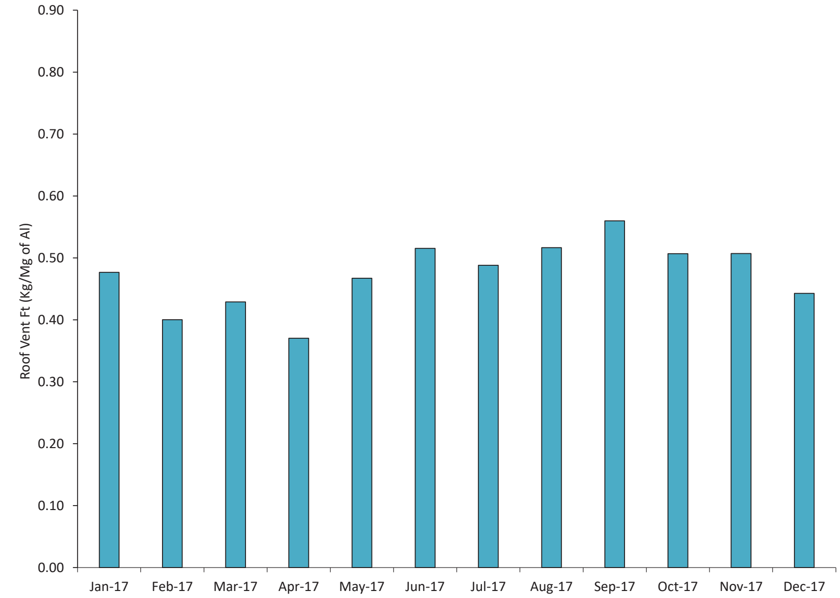


Figure 5.3
Plant-wide fluoride total, 2017

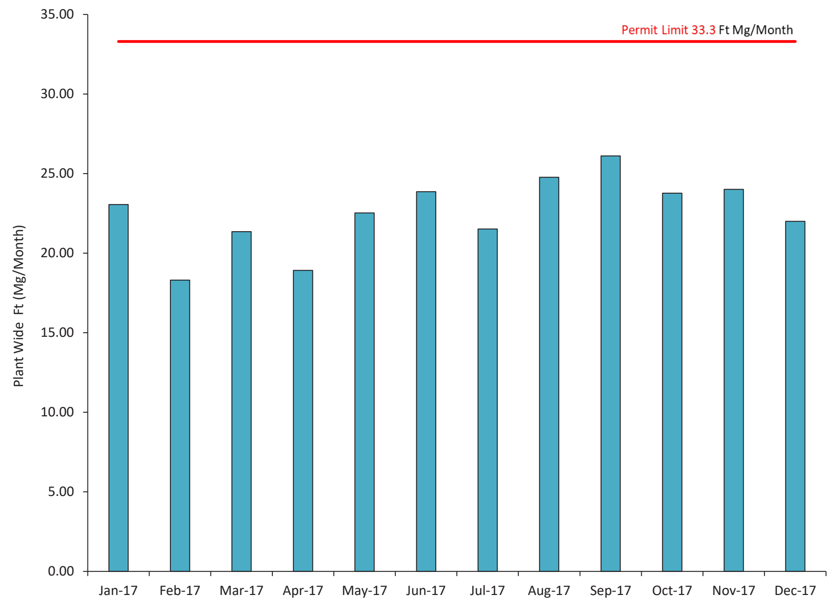


Figure 5.4
Annual average SO_2 emissions, BC Works 2007-2017

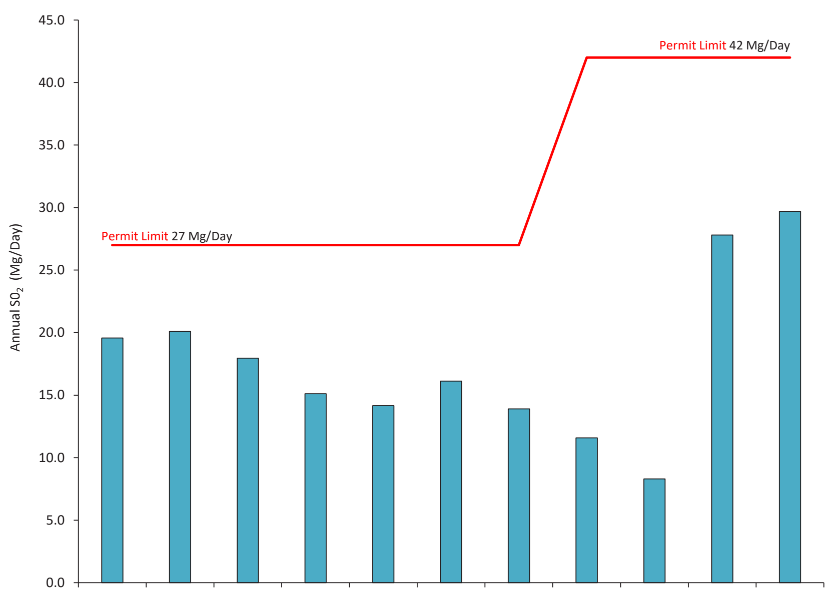


Figure 5.5 Monthly SO_2 emissions, BC Works 2017

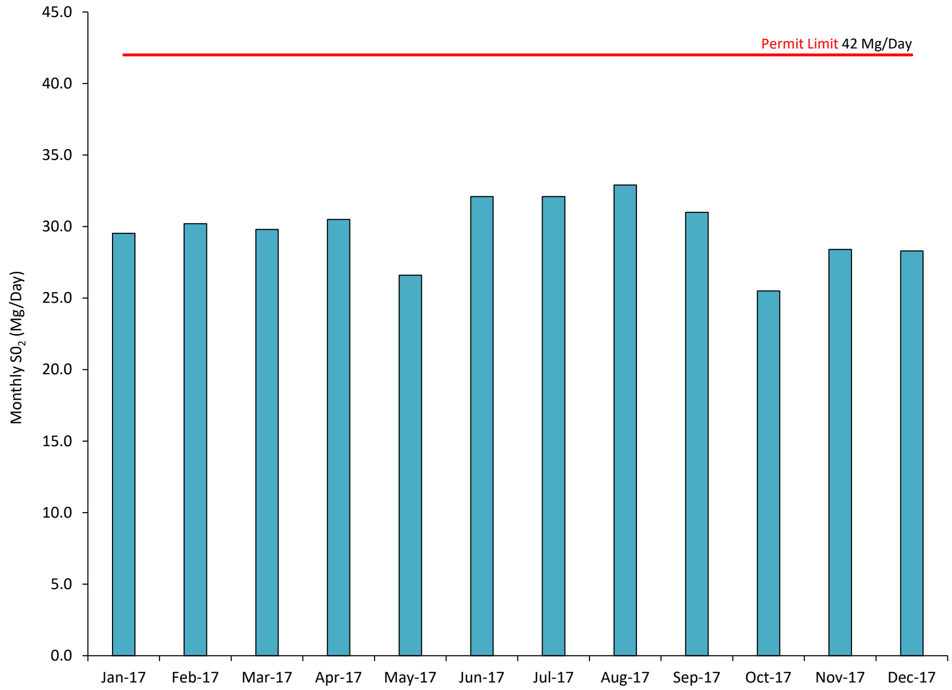


Figure 5.6 Nitrogen oxide emissions, BC Works 2007-2017

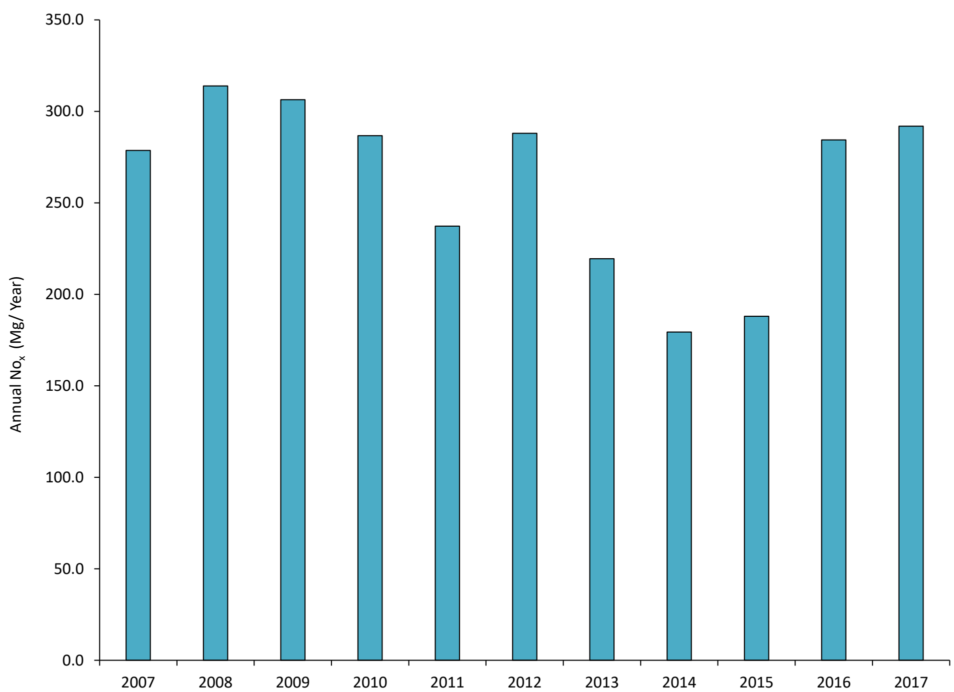


Figure 5.7
Potroom particulate emissions monthly rate, 2017

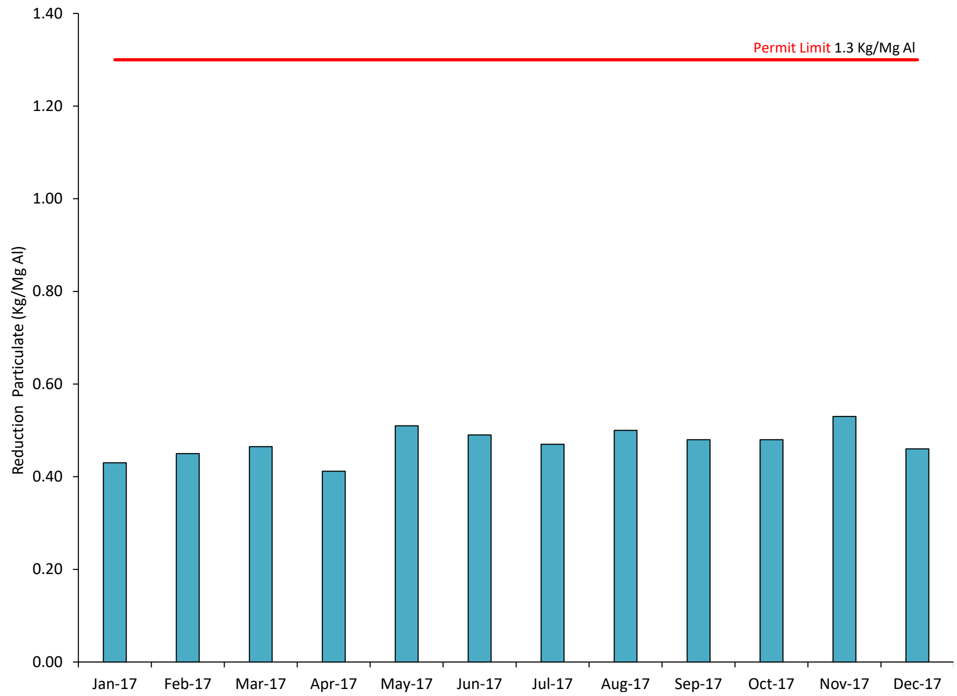


Figure 5.8
Potroom particulate emissions, 2007-2017

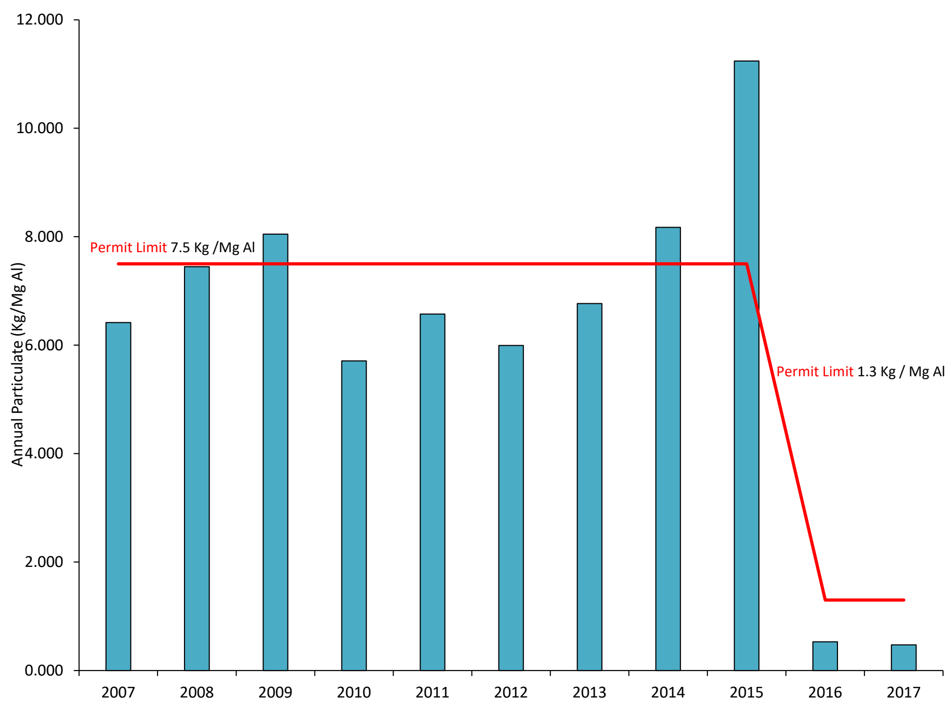


Figure 5.9
Particulate emissions distribution in 2017, BC Works

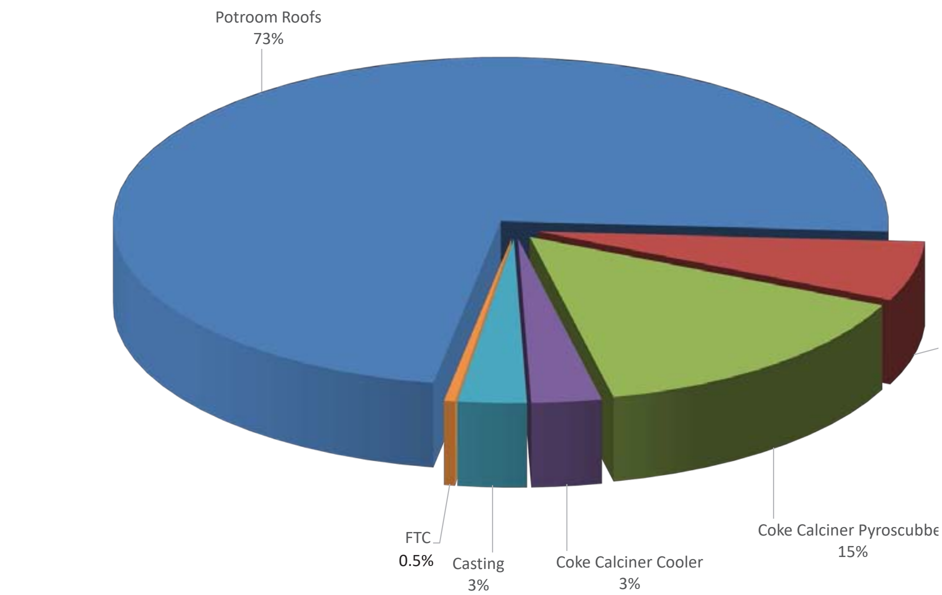


Figure 5.10
Total GHG emissions by Source, 2017

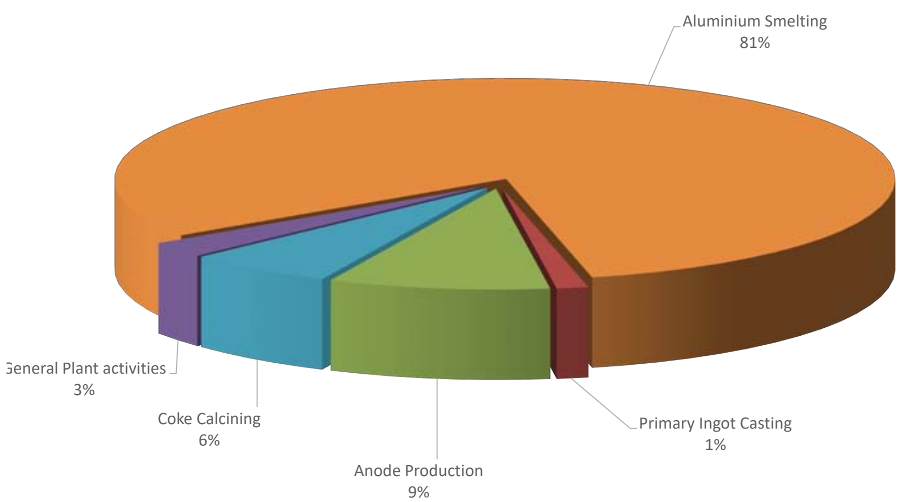


Figure 5.11
Breakdown of aluminium smelting GHG by Source, 2017

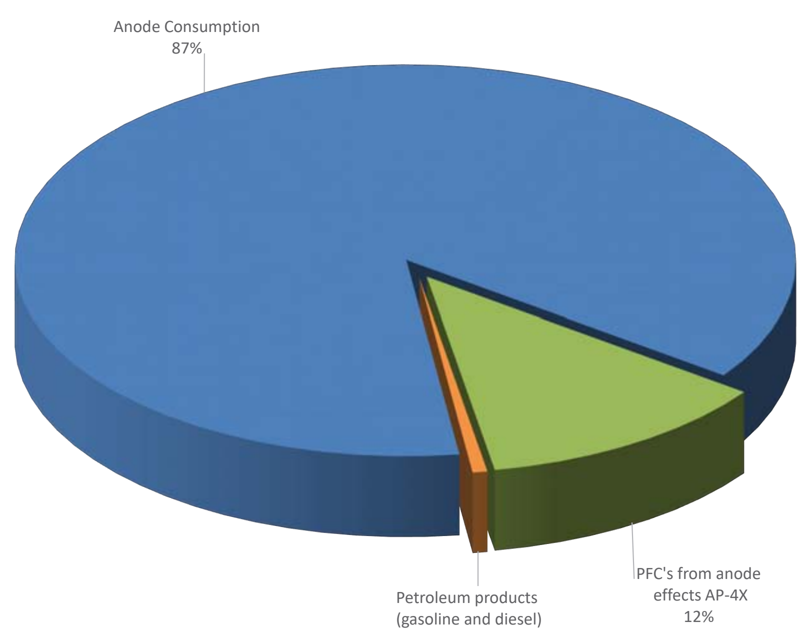


Figure 5.12
GHG Emissions,
BC Works 2017

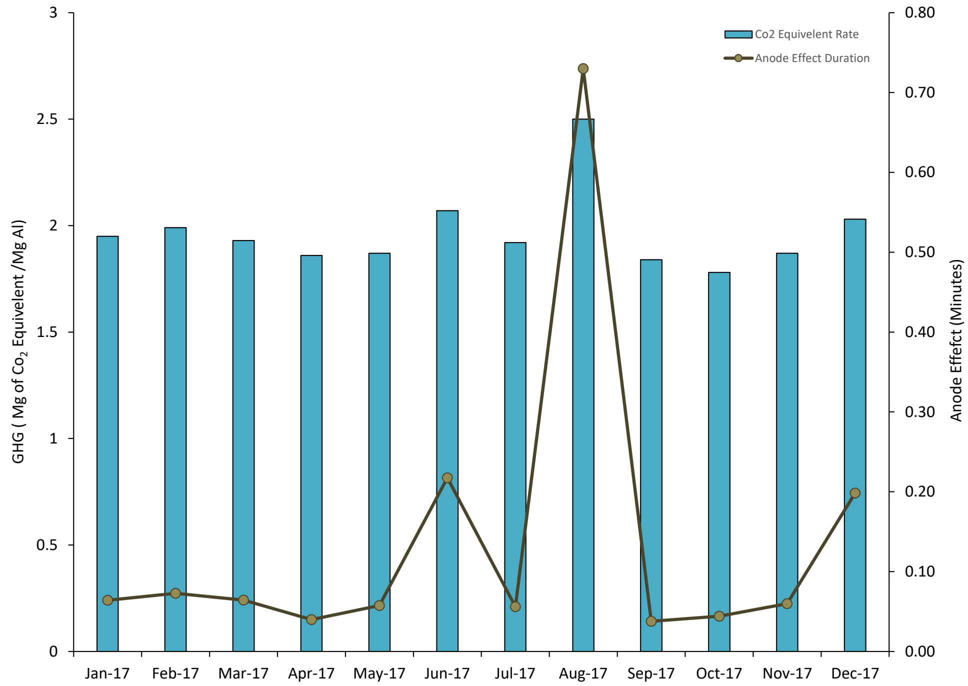
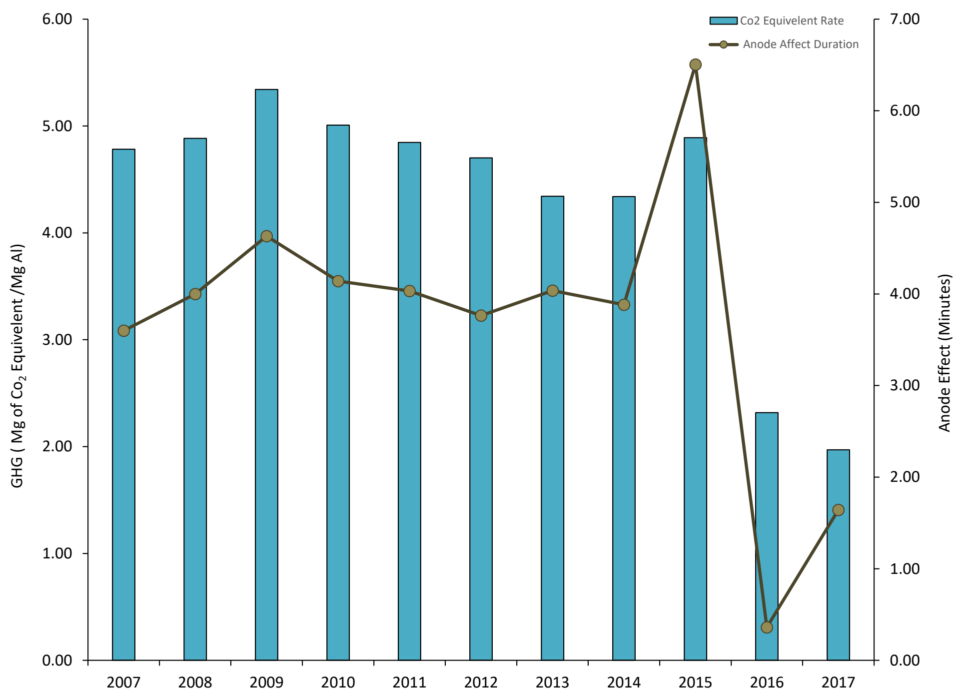


Figure 5.13
GHG emissions
BC Works 2007-2017



6. Air quality monitoring

BC Works conducts continuous ambient air quality monitoring at four stations in the lower Kitimat valley and one specialized station at Lakelse Lake. The monitoring parameters are illustrated in Table 6.1.

Network overview

Five air quality parameters are monitored: hydrogen fluoride (HF), sulphur dioxide (SO_2), polycyclic aromatic hydrocarbons (PAHs), and two levels of fine particulate matter. Particulate matter is referred to as PM_{10} and $PM_{2.5}$, and is measured against size thresholds of 10 and 2.5 microns, respectively

Meteorological (weather) monitoring data is collected at all five air quality monitoring stations plus the Yacht Club station. Precipitation monitoring and analysis is undertaken using samples collected at the Haul Road and Lakelse Lake stations. The precipitation sampler was upgraded in 2013. The weather and the precipitation data provide additional insight into air quality data interpretation.

Table 6.1 Ambient air monitoring network

Ambient Air Network	Haul Road (HR)	Riverlodge (RL)	Whitesail (WS)	Kitamaat Village (KV)	Yacht Club (YC)	Lakelse Lake (LL)
Sulphur Dioxide (SO_2)	✔	✔		✔		
Particulates ($PM_{2.5}$)	✔	✔	✔	✔		
Particulates (PM_{10})		✔				
Polycyclic aromatic hydrocarbons (PAH)	✔		✔	✔		
Hydrogen Fluoride (HF)	✔	✔		✔		
Rain chemistry	✔					✔
Meteorological monitoring	✔	✔	✔	✔	✔	

The collected air quality data is reported out according to the P2-00001 Multimedia Waste Discharge permit. Specifically, Section 8.5 of the P2 permit requires the following reporting:

- SO_2 and HF: Mean monthly concentration and daily hourly maximums.
- $PM_{2.5}$ and PM_{10}: Daily average and daily hourly maximum concentrations
- PAH (15 congeners): all PAH data on a NAPS cycle.
- Rain chemistry for the Haul Road and Lakelse Lake stations (SO2 EEM stations).

The scope of this chapter is to provide an interpretive summary of the above permit required monitoring and reporting.

Weather monitoring

Two new meteorological stations became operational in 2011, one at the Kitamaat Village station and the other at the Yacht Club located at the south end of the plant site. Each station measures temperature, wind direction and wind speed. Additionally, the Kitimat Smelter Road Station measures relative humidity.

The 2013 upgraded meteorological and weather monitoring data control program, operated by BC Works, is carried out to meet Ministry standards. In the event that air quality monitoring data indicate a problem on a particular date, weather data can provide insight into pollutant sources and other contributing factors. The upgraded meteorological installations at the ambient air quality monitoring stations go beyond the two weather station requirements in the P2 permit.

Quality assurance and control

The validation of air quality data is conducted using a quality control/quality assurance process. The quality control component is to ensure that all instrument maintenance and operational guidelines for the instruments are being followed correctly and documented. Moreover, when summarizing air quality data, a data completeness criteria of 75% is applied, as recommended in Ministry of Environment guidance documents.

Air quality monitoring stations in the Kitimat valley are operated by an independent contractor. A technician performs weekly inspections and routine maintenance on the equipment. Air quality data are reviewed monthly, validated and submitted to the Ministry. In the event that remedial actions are required to ensure the validity of the data, this information is reported to the Ministry.

