REPORT

Tonkin+Taylor

Air Quality Assessment

Glenbrook Steel Mill Air Discharge Permit Replacement

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New Zealand Steel
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Historical and alternative terms

Term used in this report	Alternative terms (used historically or interchangeably in NZ Steel materials)
Kilns	Direct Reduction Kilns, Rotary kilns.
KOBM	Klockner Oxygen Blown Maxhutte, Oxygen Steelmaking Furnace.
KOBM Flarestack	KOBM primary off gas flare, KOBM Steelmaking vessel flarestack, KOBM Converter (primary off-gas system).
Metalside Baghouses	Melter Metal Side secondary fume extraction baghouse stacks, Melter Metalside tapping fume collection.
Multihearth furnaces	Multiple Hearth Furnaces.
Paint Line	Colour Coat Line, Coil Coating Line.
Paint Line Oven incinerators	Paintline incinerator, Paintline afterburner.
Pickle Line scrubber	Pickle line fume scrubber.
Pipe Mill Blowdown scrubber	Pipe mill zinc blow out system.
Pipe Mill Galvanising Baghouse	Zinc pot baghouse, Pipe mill baghouse.
Pipe mill plant	Hollow sections, Pipe and light plate.
Primary Concentrate Drier Baghouse	Millscale and ironsand drier baghouse, SteelServ drier baghouse.
Slab Reheat Furnace	Slab reheating furnace, Reheat furnace (RHF).
Slagside Baghouse	Melter Slag Side secondary fume extraction baghouse stack, Melter Slagside tapping fume collection.
Steel Plant	Slab making plant.
Steel Plant Baghouse	KOBM secondary baghouse, KOBM secondary fume baghouse, Vanadium Extraction and KOBM Steelmaking Converter (1 baghouse), KOBM baghouse, Steelmaking baghouse.
Steelserv Ltd	Slag Reduction Company.

Glossary of terms

Term	Meaning
Acid Regeneration Plant (ARP)	Ancillary plant associated with the Pickle Line in which spent acid is regenerated through roasting for re-use. This plant is a facility within the Finishing Plant.
Air discharge permits	Refers to two consents required for the operation of the Steel Mill and its ancillary activities which are due to expire and sought for replacement, comprising of the “Air Permit” and “Commercial Iron Plating Air Permit” (see individual terms in this table).
Air dispersion modelling	The mathematical simulation of how air contaminants emitted from a source disperse in the ambient atmosphere.
Ancillary Activities	Supporting activities, including movement of molten iron and steel slabs between manufacturing plants; stockpiling and processing of raw materials, co-products and waste; tipping of slag, iron and RPCC; and all supporting vehicle movements.
Annealing	Annealing restores the ductile properties of the steel strip (through heating and cooling), which is hard and brittle after cold rolling. This process is part of the Rolling Mills.
Annealing Furnace / Uni-flow annealing system	Controlled heating and cooling of steel coils carried out in three natural gas fired furnaces.
Best Practicable Option (BPO)	Defined in section 2(1) of the RMA, as in relation to a discharge of a practicable contaminant or an emission of noise, means the best method for option preventing or minimising the adverse effects on the environment having regard, among others things, to: (a) the nature of the discharge or emission and the sensitivity of the receiving environment to adverse effects; (b) the financial implications, and the effects on the environment, of that option when compared with other options; and (c) the current state of technical knowledge and the likelihood that the option can be successfully applied.
Billet Caster	A mould machine that produces billets for further processing off site at Pacific Steel in Otahuhu, where they are manufactured into rod wire and bar.

Term	Meaning
BPIP-PRIME model	The Building Profile Input Programme (BPIP) Plume Rise Model Enhancements (PRIME) model is used to simulate building downwash impacts.
Building downwash	The influence of building (or structure) configuration in changing the trajectory of an emitted plume from a stack/vent, bringing the plume to the ground more rapidly than where there is an absence of buildings.
CALMET model	The CALPUFF meteorological pre-processor. It is a diagnostic, meteorological model which provides a construction of 3-dimensional wind and temperature fields, and a 2-dimensional determination of micro meteorological variables (such as mixing height) needed to carry out dispersion model.
CALPUFF model	The California Puff (CALPUFF) model is an advanced non-steady state, Lagrangian puff air dispersion model.
Carbon monoxide	Carbon monoxide is a colourless, odourless, and tasteless flammable gas that is a product of combustion.
Char	Partially burned coal produced at the Kilns, a component of RPCC.
Cold Strip Mill	Further reduces the strip thickness and imparts a higher quality finish than is possible in the Hot Strip Mill.
Combination Mill	Similar to the Reversing Mill that cold rolls pickled coils to the required thickness for annealing and then temper rolls the annealed coil to customer requirements.
Commercial Iron Plating Air Permit	A separate permit that was granted on 8 October 2020, which authorises discharges to air from commercial iron plating (Auckland Council reference DIS60363772).
Contaminant	Defined in section 2(1) of the RMA, as including any substance (including gases, odorous compounds, liquids, solids, and micro— organisms) or energy (excluding noise) or heat, that either by itself or in combination with the same, similar, or other substances, energy, or heat— (a) when discharged into water, changes or is likely to change the physical, chemical, or biological condition of water; or (b) when discharged onto or into land or into air, changes or is likely to change the physical, chemical or biological condition of the land or air onto or into which it is discharged.

Term	**Meaning**
Deposited particulate	Dust generally greater than 50 µm in diameter, prone to setting from the air onto surfaces.
Existing Consents	Permit 14317 (DIS60266277) which authorises the main air discharges for the Steel Mill operation and Permit DIS60363772 which authorises commercial iron plating activities. Both of which are due to expire on 1 November 2021. Referred to herein individually as the 'Main Air Permit' and the 'Commercial Iron Plating Air Permit'.
Finish Line	The process equipment in the Paint Line where finish coatings (as opposed to primer coating) are applied to the steel coil. Discharges from this process are via the Finish Oven Incinerator Stack.
Finishing Plants	The Finishing Plants comprise a continuous Metal Coating Line and a Paint Line for application of coatings to the rolled coils.
Fugitive emissions	Diffuse emissions to air, also referred to as non-point source discharges.
Ground level concentration (GLC)	The concentration in air of a pollutant to which a human being is normally exposed, typically taken to be between the ground and a height of some 2 metres above ground.
Health Effects	Effects on the health of people from exposure to a contaminant.
Hot Strip Mill	Processes slabs from the Steel Plant into hot rolled coils and plate for further processing. This process is part of the Rolling Mills.
Iron Plant	Where NZ Steel manufactures molten iron from the raw materials such as primary concentrate, coal and limestone. This plant includes the MHFs, Kilns, Melters and their associated Cogeneration facilities.
Investigation Trigger Level	The Air Permit specifies a 24-hour average concentration of TSP or PM_{10} referred to by NZ Steel as the Investigation Trigger Level. If ambient concentrations measured at a continuous monitoring station established under the Air Permit exceed this level, NZ Steel will investigate the cause of the exceedance. If the cause is determined to be attributable to NZ Steel's activities, action shall be taken to reduce the discharge from the activity.

Term	Meaning
Klockner Oxygen Blown Maxhutte (KOBM)/ Oxygen Steel Making Furnace	Vessel within which molten iron and scrap steel is turned into liquid steel.
Ladle Metallurgical Furnace (LMF)	Similar to the ladle treatment stations, produces alumina free steel for use at the Billet Caster. Additional heat is supplied by electricity. The LMF is in the Steel Plant.
Ladle Treatment Stations (LTS)	A station where ferro-alloy additions are made to the ladle of steel to bring the steel to composition required for slab casting. The LTS is in the Steel Plant.
Main Air Permit	The “main” air discharge permit, which was granted on 29 November 2006 and authorises discharges to air from the production of iron and steel and associated activities (Auckland Council reference DIS80296529 [NRSI-14317]).
Managing Risk and Safety (MARS)	NZ Steel’s system for recording and reporting safety, environmental and related information.
Material Recovery Plant	Where NZ Steel subsidiary Steelserv Limited process co-product/slag from the iron and steelmaking process to produce aggregates. Processing involves crushing and screening.
Metal Coating Line	The line cleans, anneals, coats and surface treat the steel in a continuous operation. This line is a component of the Finishing Plants.
Mill scale	Iron oxide generated on the surface of the steel during cooling of slabs. This is removed in the Rolling Mills (and can be reused as a process additive for some steel products).
Multi hearth furnace (MHF)	The first process in the Iron Plant, which raises the temperature of the raw materials (primary concentrate and coal) to 900°C and removes volatile compounds from the coal.
Nitrogen dioxide	Nitrogen dioxide is an acidic gas produced by combustion of fuel in air.
Off-gas / Waste gas	Gas generated as a by-product from a chemical process.
Operational Area	Area within the wider NZ Steel landholdings that is used for Steel Mill operations. This area does not include areas that are farmed, or the area currently used as a landfill for waste materials generated at the Site.