The quality assurance procedure is conducted by Ministry staff. This involves visits twice per year to the sites. A review of station and instrument documentation, condition and a reference audit calibration check on each instrument being operated under permit is completed.

The results of the quality control/quality assurance process are then used to validate the data collected by the Provincial Air Quality Monitoring network (www.env.gov.bc.ca/epd/bcairquality).

2017 monitoring results

Ambient air quality monitoring for all results stations and parameters are presented in Table 6.2. This summary table has been changed from the previous Annual Environmental Reports, to include summary statistics for the reporting year in addition to comparisons against the BC Air Quality Monitoring Objectives.

Hydrogen fluoride (HF)

There are currently three Picarro analyzers (cavity ring down spectroscopy) operating in the network: Riverlodge, Kitamaat Village and Haul Road. HF monitoring results are presented in Table 6.2. The annual average measurement at Kitamaat Village was 0.1 parts per billion (ppb) and Riverlodge was < 0.1 parts per billion (ppb). The maximum daily average concentrations were significantly lower than the 1 ppm HF objective for Kitimat by a factor of 10,000. Monthly HF averages for the residential stations are presented in Figure 6.2 and are below 0.1 ppb. The 30 day average is 400 times below the 40 ppb chronic exposure objective.

Sulphur dioxide (SO_2)

SO_2 is monitored at three residential stations (Riverlodge, Whitesail and Kitamaat Village) in addition to the Industrial Haul Road station. The P2 permit requires the reporting on hourly daily maximums and monthly averages. A summary of the 2017 monitoring results are provided in Table 6.2 and monthly means are shown in Figure 6.3. Beyond the required P2 permit reporting, the daily hourly averages for 2017 for all four stations are presented in Figure 6.4. Additionally the summary statistics in Table 6.2 include the percentile results for comparison to the 2016 adopted Provincial SO_2 Interim ambient Air Quality Objective. In comparison to the new interim SO_2 air quality objective of 75 ppb (that comes into effect for 2017), Riverlodge's and Whitesail's three year 97th percentile average of the maximum daily 1 hour average are 11.6 ppb and Kitamaat Village's three year 97th percentile average is 5.8 ppb. These values are 15.5% and 7.7%, respectively, of the Air Quality Objective and are compliant with the SO_2 Environmental Effects Monitoring program's Health KPI. Additionally, these values have slightly increased in 2017 over 2016's results as a complete year of full smelter production is now included in the 3 year average.

The residential maximum hourly average SO_2 concentrations shown in Table 6.2 ranged from 44.7 ppb to 14.1 ppb. There were no days in 2017 where the residential SO_2 hourly concentrations were above 75 ppb. Figure 6.4 shows the plots of hourly average SO_2 concentrations. Annual SO_2 monitoring values are provided in table 6.2. The maximum residential annual average SO_2 concentration was 0.5 ppb.

Particulate (PM_{10} and $PM_{2.5}$)

Fine particulates have a wide variety of sources, both natural and human-caused. In northern BC, forest fires (prescribed and wild), beehive burners, and emissions from fireplaces and wood burning stoves, are among the major contributors to fine particulate emissions.

In addition to these primary particulate emissions, further contribution occurs due to gas emissions undergoing physical and chemical reactions. Emissions from BC Works, including sulphur dioxide and nitrogen oxides, are among the precursors to these secondary particulates.

Provincial ambient air quality objectives define the 24 hour average for PM_{10} as 50 micrograms per cubic metre ($\mu g/m^3$) and the 98th percentile of the daily average over 1 year for $PM_{2.5}$ is 25 ug/m^3.

The P2 permit requires the reporting for particulate matter to include both daily average and daily hourly maximum concentrations for both $PM_{2.5}$ and PM_{10}. Beyond the required permit reporting, additional statistics for fine particulates are presented in Table 6.2. Charts of the daily average fine particulates for all the reporting stations are provided in Figure 6.5. Average $PM_{2.5}$ levels for Kitimat are low, ranging between 4.3 ug/m^3 to 9 ug/m^3. All stations (industrial and residential) did not have any days above the BC air quality objective of 25 ug/m^3 for $PM_{2.5}$.

Polycyclic aromatic hydrocarbons (PAHs)

PAHs are generated by the incomplete combustion of organic material. Various procedures at Kitimat Operations generate PAHs, in both dissolved and gaseous forms. They occur in emissions primarily as a by-product of the anode manufacturing process; other sources include vehicle exhaust and smoke from forest fires and wood-burning stoves.

Ambient air monitoring is conducted to test for the presence of some of the most common PAHs, although no permit limits exist. Sampling is done on a schedule that is coordinated with the National Air Pollution Surveillance (NAPS) program to enable comparison of findings from different monitoring sites. The P2 permit requires the monitoring of 15 PAH congeners.

The 2017 ambient PAH monitoring results are summarized in Table 6.3. The geometric mean PAH concentration observed at Haul Road station was 9.6 ng/m^3, Whitesail station was 3.3 ng/m^3 and Kitimat Village was 5.2 ng/m^3. In 2017, total PAHs showed a reduced degree of variability (Figure 6.7) when compared to previous years. This is due to the significant reductions in PAH emissions by the modernised smelter.

Figure 6.8 shows the distribution of the 15 PAH congeners for the three stations. The PAH congeners are sorted according to molecular weight. As can be seen in figure 6.8, over 80% of the PAHs for all three stations are light molecular weight PAHs. Changes in distribution of PAH congeners between the stations is not only due to distance from the smelter source, but also photochemical degradation and seasonal contributions of different PAH sources such as vehicle exhaust, petroleum fumes and wood stoves.

Rain chemistry

Precipitation samples are collected on a weekly basis from the Haul Road and Lakelse Lake stations. Rain chemistry monitoring has been conducted since 2000 and was expanded to include Lakelse Lake in 2013. Rainfall quantity is recorded. Samples are assessed for rain acidity and concentrations of 11 specific substances. Annual averages of weekly samples and the geometric mean measures are presented in Table 6.4. A relative colour scale has been added to the table to enhance the visualization of trends in the data. There are no permit levels or objectives for this procedure. Key observations in the rain chemistry are that the dissolved fluoride, aluminium, and base cations have reduced between 2013 and 2017 but did not change between 2016 and 2017 (except for a small increase of dissolved aluminium at the Haul Road).

High levels of acidity (i.e. a low pH) and concentrations of certain substances are characteristic of the condition referred to as 'acid rain'. Long-term vegetation monitoring (refer to Chapter 7 – Vegetation monitoring) in the Kitimat valley has confirmed an absence of this type of damage.

Table 6.2
*2017 Ambient Air Quality Monitoring Results**

Statistic	Industrial	Residential		
	Haul Road	Riverlodge	Whitesail	Kitamaat Village
	SO_2			
2017 Average (ppb)	3.9	0.5	0.5	0.3
97th percentile		11.6	11.6	5.8
Days above 75 ppb (Hourly)		0	0	0
Minimum (Hourly, ppb)	0	0	0	0
Maximum (hourly, ppb)	94.9	44.7	40.7	14.1
Percent Data Capture (%)	96	96	95	92
Standard Deviation (ppb)	7.6	1.5	1.3	0.7
	$PM_{2.5}$			
2017 Average (ug/m^3)	3.6	4.3	7.7	9
98th percentile		10.9	14	16.8
Days above 25 ug/m^3		0	2	4
Minimum (Hourly, ug/m^3)	0	0	0	0
Maximum (hourly, ug/m^3)	17.7	13.7	18.6	23.1
Maximum daily average (ug/m^3)	17.7	13.7	18.6	23.1
Percent Data Capture (%)	100	100	100	100
Standard Deviation (ug/m^3)	2.3	2.1	2.4	3.2
	PM_{10}			
2017 Average (ug/m^3)		3.6		
Minimum (Hourly, ug/m^3)		0		
Maximum (hourly, ug/m^3)		24.9		
Maximum daily average (ug/m^3)		0		
Days above 50 ug/m^3		99		
Percent Data Capture (%)		6.7		
Standard Deviation (ug/m^3)		3.6		
	HF			
2017 Average (ppb)		0		0.1
Minimum (Hourly, ppb)		0		0
Maximum (hourly, ppb)		0.1		0.1
Days above 1ppm (hourly)		0		0
Percent Data Capture (%)		100		100
Standard Deviation (ppb)		0		0.00

*Air quality data extracted from BCMOE's Envista database on January 31st, 2017

Table 6.3 Geometric mean PAH Concentrations, 2015, 2016 & 2017

Station	15 PAH Average (ng/m³)	18 PAH Average (ng/m³)			2017 15 PAH Statistics (ng/m³)		
	2017	2017	2016	2015	Min	Max	Standard Deviation
Haul Road	9.5	13.7	12.0	39.3	1.6	56.2	8.9
Whitesail	3.3	4.1	4.8	8.5	0.9	12.5	12.5
Kitimat Village	5.2	6.1	6.2	9.1	0.8	75.7	9.6

Table 6.4
Rain chemistry monitoring (2013 to 2017)

			Haul Road					**Lakelse Lake**				
Year			**2013**	**2014**	**2015**	**2016**	**2017**	**2013**	**2014**	**2015**	**2016**	**2017**
Important Milestone			**Start of NADP rain chemistry analysis**	**VSS Wind down**	**VSS stopped KMP Ramp-up**	**AP4X Last Pot Started**	**Smelter stabilization**	**Start of NADP rain chemistry analysis**	**VSS Wind Down**	**VSS stopped KMP Ramp-up**	**AP4X Last Pot Started**	**Smelter stabilization**
Parameter												
Precipitation	Precipitation Depth (mm)	Total	2201	2619	2802	2467	2372		1566	1526	1661	1506
	Rain (pH)	average	4.4	4.7	4.6	4.6	4.5	5.1	5.2	5.2	5.0	4.9
		geomean	4.3	4.6	4.6	4.5	4.5	5.1	5.2	5.2	5.0	4.9
Acidity	Acidity (to pH 8.3) $CaCO_3$ (mg/L)	average	4.4	3.5	2.2	4.0	3.9	1	1.8	0.7	1.0	2.1
		geomean	3.2	2.7	1.9	3.4	3.5	0.9	1.2	0.7	1.0	1.2
	Acidity - Free (µeq/L)	average	24.5	15.3	9	21.0	20.4	5.3	9.9	3.6	5.4	7.6
		geomean	16.7	7.6	5.1	10.5	14.9	4.5	3.3	2.7	3.1	5.1
	Alkalinity - Total $CaCO_3$ (mg/L)	average	0.3	0.7	3.7	1.1	0.9	0.8	0.9	1.8	0.79	0.94
		geomean	0.3	0.7	1.0	1.0	0.9	0.8	0.8	1.1	0.77	0.94
Concentration of Specific Substances (mg/L)	Chloride (Cl)	average	0.3	0.4	0.3	0.3	0.3	0.09	0.15	0.13	0.11	0.10
		geomean	0.2	0.2	0.2	0.2	0.2	0.05	0.1	0.08	0.08	0.07
	Fluoride (F)	average	1.9	0.6	0.4	0.6	0.6	0.03	0.2	0.02	0.02	0.11
		geomean	1.4	0.4	0.3	0.4	0.5	0.03	0.03	0.01	0.02	0.02
	Sulphate (SO_4)	average	1.4	1.2	1.5	1.8	1.8	0.46	0.39	0.28	0.56	0.55
		geomean	1.1	0.7	0.8	1.4	1.4	0.35	0.22	0.19	0.37	0.37
	Ammonia Nitrogen (NH4)	average	0.05	0.06	0.06	0.06	0.06	0.06	0.13	0.03	0.02	0.03
		geomean	0.04	0.04	0.03	0.0	0.0	0.02	0.02	0.00	0.01	0.02
	Nitrate Nitrogen (NO3)	average	0.16	0.16	0.22	0.17	0.18	0.16	0.16	0.22	0.17	0.17
		geomean	0.13	0.13	0.13	0.13	0.14	0.13	0.13	0.13	0.13	0.13
	Total Dissolved Phosphate (PO4)	average	0.01	0.01	0.01	0.03	0.01	0.02	0.08	0.00	0.01	0.00
		geomean	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Aluminium (D-Al)	average	0.46	0.15	0.08	0.17	0.23	0.004	0.026	0.01	0.02	0.03
		geomean	0.24	0.1	0.06	0.11	0.15	0.00	0.01	0.01	0.01	0.01
	Calcium (D-Ca)	average	0.22	0.08	0.09	0.14	0.06	0.04	0.04	0.06	0.04	0.03
		geomean	0.11	0.06	0.05	0.06	0.05	0.03	0.03	0.03	0.03	0.02
	Magnesium (D-Mg)	average	0.06	0.03	0.03	0.03	0.02	0.01	0.02	0.01	0.01	0.01
		geomean	0.04	0.02	0.02	0.03	0.01	0.01	0.01	0.01	0.01	0.01
	Potassium (D-K)	average	0.16	0.02	0.02	0.08	0.02	0.05	0.05	0.02	0.02	0.01
		geomean	0.06	0.01	0.01	0.02	0.01	0.02	0.01	0.01	0.01	0.01
	Sodium (D-Na)	average	0.54	0.31	0.28	0.27	0.26	0.05	0.09	0.07	0.06	0.06
		geomean	0.36	0.22	0.18	0.20	0.22	0.03	0.06	0.04	0.04	0.03

Figure 6.1
Location of Ambient Air Monitoring Stations in the Kitimat Valley.