Term	Meaning
Paint Line	The Paint Line applies paint or laminate to coils of hot-dipped galvanised, Zincalume® and cold rolled steel in continuous coil-to-coil operation to produce Colorsteel®. The Paint Line is in the Finishing Plants.
Particulate Matter/ Total suspended particulate	Mixture of solid particles and liquid droplets found in the air, ranging in diameter from 10 to 50 µm (microns). Reference to fine particulates which can be inhaled are 10 microns or less (PM10) and 2.5 micron or less (PM2.5).
Pickle Line	A series of pickling tanks containing hydrochloric acid solutions and wash water that removes the fine layer of iron oxide scale that is generated during hot rolling and produces a strip surface suitable for cold rolling. This process is part of the Rolling Mills.
Plating/Iron Plating	Process whereby molten iron is poured into pits to solidify.
Point source	A point source is an identifiable stationary source of air pollution that emits air contaminants through a stack or vent.
Point source emissions	Emissions from stacks and chimneys, so not diffuse like fugitive or non-point source emissions.
Polycyclic Aromatic Hydrocarbons (PAHs)	Compounds with a molecular structure of multiple aromatic rings consisting of only carbon and hydrogen atoms.
Primary concentrate (PC)	Iron sand (from the west coast of the North Island) that has been through a separation processes (magnetic/gravity) to increase the iron content and reduce any mineral impurities.
Primary Plants	Consists of the Iron Plant, Steel Plant and associated raw material handling operations. The MHF and Kilns cogeneration facilities
Prime Line	The process equipment in the Paint Line where primer coatings are applied to the steel coil. Discharges from this process are via the Prime Oven Incinerator Stack.
Receiving Environment	The environment that would exist without the activities and associated effects authorised by the expiring consents (i.e., removing the effects that arise as a result of current operations).

Term	Meaning
Recoil Line	Processes coil by uncoiling and removing off-gauge material, side trimming, slitting to width for customer requirements, inspecting, oiling and recoiling. This process is part of the Rolling Mills.
Reduced Primary Concentrate and Char (RPCC)	The Kilns convert pre-heated primary concentrate and char mixture from the MHFs to metallic iron by chemical reduction to produce RPCC. RPCC is then discharged from the Kilns to closed transfer vessels for delivery to the Melters. Note RPCC consists of: • prime RPCC, which is RPCC that meets the specification for further processing at the Melters; • off-specification RPCC, which is RPCC that does not contain sufficient iron content for further processing; and • accretion RPCC, which is a boulder-like build up that must be removed from the Kilns.
Rolling Mills	The Rolling Mills consist of a hot and cold rolling mill and associated facilities to mechanically form steel slab into flat product.
Roughing Mill	Reversing mill with attached edger that flattens the steel slab to between 18 mm and 32mm and coils. This process is part of the Rolling Mills.
Reversing Mill	Reduces the gauge of the coil by passing it through the reversing mill in one direction, recoiling, and then passing it through the mill in the reverse direction. Between five and seven passes are made. This process is part of the Rolling Mills.
Scrubber	Scrubber systems are air pollution control devices remove particulates and/or gases from industrial exhaust streams through the spraying of a scrubbing solution through the gas stream (wet scrubbers).
Sensitive receptor	Locations where people may be present all times of the day, both indoors and outdoors and may include people of high sensitivity (such as children and the elderly). Sensitive land uses include, but are not limited to, hospitals, schools, childcare facilities, rest homes, marae, residential dwellings and recreation spaces.
Shear Line	Receives cold rolled, annealed and temper rolled coil which it levels, cuts to length, oils, piles and packs for dispatch as flat sheet. This process is part of the Cold Strip Mill in the Rolling Mills.