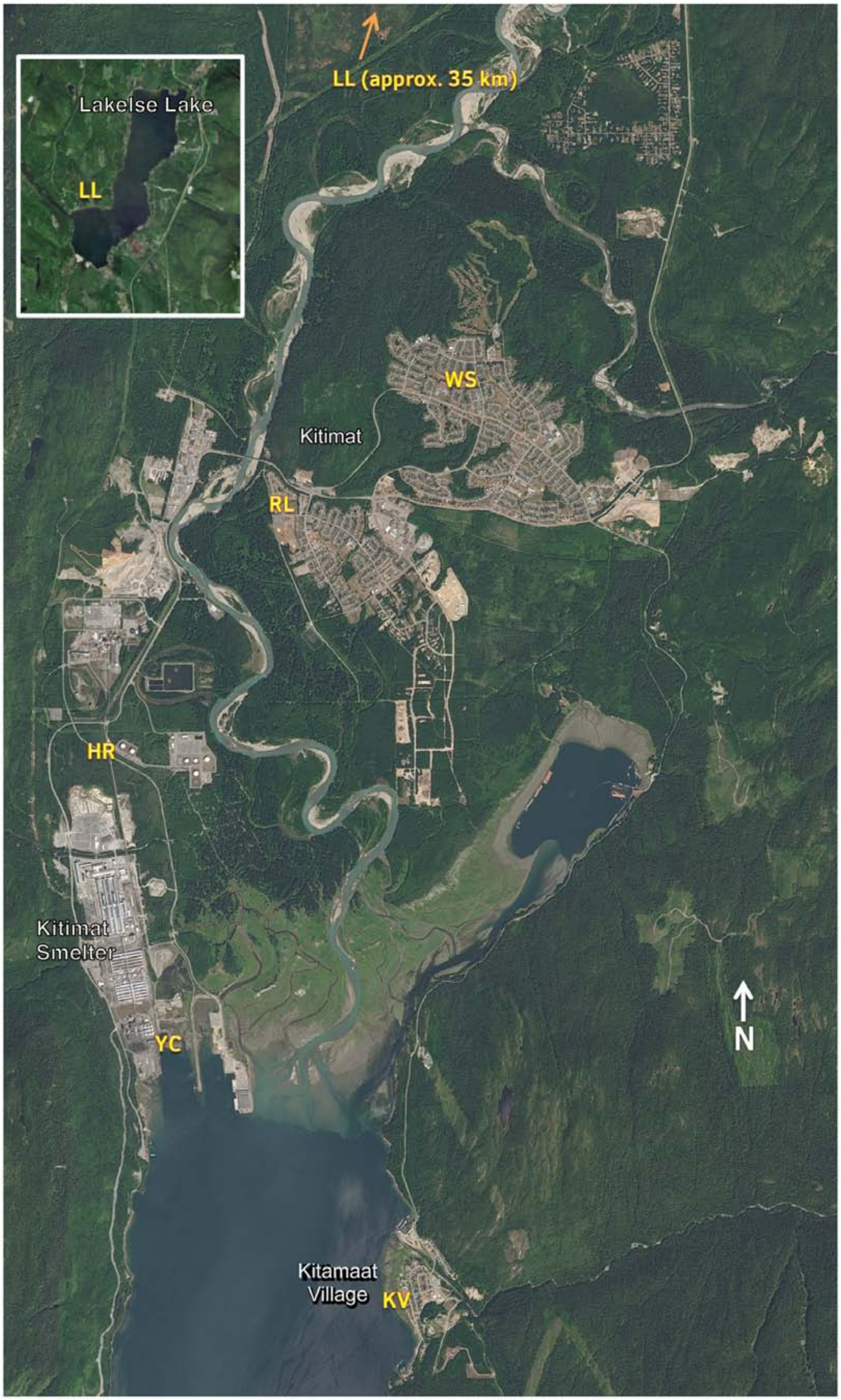


Figure 6.2
Hydrogen Fluoride Monthly Average Concentrations

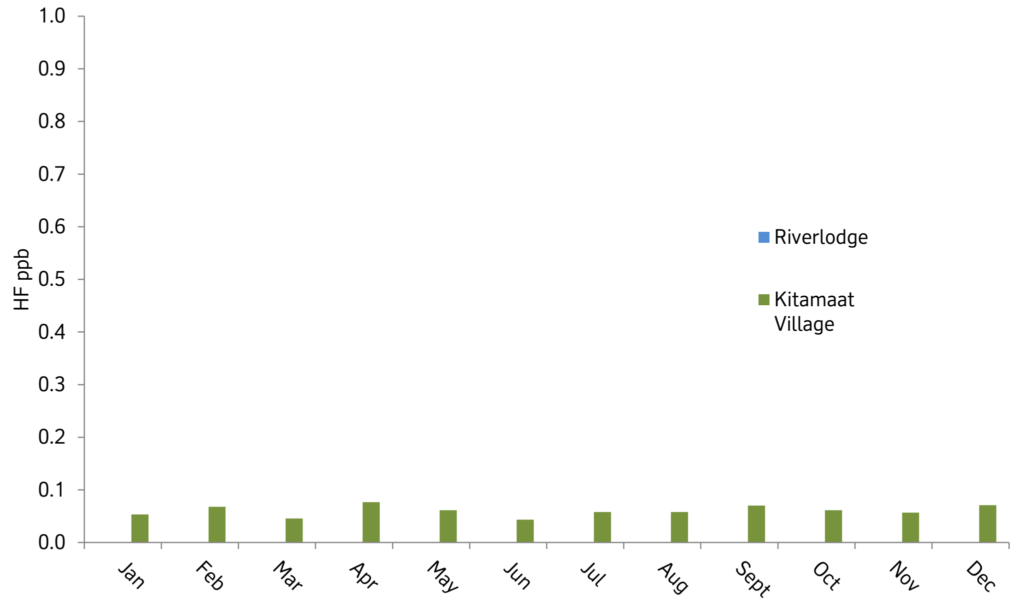


Figure 6.3a
SO_2 Residential Monthly Average Concentrations

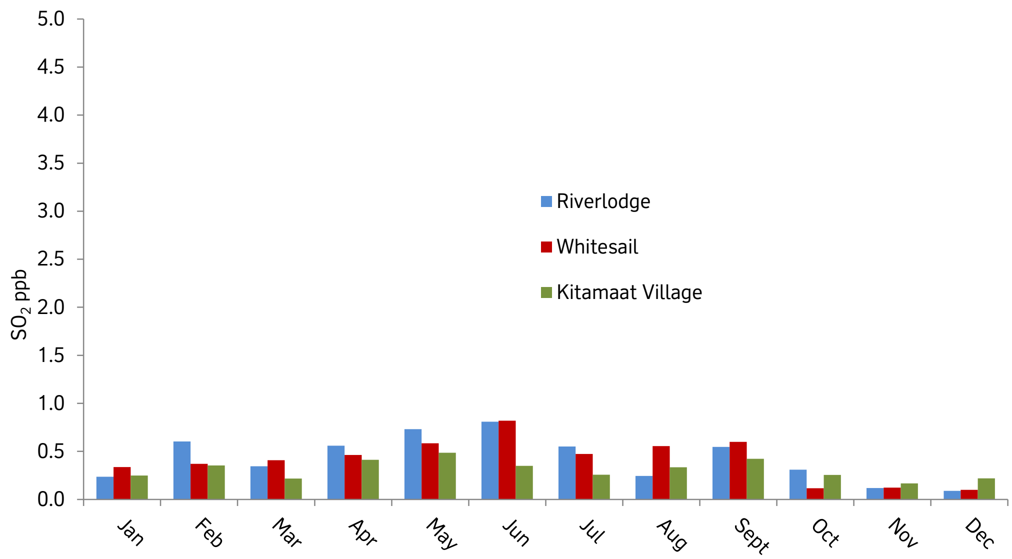


Figure 6.3b
SO_2 Haul Road Monthly Average Concentrations

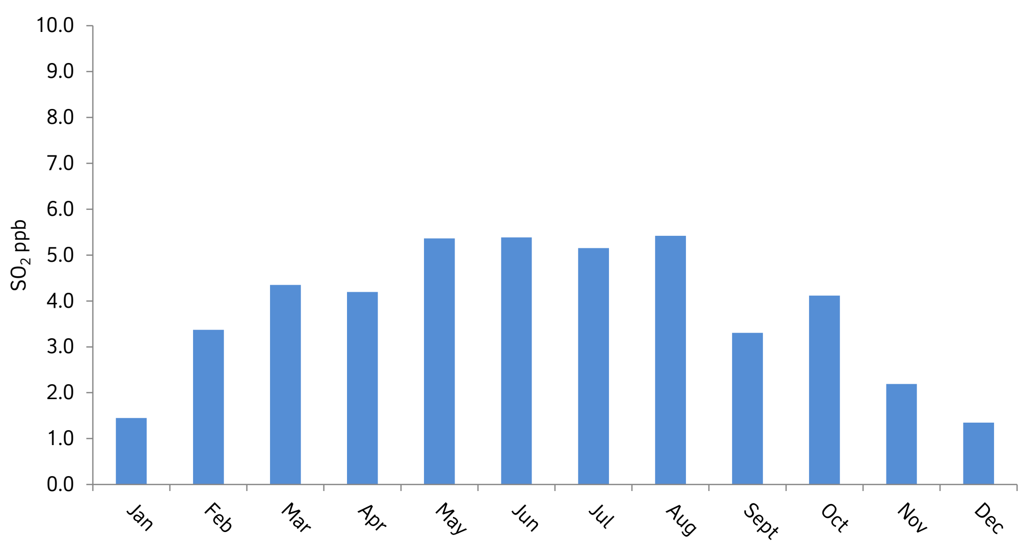


Figure 6.4a SO_2 Haul Road 2017 Hourly Concentrations

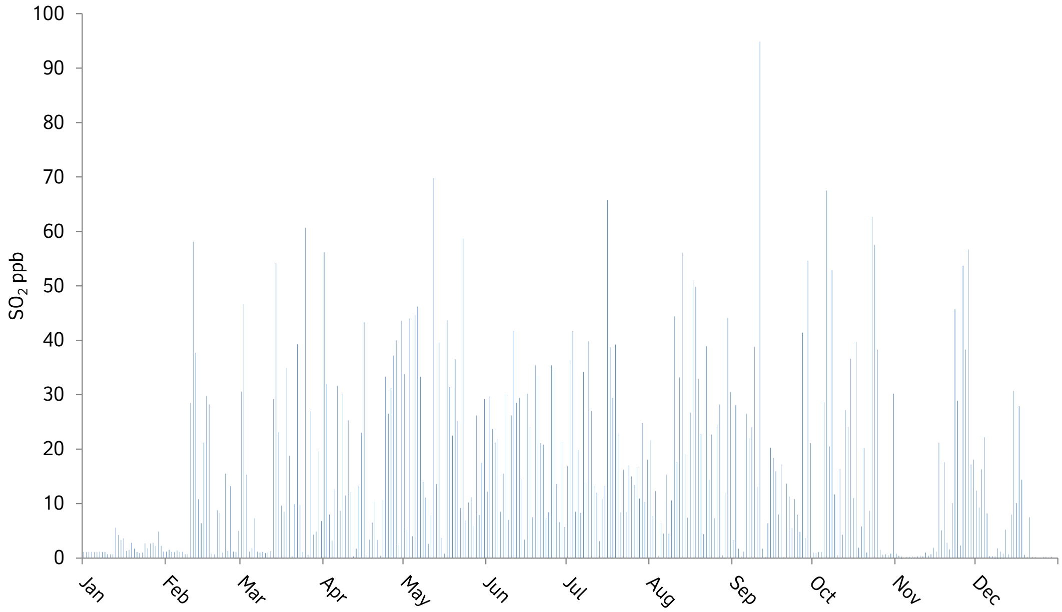


Figure 6.4b Riverlodge 2017 Hourly SO_2 Concentrations

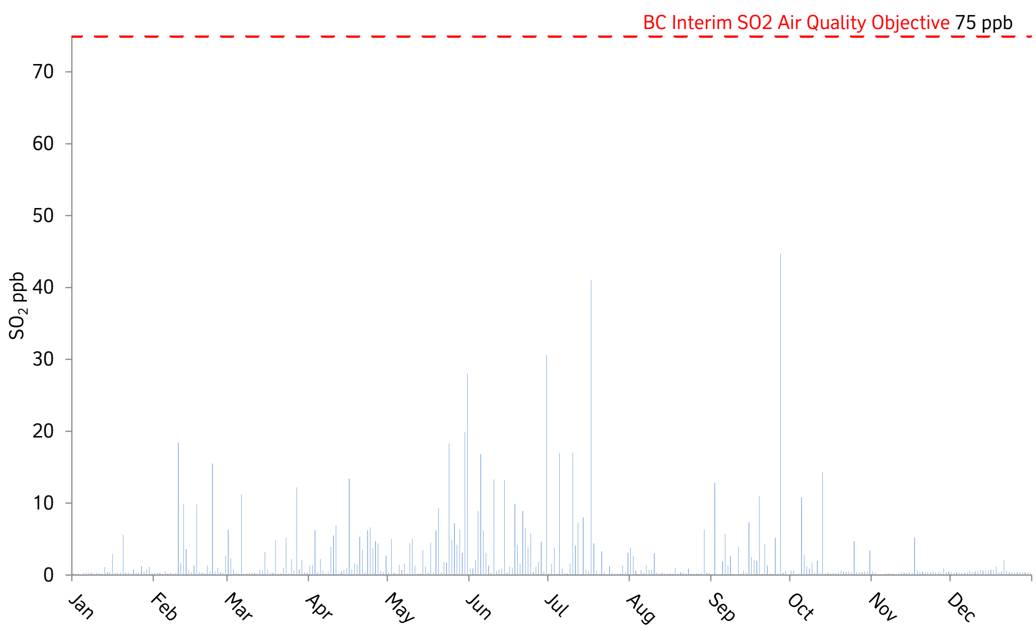


Figure 6.4c Whitesail 2017 Hourly SO_2 Concentrations

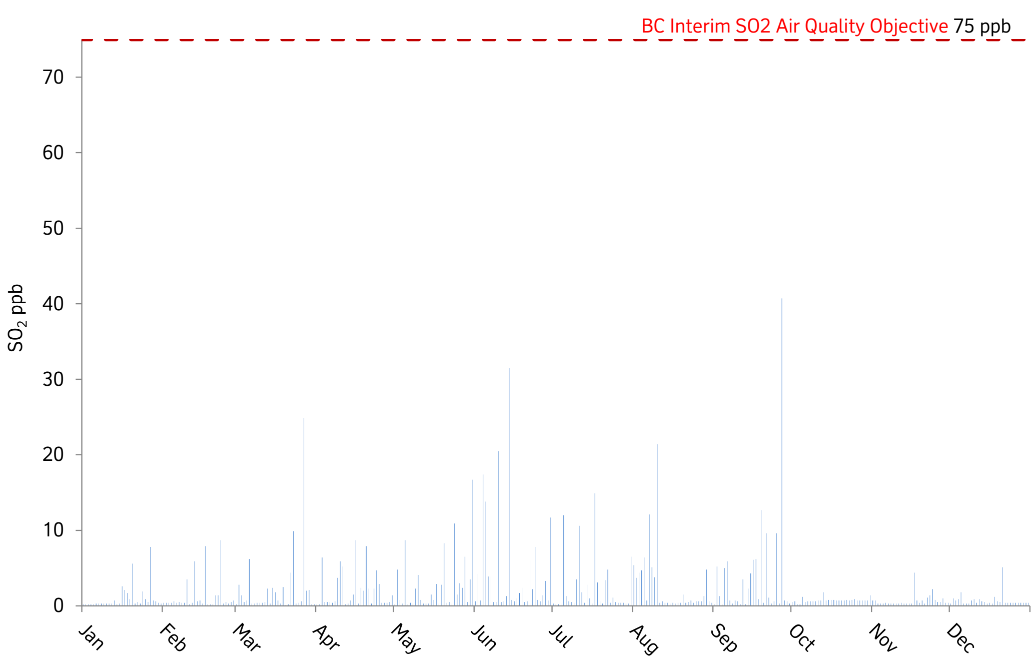


Figure 6.4d
Kitamaat Village 2017 Hourly SO_2 Concentrations

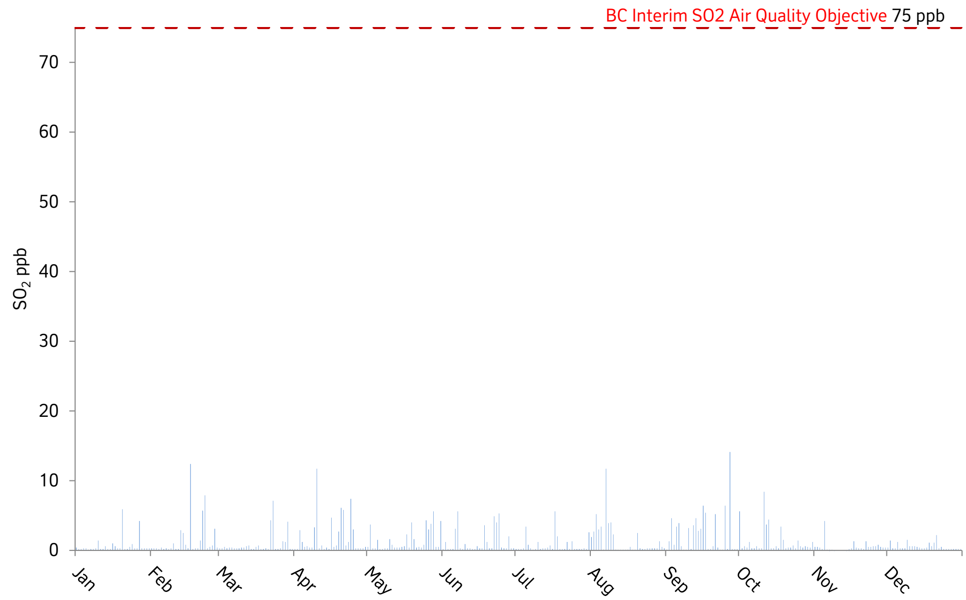


Figure 6.5a
Haul Road $PM_{2.5}$ 2017 Daily Average

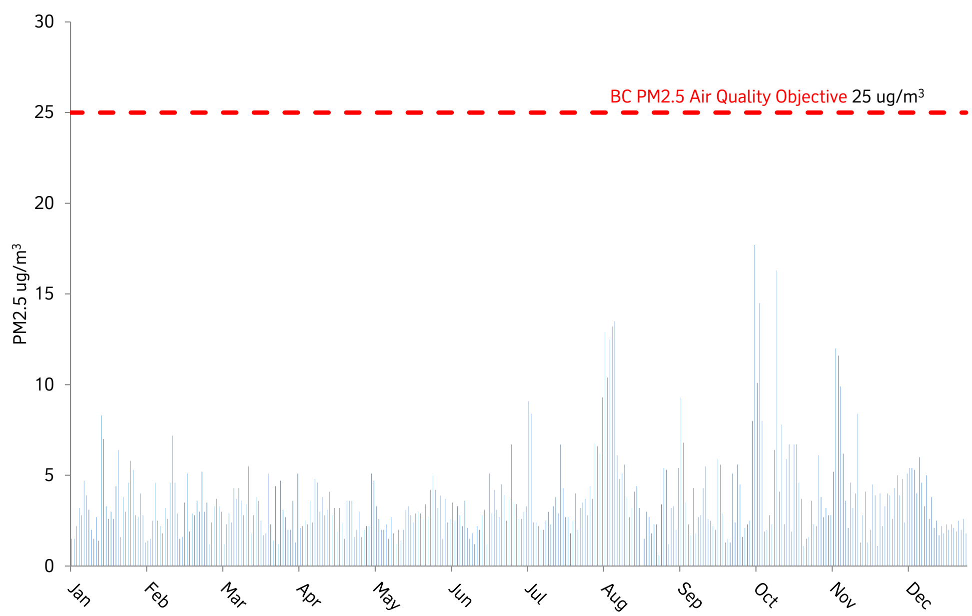


Figure 6.5b
Riverlodge 2017 $PM_{2.5}$ Daily Average

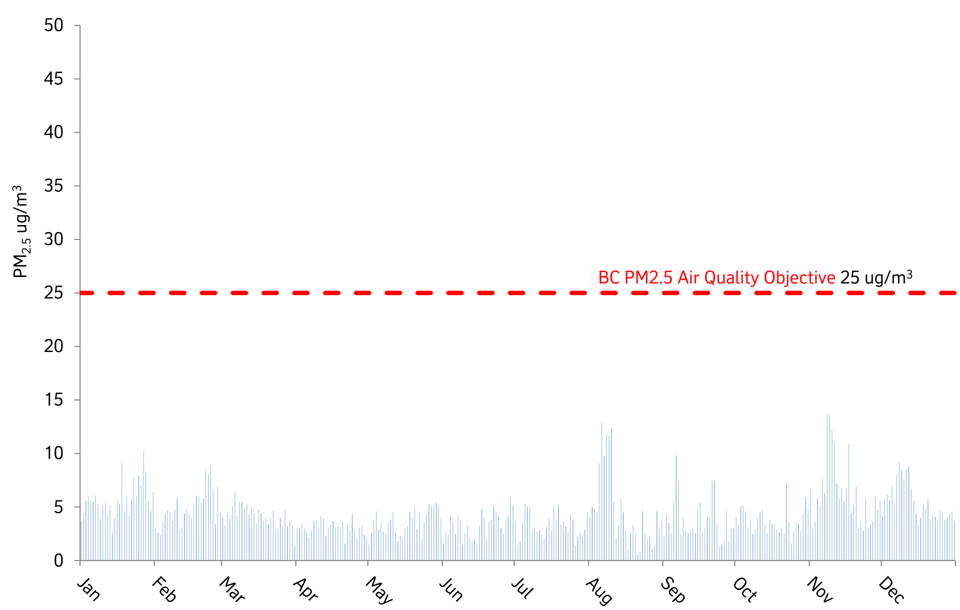


Figure 6.5c
Whitesail 2017 $PM_{2.5}$
Daily Average

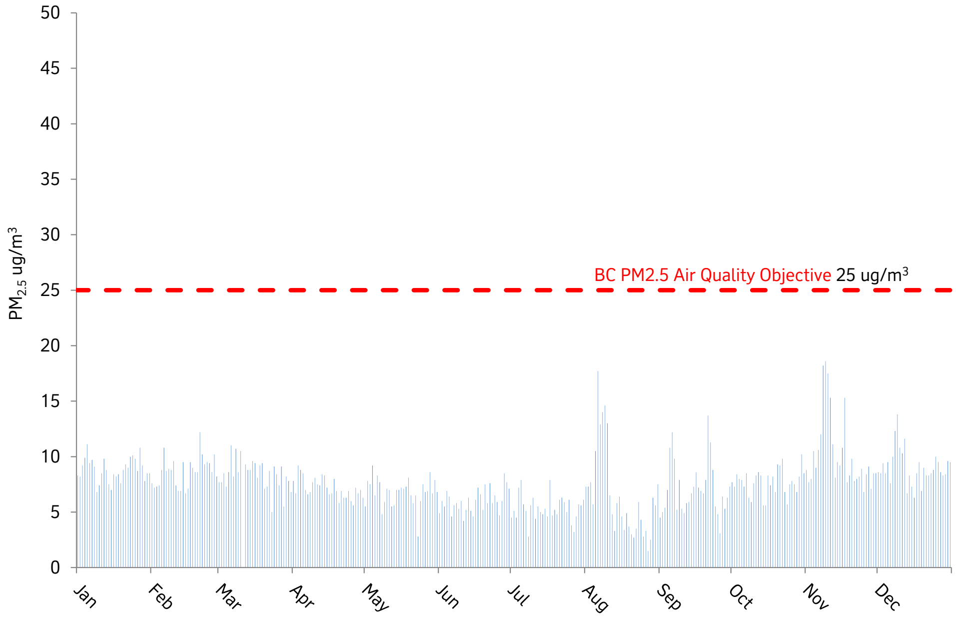


Figure 6.5d
Kitamaat Village
2017 $PM_{2.5}$
Daily Average

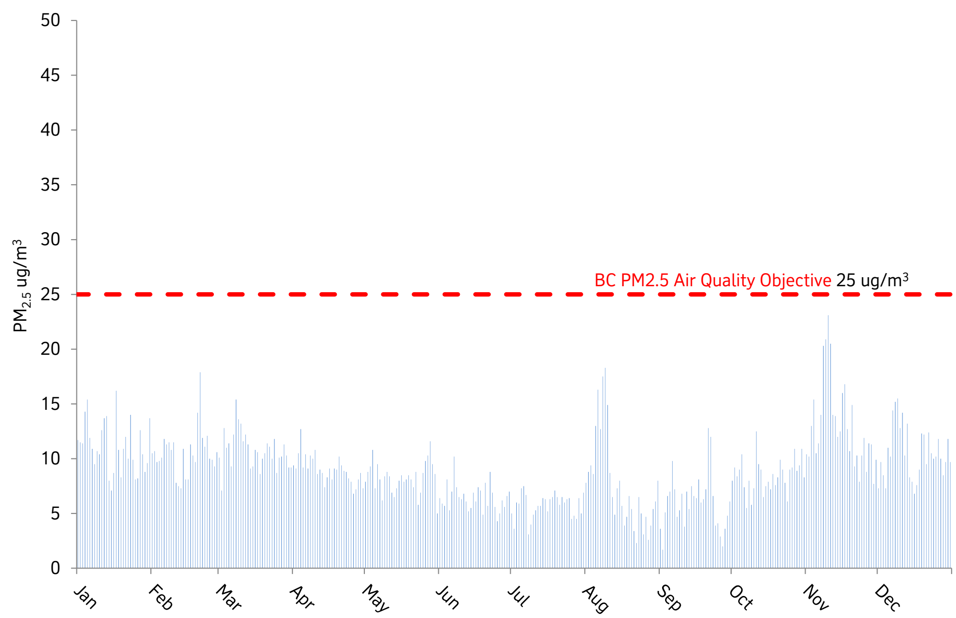


Figure 6.6
Riverlodge 2017 PM_{10}
Daily Average

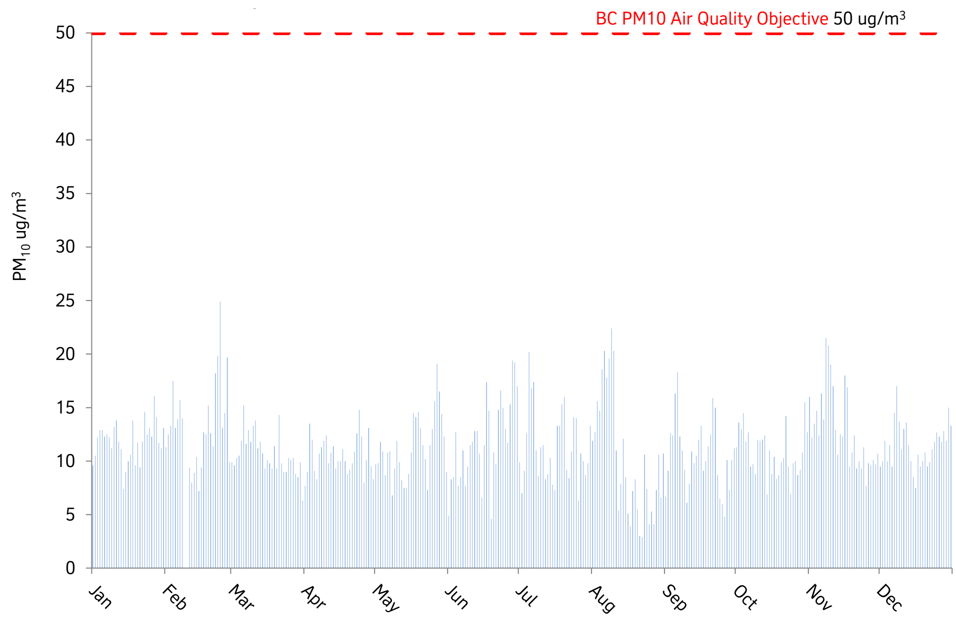


Figure 6.7a
Haul Road 2017
Total PAH

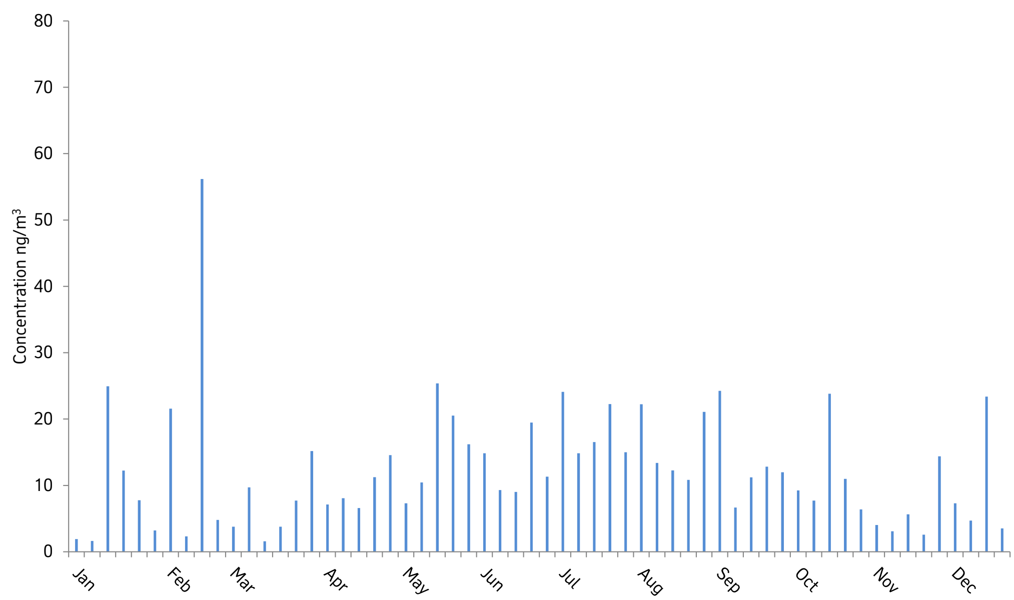


Figure 6.7b
Whitesail 2017
Total PAH

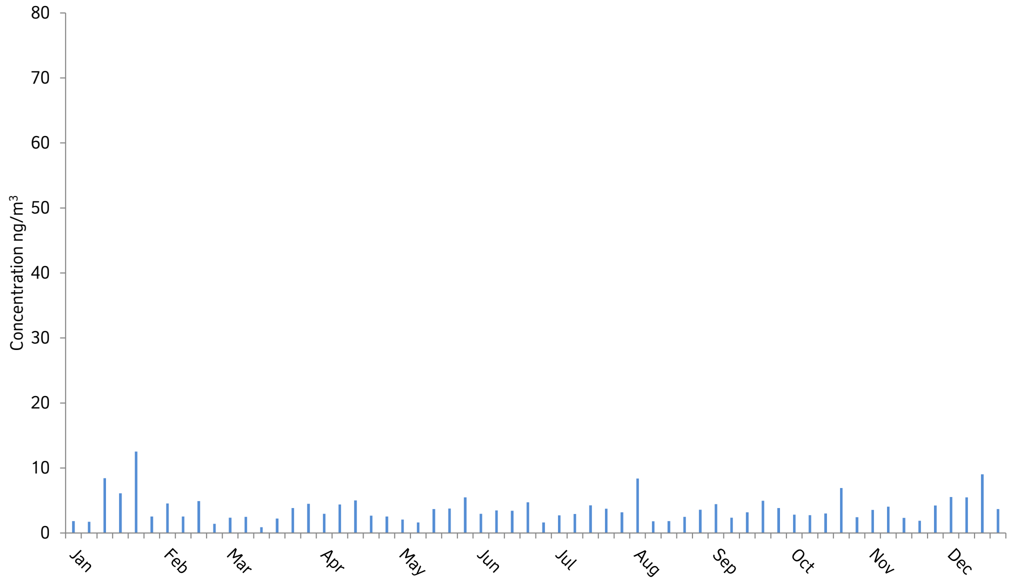


Figure 6.7c
Kitamaat Village
2017 Total PAH

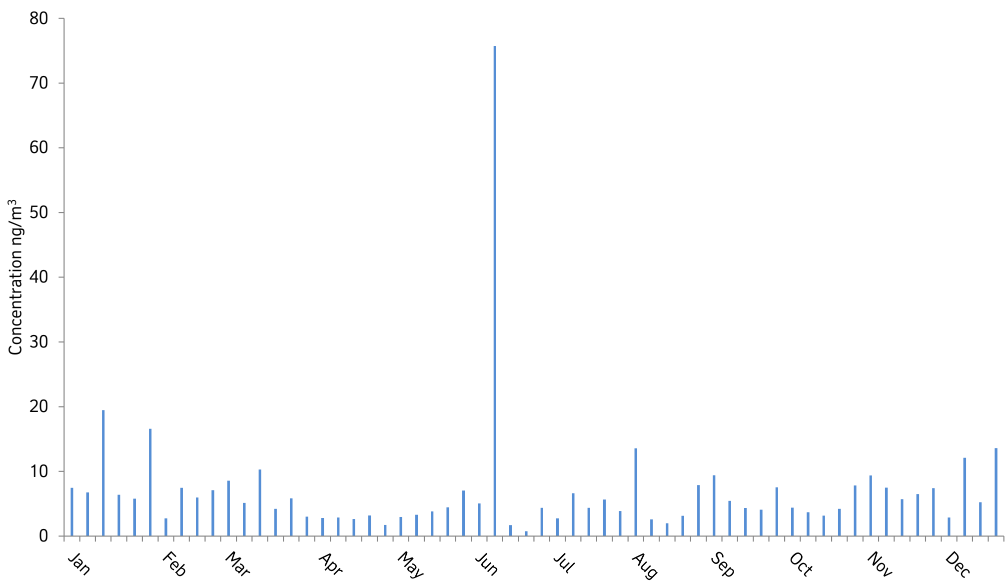
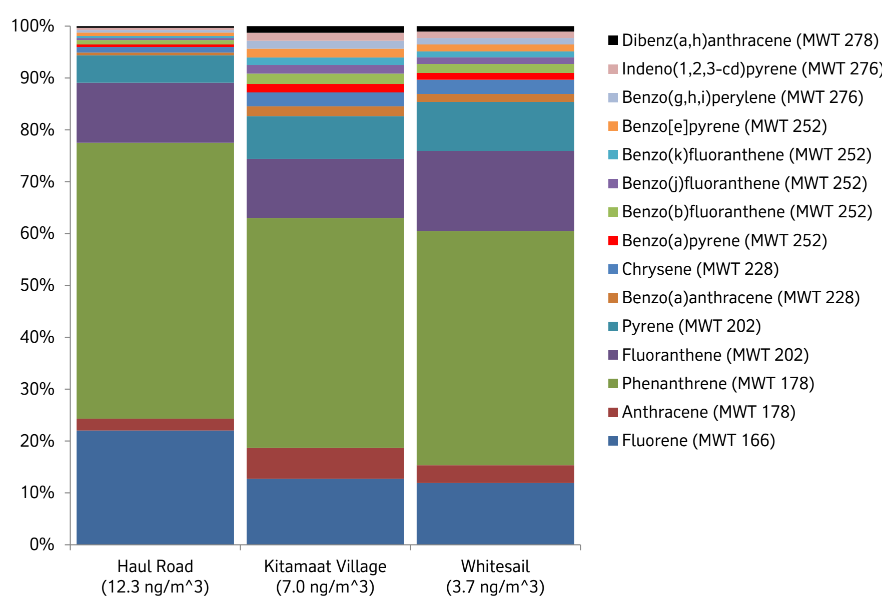


Figure 6.8
2017 PAH Congener
Distribution



7. Vegetation monitoring

The vegetation monitoring and assessment program consists of two parts: first, an annual collection of current year foliage of western hemlock, followed by an analysis of the concentration of fluoride and sulphur content in needle tissue; and second, on a biennial basis, a survey of vegetation in the vicinity of Operations to document the health and condition of vegetation.

Introduction

The annual collection of vegetation has been conducted since 1970, giving BC Works one of the largest historical databases of its kind in British Columbia. The data provides long-term and comparable measures of fluoride and sulphur absorption in vegetation, both of which are found in emissions from BC Works. The purpose of the monitoring and assessment program is to:

- Document the general growing conditions in the Kitimat area during the year of the inspection.
- Provide an assessment of the overall health of vegetation in the area, including documenting significant occurrences of insects and diseases.
- Document the concentration of fluoride and sulphur content in vegetation.
- Document the extent and severity of injury to vegetation associated with emissions (gaseous fluoride) from the BC Works.
- Provide early warning of changes in conditions.

In 2010 changes were made to the vegetation monitoring and assessment program based on Dr. John Laurence's (plant pathologist consultant) recommendations. The results of that investigation centered on the effectiveness of the monitoring program. Changes to the program were made in three areas:

- Changes to sample site locations.
- Standardization of sampling protocols.
- Increased quantitative assessment and documentation of the vegetation condition during biennial visual inspections.

Collection of western hemlock for foliar analysis is now conducted along directional transects away from the centre of BC Works. The directional transects allow an estimation of the maximum concentrations of fluoride and sulphur in foliage as well as the reduction in deposition with distance from the smelter. Sample harvesting is usually conducted at 39 sites at the end of the growing season by gathering the current year's growth.

This is done because vegetation is more sensitive to fluoride and sulphur emissions in the spring, when new tissue is tender and growing rapidly.

The sampling program focuses on hemlock because it is evenly distributed throughout the valley and is a reliable indicator for vegetative absorption of emissions. This year's samples were collected by an independent consultant and analyzed at Rio Tinto's Vaudreuil Analytical Laboratory in Quebec.

2017 monitoring results

Fluoride content

There is a historically strong correlation between fluoride concentrations in hemlock and fluoride emissions from the reduction roof vents at BC Works (Figure 7.1). Fluoride concentration in hemlock decreased in 2017 in comparison to 2016 from 24.7ppm to 6.1 ppm. The 2017 value represents an 18% decrease in fluoride concentration in hemlock from the previous ten year average of 32.7ppm.

On a monthly basis, total fluoride emissions from BC Works did not exceed the permit limit of 33.3 tonne per month (Figure 7.2). The permit limit came into effect in September 2016 when the process stabilized, and there were no Fg totals for annual fluoride emissions for that year (Figure 7.1)

There were no non-compliances relative to the total fluoride emissions in 2017.

Sulphur content

Vegetation can absorb higher concentrations of sulphur than fluoride before visual damage can be detected. Annual averages of sulphur concentrations in vegetation in the Kitimat-Terrace area have decreased over the past ten years and results have remained relatively uniform from 2013-2016. The average sulphur content of 2017 growth increased to an average content of 0.088% which is in range of typical background sulphur content in vegetation (Figure 7.3).

Qualitative assessment

In addition to annual vegetation sampling, the multi-media permit also requires that a qualitative assessment of vegetation condition in the Kitimat valley be conducted by an external expert every second year. The qualitative assesment was completed in 2016, and the next assement will occur in 2018.

Some of the observations reported in 2016 are as follows.

- The condition of vegetation was similar to what was reported in 2015. No symptoms of injury to vegetation were observed except some minor injury at the RT administration building.
- There were no remarkable insect outbreaks, disease epidemics or other stress factors affecting vegetation.

Figure 7.1 Western hemlock fluoride content and fluoride emissions, 2007-2017

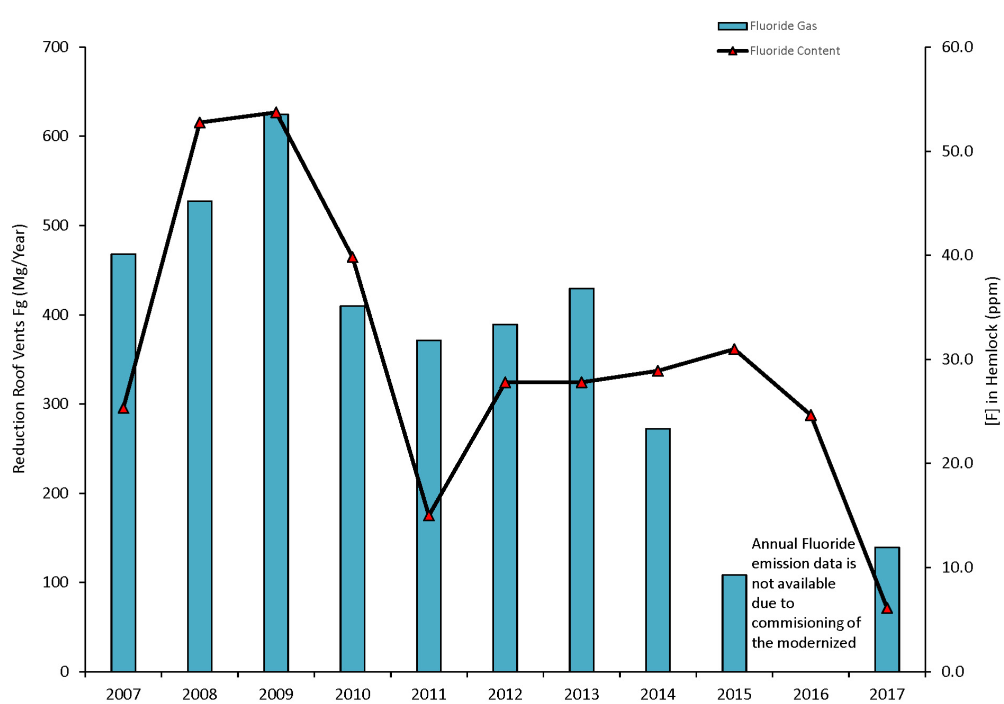


Figure 7.2
Potroom total fluoride emission monthly loadings, 2017

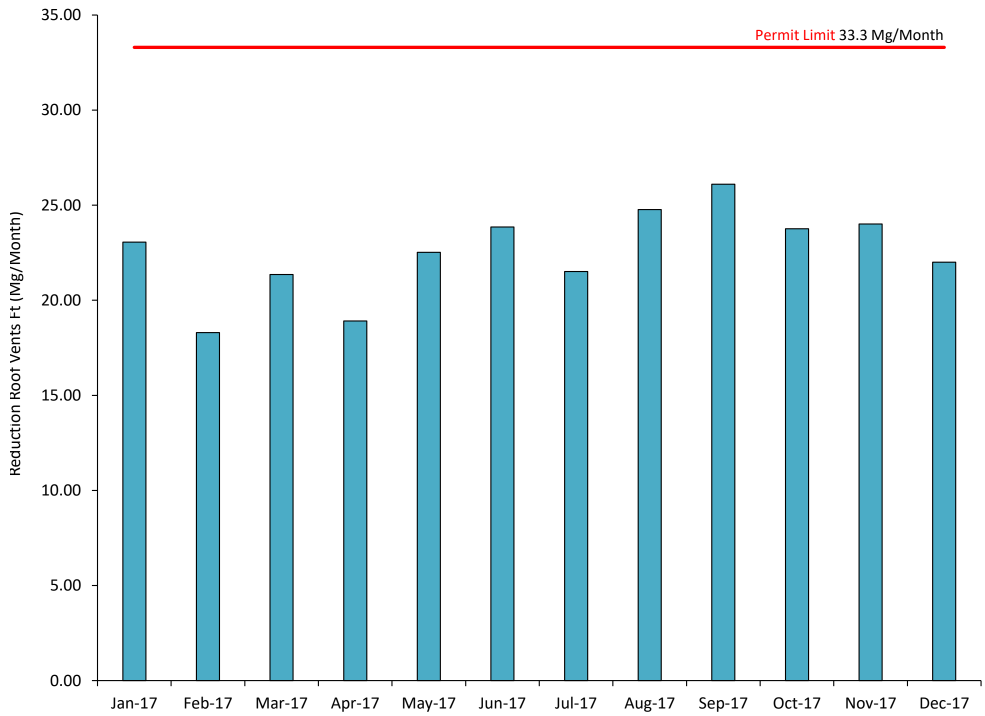
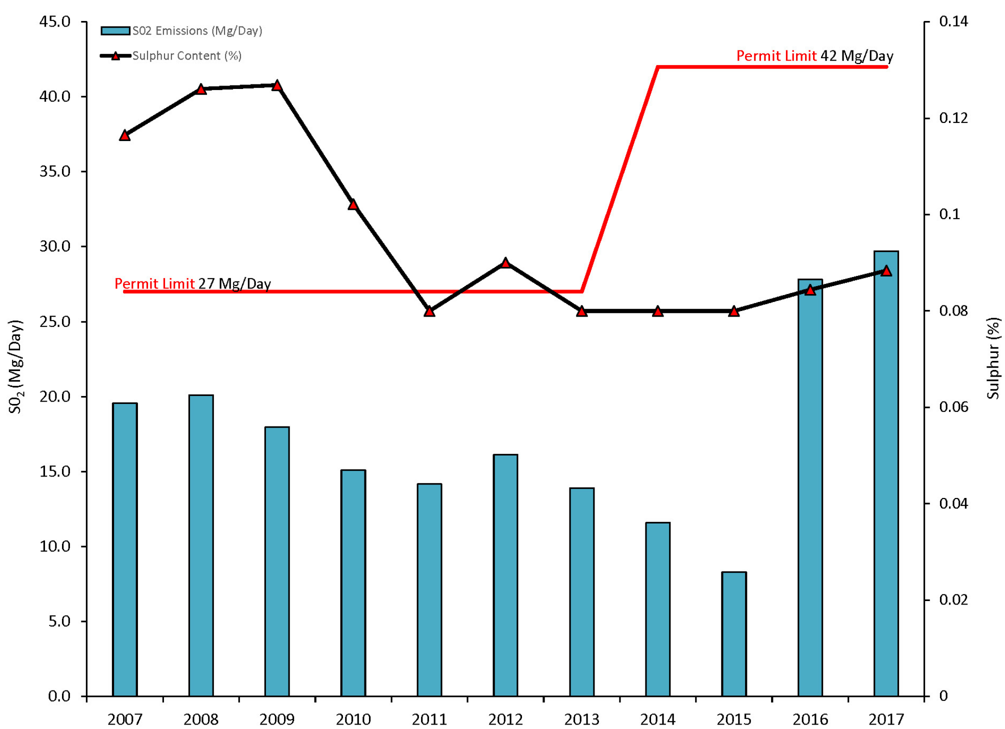


Figure 7.3
Western hemlock sulphur dioxide emissions, BC Works, 2007-2017



8. Waste management

The operation of the smelter results in the generation of various solid and liquid wastes. Appropriate management of these wastes is a central part of BC Work's operating strategy with the objective of limiting the smelter's environmental footprint.

Introduction

In August 2010, the multimedia permit was amended to allow for the disposal of KMP non-hazardous related wastes into the south landfill.

The amendment is inclusive of the design, operation and closure phases. The appropriate procedures for handling, storage and disposal of these wastes are in place and are reviewed as changes in operations occur.

Waste management procedures ensure full compliance with requirements related to regulated hazardous wastes and additional materials deemed to be hazardous by BC Works.

Opportunities for waste reduction and for improvements in waste handling are assessed and implemented on a continuous basis. In particular, opportunities to recover, reuse, and recycle waste materials are pursued whenever feasible. On-going practices include reducing raw material usage, thus reducing demand on the landfill and contributing to reducing the overall impact on the environment.

Waste management activities are tracked and reported. All waste types including those disposed at the South Landfill (i.e. inert industrial waste, asbestos materials, contaminated soil, and putrescibles), monthly wood waste and hazardous waste externally disposed or sent for recycling are reported in compliance with the permit requirements.

2017 performance

Spent potlining

Spent potlining (SPL) is one of the most significant hazardous waste materials produced at BC Works, and its disposal presents a challenge throughout the aluminium industry.

During 2017, 20,249 metric tonnes of SPL was generated and shipped off-site. 100 percent of that material was sent to the Spent Potlining Recycling Plant located in Saguenay, Quebec where the material was treated and recycled. Most of the SPL generated in 2017 originated from the VSS pot dismantling activities taking place in the old Pot Lines 1-5.

Asbestos and refractory ceramic fibres (RCF)

Asbestos and refractory ceramic fibres (a less hazardous substitute to asbestos) are used for insulation. These materials are considered by BC Works to be sufficiently hazardous to require special disposal methods.

In 2017, no asbestos or ceramic fibers materials were sent to the North and South Landfill (refer to BC Works map Figure 2.1 for waste storage, disposal and managed sites).

Wood waste

Wood waste is collected from around the smelter site on a regular basis and sent to a wood containment area. Wood is burned once sufficient volumes have accumulated at the containment area. In 2017, a total of 5,266 m^3 of wood waste was burned during the year using open burning.

Wood waste is collected from around the smelter site on a regular basis and sent to a wood containment area. Wood is burned once sufficient volumes have accumulated at the containment area. In 2017, a total of 5,266 m^3 of wood waste was burned during the year using open burning. Additionally, 8,960 mT of wood waste was burned using an Air Curtain Incinerator (ACI). Of this, 1,000 m^3 of soil and gravel was screened from the ACI, and 2,000 m^3 of non-burnable material was removed from the wood pile for disposal.

South Landfill management

The South Landfill is the main landfill for smelter operations. It has been operational since the plant opened and is expected to be open until full capacity. Incoming waste streams included: industrial waste, putrescible waste, contaminated soils, asphalt and asbestos contaminated materials which include soil and concrete.

A survey is carried out once a year for reconciliation of the forecasted disposed volumes. The total volume of materials disposed at the South Landfill in 2017 was 3,584 m^3, which corresponds to 4,807 metric tonnes.

As part of the requirement of the P2-00001 Multi-Media Permit related to the South Landfill, Rio Tinto completes and Environmental Effects Monitoring program (South Landfill EEM) annually. The overall objective of the ongoing South Landfill EEM program is to evaluate the health of the receiving environment which is potentially impacted by the landfill.

The overall conclusion of the 2017 South Landfill EEM program was that there was a low risk to ecological receptors due to impacts from the South Landfill. These results were based on consideration of chemistry, toxicity tests, and benthic community.

9. Groundwater monitoring

Long-term initiatives are underway with objectives to further reduce groundwater impact and identify disposal and treatment options for stored materials.

Introduction

A variety of monitoring programs are conducted relating to groundwater quality and flow in the vicinity of BC Work's Kitimat landfill sites that are, or have the potential to be, a source of contamination. In 2017, these efforts focused on the spent potlining landfill and the dredgeate short-term storage cells. Long-term initiatives are underway with objectives to further reduce groundwater contamination and identify disposal and treatment options for stored materials.

2017 monitoring results

Spent potlining landfill

The spent potlining landfill is comprised of three separate subsections formerly used to dispose of spent potlining (SPL). The landfill is located south of Potroom 1A and north of the Anode Paste Plant (refer to Kitimat Operations map Figure 2.1).

Prior to 1989, approximately 460,000 m^3 of SPL were disposed of at the landfill site as per permit limits. The landfill was decommissioned in the fall of 1989 and initially capped with a low permeability cover. Over the next decade the three subsections were capped with polyvinyl chloride (PVC) liners. The capping significantly reduced surface water infiltration, thus reducing contaminant loading into the environment.

Groundwater monitoring has been carried out in accordance with the requirements of the multi-media permit and the SPL management plan. The existing program consists of a quarterly monitoring program where selected wells are visited to monitor water level trends. In addition to monitoring water levels a geochemical sampling campaign that occurs in the fall of each year also occurs as part of the annual program. The information collected is used to assess groundwater quality for any significant changes in chemistry that may exceed previous year's results.

Estimated groundwater flux for 2017 (269,122 m^3/yr) was similar to 2016 (260,491 m^3/yr), reflecting similar amounts of precipitation. For 2017, loadings for fluoride, cyanide, aluminum and iron were estimated at 18,778 kg/yr, 108 kg/yr, 649 kg/yr and 275 kg/yr, respectively.

The 2017 loading estimates are within the range of estimates for previous years. For 2017, as compared to 2016, the loading estimates for fluoride and aluminum were respectively 25% and 35% higher, and the loading estimates for cyanide and iron were respectively 5% and 19% lower. These differences are due to variations in the measured concentrations of these parameters in the nearshore monitoring wells.

Estimated groundwater flux for 2016 (260,491m^3/yr) was lower than 2015 (354,026 m^3/yr). For 2016, fluoride, cyanide, aluminium and iron loading were estimated at 15,062 kg/yr, 114 kg/yr, 478 kg/yr and 339 kg/yr, respectively.

The 2016 loading estimates for fluoride, aluminium, and iron were lower than the 2015 loading estimates and within the range of estimates from previous years The lower values in 2016 can be attributed to less precipitation in 2016 along with a slight reduction in concentrations of chemistry in the near shore groundwater wells.

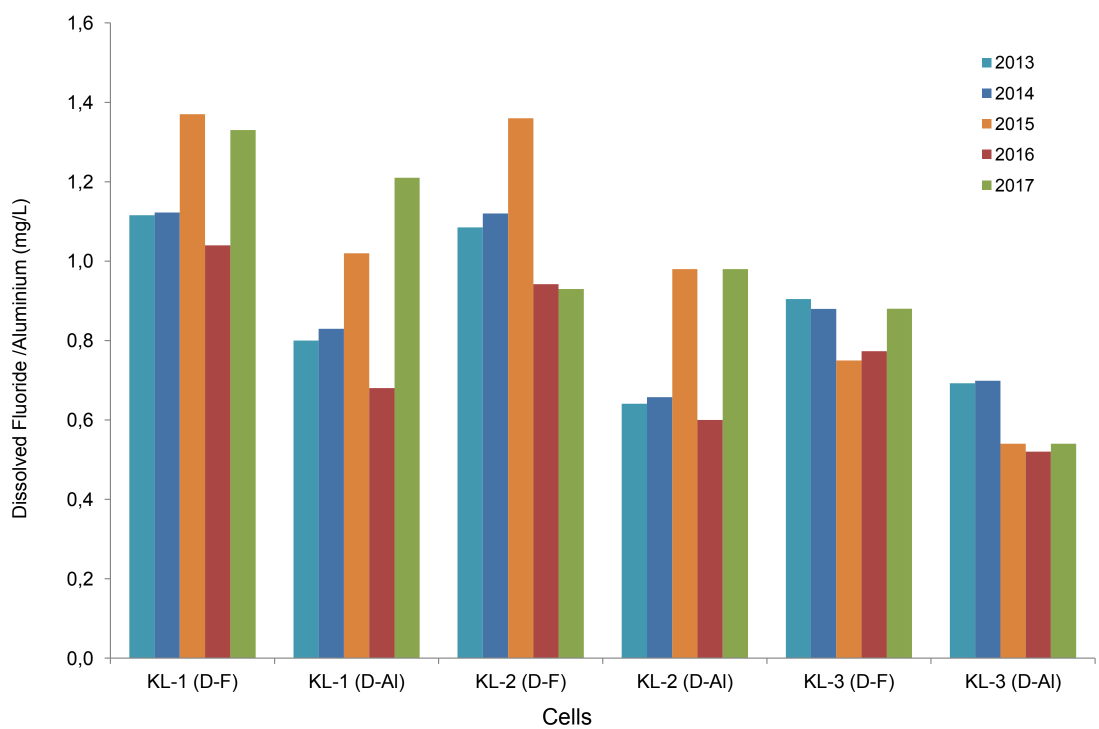
Dredgeate cells and SPL overburden cell

The wharf dredgeate cells consist of two lined cells located north of Anderson Creek. They contain approximately 2,000 m^3 of ocean sediment dredged from the wharf berthing area in 1995. This sediment was removed during a normal dredging operation and required special disposal because of the presence of PAHs in the form of solid pitch (pencil pitch). BC Works no longer receives pitch in this form. Three wells are used to monitor groundwater in the area surrounding the wharf dredgeate cells. They are referred to as KL-1, KL-2 and KL-3 and are located to the West, South and East of the cells respectively. Groundwater sampling was conducted on a quarterly basis in 2017. The samples were analyzed for dissolved fluoride and dissolved aluminium. The 2017 contaminant monitoring results are comparable to historical trends from previous years (Figure 9.1).

The SPL overburden cell is located west of the wharf dredgeate cells. The SPL material is composed of approximately 10,500m^3 of overburden material that came from the eastern lobe of the SPL landfill in 1996. The overburden cell was originally lined with a Claymax liner that has since been replaced several times, with a synthetic liner most recently in 2010.

Both the wharf dredgeate cells and SPL overburden cell have a double membrane lining system that collects water between the primary and the secondary liners. This water is tested and pumped out on a regular basis. In 2017 no water was pumped out from the six pumps.

Figure 9.1 Dissolved fluoride & aluminium, wharf dredgeate monitoring cells



10. Kemano permits

BC Works Kemano facility is the hydroelectric power station that supplies electricity to BC Works.

Introduction

Up until 2000, Kemano Operations included a town site with a resident population of 200 to 250 people. At that time the powerhouse was automated which reduced the operations and maintenance personnel to rotating crews of 20 to 30 people.

2017 performance

In 2015, BC Ministry of Environment conducted a compliance inspection on all Kemano permits. All permits were found to be compliant.

Kemano effluent discharge

The Kemano sewage treatment plant and several septic tanks in the area surrounding Kemano have effluent discharge permits. The discharges consist of treated sewage and are subject to permit requirements with respect to Biological Oxygen Demand (BOD) levels and concentrations of TSS. BOD is an indirect measure of the concentration of biodegradable matter, while TSS is a direct measure of suspended solids. Prior to 2006, effluent results were analyzed monthly to establish a baseline. Since then, the permit requires only quarterly sampling. In 2017 all effluent discharge permit measurements were in compliance (Figure 10.1).

Kemano emission discharge

An incinerator is used to burn municipal-type waste generated by rotating crews while residing at Kemano Operations. The incinerator is a double-chambered, fuel-fired, forced air unit. The permit requires that the exhaust temperature of the incinerator remain above 980°C and in 2017 permit requirements were in compliance.

Kemano landfill

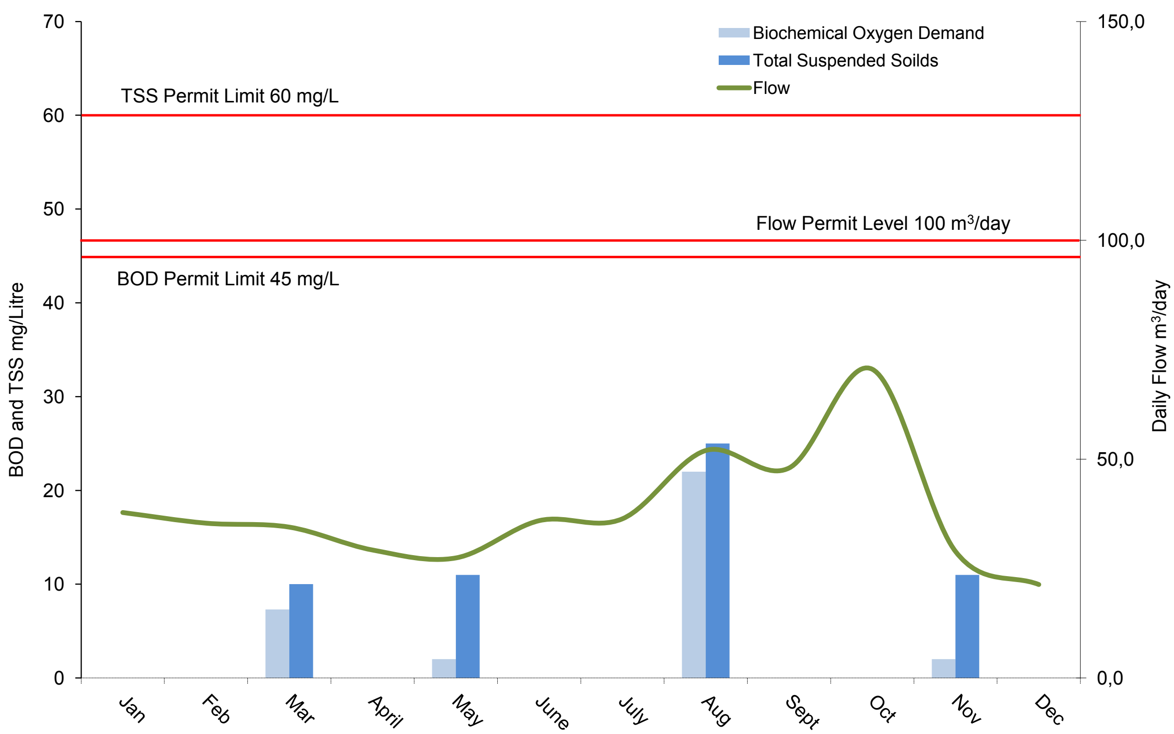
Non-combustible refuse and ash from the incinerator is buried in a landfill near Kemano. The landfill permit limits the amount of material to an annual maximum of 300 m^3. In 2017, 15.4 m^3 of refuse was buried.

Treated sludge from the sewage treatment plant, septic tanks and biological containers are also deposited in the same landfill. Filtration ponds are used to de-water the sludge before disposal. The permit allows for disposal of up to 900 m^3 of treated sludge per year. In 2017, 121 m^3 of sludge was disposed of which is a slight decrease from 2016.

Seekwyakin camp effluent discharge

Seekwyakin construction camp, located three kilometers north of Kemano, was historically used by West Fraser Timber Co. Ltd. and BC Works. Effluent sewage discharges from the camp require a permit when the camp has more than 25 residents. In 2017, Seekwyakin camp saw very little activity and usage remained well below 25 residents.

Figure 10.1
Effluent discharge, Kemano 2016



11. Summary of non-compliance and spills

In 2017, there were a total of 27 non-compliances for Kitimat and zero non-compliance for Kemano.

2017 performance

Non-compliance summary

These non-compliances are summarized with a brief description of their causes and the corrective actions that are either being assessed or implemented at the time this report was prepared (Table 11.1).

Spill summary

Spills at BC Works are first reported to the Plant Protection department and subsequently to the Environmental Services Department. Regulatory requirements are in place to report certain types of spills to the Ministry of Environment (referred to as “reportable” spills), depending on the nature and volume of the substance spilled. In 2017, 12 spills were reported to the Ministry (Table 11.2).

Spill-related awareness and prevention is a major focal point throughout BC Works. Immediate containment and minimization of potential environmental damage is the first priority. Specially equipped response teams are available when required. If appropriate, other agencies are informed and their cooperation enlisted.

Root cause analysis of reportable spills is conducted to prevent recurrence, and a system is maintained for recording and reviewing all spills and their frequency by type. This ensures that appropriate corrective actions are identified and tracked through to completion.

No known environmental damage was associated with any of the spills reported during 2017.

Table 11.1 Summary of non-compliances, 2017

Non-Compliance	Occurrence date	Impact	Permit Requirement	Cause	Implemented Corrective Actions
Toxicity test (LC5096h) failure and/or dissolved Aluminium (dAl) and/or total suspended solids (TSS) exceeding permit limits during overflow events at F Lagoon.	16 January dAl: 2.64 mg/L LC5096h: Fail 28 January dAl: 2.05 mg/L LC5096h: Fail 13 March dAl: 1.77 mg/L 14 March dAl: 1.22 mg/L LC5096h: Fail 10 September dAl: 2.67 mg/L LC5096h: Fail 23 October dAl:1.68 mg/L LC5096h: Fail TSS: 86.8 mg/L	Discharge to fresh water	F Lagoon permit limits : Dissolved Aluminium: 1mg/L Toxicity test (LC5096h) : pass with 50% survival Total Suspended Solids : 75 mg/L	Process material losses (sources control) in different areas of the smelter and F Lagoon capacity	Short term: Detailed investigation - Completed Corrective action: • Housekeeping in contributing areas- Ongoing • Deployed action plan to address material losses for Gas Treatment Centre areas and Bath Tower area • Install passive and active filters in drains - Completed • Install silt curtain at F-Lagoon discharge - Completed • Deploy Receiving environment assessment - Completed • Install temporary pumping system to reduce overflow occurrences and minimize volume spilled - Completed • Increase culvert size from A to B-Lagoon to 4x30" for better flow - Completed • Increase culvert size from F-Lagoon to 4x30" for better flow - Completed • Dredge F-Lagoon at culvert discharge - Completed • Clean existing culverts and inverted syphons - Completed • Dredge A-Lagoon to increase flow - Completed • Repair Moore creek dyke to prevent overflows to lagoon - Completed • Limestone placement in F-Lagoon ditch - Completed Long Term: Implement engineered solution at F-Lagoon to eliminate non-compliant overflows to fresh water environment
Fugitive dust emissions from bath pan conveyor at the Gas Treatment Centre and Bath Tower area	8 February	Impact to water chemistry in lagoons.	Minimize emissions consistent with good operation and maintenance practices	Emission minimization efforts not entirely deployed	Corrective action: • Housekeeping in contributing areas - Ongoing • Deployed action plan to address material losses for Gas Treatment Centre areas and Bath Tower area
Fugitive dust emissions from alumina conveyor to Moore Creek	4 April	Discharge to freshwater	Minimize emissions consistent with good operation and maintenance practices	Maintenance of alumina conveyor	Short term: Detailed investigation - Completed Corrective action: • Seal the leaks on the conveyor - Completed • Inspect and maintain alumina conveyor in order to prevent leaks - Ongoing
FTC bypass events were not reported to the MOE on the next business day	12 July 14 July 19 July 17 August	Administrative	On the event of FTC bypass or FTC system failure, the event will be reported to the Director on the next business day.	Operational standards for reporting requirements and communications during bypass events unclear and not established	Corrective action: • Update, improve and implement standard operational procedures for FTC bypass - Completed • Implement phone alarm notifications - Completed • Deploy awareness package on reporting requirements during FTC bypass - Ongoing
Pitch fume escaping the pressure relief valves from the Pitch Tanks.	13 August	Discharge to the atmosphere	Minimize emissions consistent with good operation and maintenance practices	Pressure buildup in Pitch Tanks resulted in a bypass of the pollution control device.	Short term: Detailed investigation - Completed Corrective action: • Update, improve and implement standard operational procedures for pitch unloading - Completed Long term: Install engineered controls for the system

Table 11.1 Summary of non-compliances, 2017 (continued)

Non-Compliance	Occurrence date	Impact	Permit Requirement	Cause	Implemented Corrective Actions
Alumina dust on the ground near the alumina silos	26 September	Discharge to air and fresh water	Minimize emissions consistent with good operation and maintenance practices	No source control of the fugitive emission of the silos	Corrective action: • Dust Collection Action Plan deployed and focus on housekeeping around the silos - Ongoing • Replace 6 dust collectors from the silos - Completed
Environmental Compliance Website (ECWS) compliance indicators not updated in a timely manner	27 September	Communication	Publish and contemporaneously maintain an official Environmental Compliance Web Site (ECWS) under the Environment Section of RTA's Primary Metal BC Operations publically accessible Internet site	Communication and website update process not established	Corrective action: • Implement a communication process with the BC Works Communities & Communication's team to ensure the graphs displayed on the website will be updated on the last week of every month - Completed
B-lagoon temperature was not reported in the July monthly report	29 September	Administrative	Monitor effluent sources at corresponding frequencies according to parameters and conditions stated in section 8.2.1 of the permit.	Reporting standards and procedures unclear	Corrective action: • Review the procedures for extracting and reporting the effluent data - Complete • Implement review process of monthly report - Completed
Hazardous waste storage facility annual report not submitted on time to MOE	13 December	Administrative	When operating a hazardous waste storage facility, you must submit an annual report to the MOE at the latest 31 March of the following year	Administrative	Corrective action: • Review the accountability and procedures for annual reporting - Completed
Opacity of the discharge from the air curtain incinerator exceeded 10% for more than 3 min.	29 September, 1, 2, 4, 7, 8, 9, 15, 16, 18, 19, 20, 22, 23, 24, October 1, 2, 5, 7 November	Discharge to atmosphere	Air contaminants must not exceed 10% opacity for more than three (3) minutes in any (30) minute period as determined by an Opacity reader.	Lack of knowledge of the operational plan by crew	Corrective action: • Create a schedule for operational site weekly visits • Create a checklist/form to be filled out during site weekly visits • Ensure a clear protocol is in place for any violations of the operational plan • Implement workshop to review each section of the operational plan • Sign off competencies
No custom venting index obtained for burning operations when the Terrace venting index was poor.	28 September 4, 5, 8, 9, 10, 15, 16, 19, 20, 23, 24, 25 October	Discharge to atmosphere	The ACI(s) must not operate if the ventilation index is poor.	Lack of knowledge of the operational plan by crew	Corrective action: • Create a schedule for operational site weekly visits • Create a checklist/form to be filled out during site weekly visits • Ensure a clear protocol is in place for any violations of the operational plan • Implement workshop to review each section of the operational plan • Sign off competencies

Table 11.1 Summary of non-compliances, 2017 (continued)

Non-Compliance	Occurrence date	Impact	Permit Requirement	Cause	Implemented Corrective Actions
The ACI monitoring log did not compile all the legally required information for the time of its operation	NA	Administrative	The ACI owner/ operator must maintain a monitoring log. The permittee must track the status of the ACI operations.	Lack of knowledge of the operational plan by crew	Corrective action: • Create a schedule for operational site weekly visits • Create a checklist/form to be filled out during site weekly visits • Ensure a clear protocol is in place for any violations of the operational plan • Implement workshop to review each section of the operational plan • Sign off competencies
The ACI was operated when the ambient 24 hours running average PM 2.5 exceeded 15 ug/m^3	4 November 5 November	Discharge to atmosphere	The ACI(s) must not operate if the ambient 24 hours running average PM 2.5 exceeds 15 ug/m^3.	No alarm was ever commissioned to indicate that the ambient 24 hours running average for PM 2.5 had exceeded the limit.	Corrective action: • Use Management of Change procedures when requesting a modification to a piece of equipment.

Table 11.2 Summary of reportable spills, 2017

Occurrence	Substance	Amount	Environmental Media	Causes	Corrective Actions
4 January	Ethyl glycol	534 kg	Gravel	Leak from Furnace # 1 cooling tower	Clean up of soils and leak was fixed
15 January	Pitch	1 L	Marine environment	Pitch was spilled over the edge of the vessel while unloading pitch	Process was stopped and equipment to deliver pitch was fixed
26 January	Alumina Ore	500 kg	Gravel & Asphalt	A storage bin tipped over	Sweeper was sent to clean up the spill
31 March	Chlorined process water	1400 L	Soil, and ditch leading to Tour building creek	Overflow of the hill tank #4	Pipefitters made adjustments to the valve chamber to prevent future overflow events from occurring
4 April	Alumina Ore	300 kg	Air, Freshwater, Moore Creek Bank	Leak from the conveyors between tower 9 and 10	Refer to April 4th, noncompliance table 11.1
21 April	Fluoride	500 KG	Gravel	During lifting operation of fluoride bags, the bag broke	Spill was immediately cleaned up
2 May	Skim/dross air pollution	NA	Air	Skim/Dross Fire due to hot material	The fire was extinguished
3 May	Skim/dross air pollution	NA	Air	Skim/Dross Fire due to hot material	Review process for handling dross, improved dross handling procedures and training
28 September	Alumina Ore	40kg	Freshwater, Gravel, Banks of Moore creek	Leak in the conveyor at tower 9	Repairs were made to section of conveyor above creek to prevent fugitive dust losses
8 October	Hydraulic Oil	4 Litres	Marine Environment	Leak from hydraulic hose on a winch truck at Kemano Barge ramp	Absorbent booms were set up along the shoreline The hose was repaired
11 October	Bath	500 kg	Asphalt	Leak in mixing box	Sweeper was sent to clean up the spill
5 November	Hydraulic Oil	5 Litres	Marine Environment	Leak in the Hydraulic hose for of the Terminal B barge ramp	Absorbent pads were placed under the leak to stop oil from reaching environment The hose was repaired.

12. Glossary

Anode
One of two electrodes (the positive electrode) required to carry an electric current into the molten bath, a key component of the electrolytic reduction process that transforms alumina ore into aluminium.

Anode Baking Furnace
Green anodes (un-baked) are brought to the Anode Baking Furnace (ABF) to bake the anodes. This process hardens the anodes and drives off volatile hydrocarbons (such as PAHs) from the liquid pitch used to bind the calcined coke and recycled carbon.

Anode Rodding Shop
The shop where baked anodes are rodded with electrodes and where spent anodes from the potrooms are disassembled.

Anode effects
A chemical reaction that occurs when the level of alumina in a pot falls below a critical level, resulting in reduced aluminium production and the generation of perfluorocarbons (PFCs) – a variety of gases with a high carbon dioxide equivalency.

Anode paste
One of the materials used to manufacture green anodes, composed of calcined coke and coal tar pitch.

Attrition index
An index used to express alumina strength; the higher the value, the weaker the alumina.

Bath
An process material consisting primarily of sodium aluminum fluoride which is melted in the pots and used to dissolve the alumina for the electrolytic reduction process of making aluminium.

Bath Plant and Bath Tower
Bath generated from the pots is taken to the bath plant for processing and recycling. The bath tower is one component of the plant that conveys the reclaimed bath for processing.

Carbon dioxide equivalency (CO_2e)
This is a quantity that describes, for a given mixture and amount of greenhouse gas, the amount of $C0_2$ that would have the same global warming potential as the emission, when measured over a specified time period.

Cassette sampling
A sampling procedure for air emissions where contaminants are collected using filters placed at regular intervals along the length of the potroom.

Cathode
One of two electrodes (the negative electrode) required to carry an electric current into the molten bath; a key component of the electrolytic reduction process that transforms alumina ore into aluminium.

Coke calcination/calcined coke
A process involving the use of high temperatures to drive off volatile matter found in green coke, thus producing calcined coke for use in anode manufacturing.

Composite sample
A composite sample is treated as a single sample, despite being made up of multiple temporally discrete samples. For example, all effluent composite samples are taken over 24 hours during which a 50mL sample is collected every 10 minutes.

Dredgeate
Any material removed by dredging.

Dry scrubber
Pollution control equipment used to remove contaminants (in gaseous or particulate forms) from air emissions.

Effluent (B-lagoon)
Water discharge flowing out of the B-Lagoon outfall after treatment in the B-Lagoon system.

Electrolyte
A chemical compound that provides an electrically conductive medium when dissolved or molten.

Electrolytic reduction
This process uses electricity to remove oxygen molecules from aluminium oxide to form aluminium metal.

Fugitive dust
Solid airborne particulate matter that is emitted from any source other than a stack or a chimney.

Fume Treatment Centre
Is the primary pollution control system for the anode baking furnace. The Fume Treatment Centre (FTC) uses water to cool the hot fumes from the ABF. The FTC then filters the fumes to remove particulates, fluorides and PAHs.

Geometric mean
A geometric mean is a type of mean or average, which indicates the central tendency or typical value of a set of numbers by using the product of their values. The geometric mean is often used when comparing different items when each item has multiple properties that have different numeric ranges.

Green coke
The raw form of coke received at Kitimat Operations, which is calcined for use in the manufacture of anodes; a by-product of oil refining.

Grab sample
A grab sample is a discrete sample used to collect information for a specific or a short time. Variability of this data is much higher than a composite sample.

Gas Treatment Centre
Is the primary pollution control system for the potline. There are two Gas Treatment Centres (GTCs) for the modernized smelter, replacing the function of the 9 dry scrubbers used in the old VSS smelter. The GTCs filter the pot gases to remove particulates and fluorides.

Leachate
A liquid which results from water collecting contaminants as it passes through waste material.

Leftover metal
Metal which accumulates in a pot when the schedule to remove the metal is not followed.

Loading
Loading is the emitted amount of a contaminate in a given time period.

Maximum allowable level
This level provides adequate protection against pollution effects on soil, water, vegetation, materials, animals, visibility, personal comfort and well-being.

Maximum desirable level
This level is the long-term goal for air quality programs and provides a basis for the federal government’s antidegradation policy for unpolluted parts of the country.

Maximum tolerable level
This level denotes time-based concentrations of air contaminants beyond which appropriate action is required to protect the health of the general population.

Ministry
The British Columbia Ministry of Environment (BCMOE) to which BC Operations reports on compliance with its permit requirements.

Piezometer
A small diameter water well used to measure the hydraulic head of groundwater in aquifers.

Pitch
One of the materials from which anodes are made, and a by-product of metallurgical coke production.

Polycyclic aromatic hydrocarbons (PAHs)
A group of aromatic hydrocarbons containing three or more closed hydrocarbon rings. Certain PAH are animal and/or human carcinogens.

Pots/potline
Pots are large, specially designed steel structures within which electrolytic reduction takes place. The 396 pots at Kitimat Works are housed within a single potline.

Process correction
Accessing the condition of exception or sick pots and bringing them back to normal operating conditions.

Putrescible waste
Waste that rots which can be easily broken down by bacteria, for example food and vegetable waste.

Pyroscrubber
A combustion-based system that controls dust emissions from the coke calciner.

Retention time
The average time a drop of water takes to move through a lagoon from inlet to outlet.

Scow grid
A dry dock for flat bottomed vessels (scows) formed from a series of piles and sills.

Sick pot
A pot that has an elevated bath temperature and cannot be sealed properly or is uncovered.

Spent pot lining (SPL)
Lining from the inside of pots, composed of refractory bricks and carbon that has deteriorated to the point where it needs to be replaced.

Stud
Studs constructed of steel are inserted vertically into the anode to conduct the flow of electricity through the anode and into the electrolyte.

Total suspended solids (TSS)
A water quality measurement that refers to the dry weight of particles trapped by a filter, typically of a specified pore size.

Appendix 1:
Air Curtain Incinerator Operating Log

Wood Burning Date	$PM_{2.5}$ Maximum 24-hour running average Riverlodge	Whitesail	Kitamaat Village	Venting Index	Custom Venting Index	Opacity	Comment	Process Adjustments
28-Sep-17	4.4	8.0	3.8	poor		4%	ACI took 1 hour to bring the ACI to a high enough temperature to reduce smoke.	
29-Sep-17	3.0	6.3	4.8		fair	17%	Feed rate adjusted due to poor burning; mostly steam being generated by moist wood. Opacity reading was taken too soon after feeding.	Adjusted feeding rate
30-Sep-17	3.8	7.8	6.1	fair		10%		
1-Oct-17	4.0	7.8	8.0	good		19%	Feed rate adjusted due to poor burning; mostly steam being generated by moist wood.	Adjusted feeding rate
2-Oct-17	4.3	8.0	9.3			15%	Feed rate adjusted due to poor burning; mostly steam being generated by moist wood.	Adjusted feeding rate
3-Oct-17	5.2	8.8	9.3	fair		3%	Noticecd paticulate emissions from ash cooling.	Apply more water to cool ashes.
4-Oct-17	5.1	8.3	9.2	poor		14%		
5-Oct-17	5.9	8.4	11.3	poor		9%		
6-Oct-17	4.5	7.9	9.6	good		10%		
7-Oct-17	3.8	8.5	7.7	fair		25%	Feed rate adjusted due to poor burning; mostly steam being generated by moist wood.	Adjusted feeding rate
8-Oct-17	4.1	8.7	9.0	poor		12%	Feed rate adjusted due to poor burning; mostly steam being generated by moist wood.	Adjusted feeding rate
9-Oct-17	2.9	6.2	7.8	poor		23%	Feed rate adjusted due to poor burning; mostly steam being generated by moist wood.	Adjusted feeding rate
10-Oct-17	4.0	7.6	7.3	poor		2%		
15-Oct-17	3.8	5.6	7.5	poor		29%	Feed rate adjusted due to poor burning; mostly steam being generated by moist wood. Drier wood was blended with the wet wood to improve burning.	Blending of dry wood into wet feedstock. Overfed ACI to contain heat to sustain burn.
16-Oct-17	4.7	8.3	8.1	poor		29%	Feed rate adjusted due to poor burning; mostly steam being generated by moist wood.	Reduced feeding rate
17-Oct-17	3.7	8.3	8.4		fair	5%	Wood was wet from rain overnight. Feed rate slowed down.	Feed rate slowed down
18-Oct-17	3.6	8.2	8.6		good	34%	Feed rate adjusted due to poor burning; mostly steam being generated by moist wood.	Wood was wet from rain. Feed rate was slowed down.
19-Oct-17	3.1	8.3	9.3	poor		18%	Feed rate adjusted due to poor burning; mostly steam being generated by moist wood.	Feed rate was slowed down
20-Oct-17	3.0	9.3	8.3	poor		20%	Feed rate adjusted due to poor burning; mostly steam being generated by moist wood. Drier wood was blended with the wet wood to improve burning.	Blending of dry wood into wet feedstock
22-Oct-17	7.3	9.8	11.1		fair	36%	Feed rate adjusted due to poor burning; mostly steam being generated by moist wood. Rain was making the wetting the wood waste.	Adjusted feeding rate

* Volume to weight conversion factors, U.S. Environmental Protection Agency Office of Resource Conservation and Recovery, April 2016.
Green wood chips assumed to best represent the denisity of moist & crushed wood waste (473 lbs/yd3)

** Average of six opacity readings with four measuremnet intervals per reading.

Wood Burning Date	$PM_{2.5}$ Maximum 24-hour running average			Venting Index	Custom Venting Index	Opacity	Comment	Process Adjustments
	Riverlodge	Whitesail	Kitamaat Village					
23-Oct-17	7.8	10.7	9.0	poor		13%	Feed rate adjusted due to poor burning; mostly steam being generated by moist wood.	Adjusted feeding rate
24-Oct-17	3.5	6.7	7.5	Poor		39%	Feed rate adjusted due to poor burning; mostly steam being generated by moist wood. Increased soil and gravel was found to be in the wood pile.	Screeninng plant ordered
25-Oct-17	2.8	7.5	9.0	Poor		15%	Feed rate adjusted due to poor burning; mostly steam being generated by moist wood.	Adjusted feeding rate
01-Nov-17	6.8	9.1	10.4	Good		15%	Feed rate adjusted due to poor burning; mostly steam being generated by moist wood. Wood waste fed through vibrating grizzly screen to remove gravel.	Adjusted feeding rate
02-Nov-17	6.8	8.9	11.3	good		25%	Only small ACI in use.	Repair clutch in large ACI
03-Nov-17	3.8	8.0	13.0	good		6%		
4-Nov-17	6.0	10.5	15.6	good		10%	Steam being generated by wet wood. $PM_{2.5}$ levels above 15 ug/m3 from 10pm to 1am (Nov. 6th).	
5-Nov-17	6.3	11.0	15.2	good		48%	Wood is wet and takes awile for every bucket fed to start to burn. New feed was smoothering the flames inside the ACI. Feed rate adjusted due to poor burning; mostly steam being generated by moist wood. $PM_{2.5}$ levels above 15 ug/m^3 from 12am to 1am (continuation form Nov. 5th).	Adjusted feeding rate
06-Nov-17	7.9	10.6	11.5	poor		10%	Wood was burning well after adjustments made. Wood burning was stopped due to poor venting index.	Stopped wood burning for the day after venting index was issued.
07-Nov-17	7.7	12.0	14.0	fair		15%	Feed rate adjusted due to poor burning; mostly steam being generated by moist wood.	Adjusted feeding rate
15-Nov-17	6.7	9.5	12.7	good		6%		

* Volume to weight conversion factors, U.S. Environmental Protection Agency Office of Resource Conservation and Recovery, April 2016.
Green wood chips assumed to best represent the denisity of moist & crushed wood waste (473 lbs/yd3)

** Average of six opacity readings with four measuremnet intervals per reading.

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