Term	Meaning
Site	All NZ Steel landholdings in relation to the Steel Mill at Glenbrook.
Skin Pass Mill	Hot rolled coils are processed to correct shape and improve surface finish. Export coils get sprayed with oil to prevent rust. This process is part of the Hot Strip Mill in the Rolling Mills.
Slab Reheating Furnace	This facility raises the temperature of slabs using a natural gas fuelled furnace. This process is part of the Hot Strip Mill in the Rolling Mills.
Slag	A co-product of the iron and steel making process that is similar in character to volcanic rock. Slag is a mixture of non-metallic and metallic materials that float on top of the molten iron or steel (removing impurities such as silicon, titanium and sulphur). Melter Slag is a co-product of the iron making process, that is similar in character to volcanic rock. KOBM Slag is a co-product of the steel making process, formed in the KOBM. It has cementitious properties and is used to partly replace limestone on Site. Vanadium Slag is a co-product of the steel making process, formed after oxygen is blown into a ladle of molten iron at the VRU. Steelmaking Slag means both KOBM Slag and Vanadium Slag.
Stack (may also be referred to as vent)	A hollow column or opening used to gaseous and/or particulate matter emissions to atmosphere.
Stack emission testing	Measurement of emissions to air exiting a stack, chimney or vent.
Steel Mill	The integrated iron and steel making facility in Glenbrook and ancillary activities on the Site.
Steel Plant	Where NZ Steel manufactures steel slabs and billets made from iron produced at the Iron Plant.

Term	Meaning
Steelserv Limited	Company that operates large mobile equipment on Site and provides a range of services, including stockpiling and handling of coal, movement of iron lades to the steel plant, slag ladles and bins to the tipping banks, waste and co-products to processing areas. Steelserv also operates the Site landfill and the screening and crushing facilities for production of a range of slag products for direct sale.
Sulphur dioxide	A colourless, soluble acid gas with a characteristic pungent smell. It Is produced through combustion of fuels containing sulphur.
Vanadium	A high-value metallic co-product entrained in slag.
Vanadium Recovery Unit (VRU)	Produces a vanadium rich slag from molten iron prior to steel making in the KOBM.
Waiuku Estuary	The Steel Mill is located on the Eastern bank of the Waiuku River, which, despites its name, is a long and relatively narrow tidal arm (estuary) of the Manukau Harbour. For the avoidance of confusion, the term “Waiuku Estuary” is therefore used in this report to describe this area.
Works debris	A collective term for the debris that can be recovered from around the Site, including the ‘skulls’ (solidified metal that forms on the top of the molten metal in the ladles) and material that is chipped out of the ladles, metal deposits from the floors of the Iron and Steel Plan areas, refractory bricks that are in the KOBM and VRU areas, and other metallic waste materials.
WRF model	The Weather Research and Forecast (WRF) model is a prognostic mesoscale numerical weather prediction model.

Executive summary

This air quality technical assessment has been prepared for New Zealand Steel (NZ Steel) to support a resource consent application to authorise the continued discharge of contaminants into air from the Steel Mill. Its purpose is to assess the air quality effects associated with discharges to air from the continued operation of the Steel Mill, including hazardous air pollutants, odour and dust emissions.

The Steel Mill has been operational at Glenbrook since 1968. It is a fully integrated Steel Mill consisting of the Iron Plant (which converts the raw materials iron sand, limestone and coal to iron), the Steel Making Plant (which converts the iron to steel and then into steel slab and billets), the Rolling Mills (where the cast slab is rolled into coils for further processing) and the Finishing Plants (where a range of metal-coated and colour coated products are produced).

The Steel Mill is located in an area zoned for Business – Heavy Industry and the mill operational area is 190 hectares of a larger 550-hectare landholding, which extends to the north east and south of the operational area and acts as a buffer between the site’s activities and the surrounding farmland and communities. To the west of the Steel Mill is the Waiuku Estuary, which is a long and relatively narrow tidal arm of the Manukau Harbour. The activities with highest sensitivity to emissions air from the Steel Mill include the surrounding rural residents, the closest of which are located approximately 340 m southeast of the easternmost boundary of the Operational Area, and Glenbrook School located 1.6 km east of the site.

The nature of emissions to air from the Steel Mill include those from point sources at the various manufacturing processes and from proposed diesel generators, which are principally particulate, metals, nitrogen oxides, sulphur oxides, hydrogen chloride, chlorine, with trace emissions of polyaromatic hydrocarbons and dioxins. Fugitive emissions from the Site include particulate, and associated metals, from raw materials storage and handling, processing of steel production by-products, truck movements on sealed and unsealed roads; and emissions from slag tipping, commercial iron plating and other contingency operations (process iron plating and RPCC tipping).

The topography of the surrounding area can broadly be described as flat, low-lying coastal terrain. Meteorological monitoring show that wind speeds at the Site tend to be relatively high, with a low frequency of calms (wind speeds less than 0.5 m/s), and a predominance of south-westerly winds blowing inland.

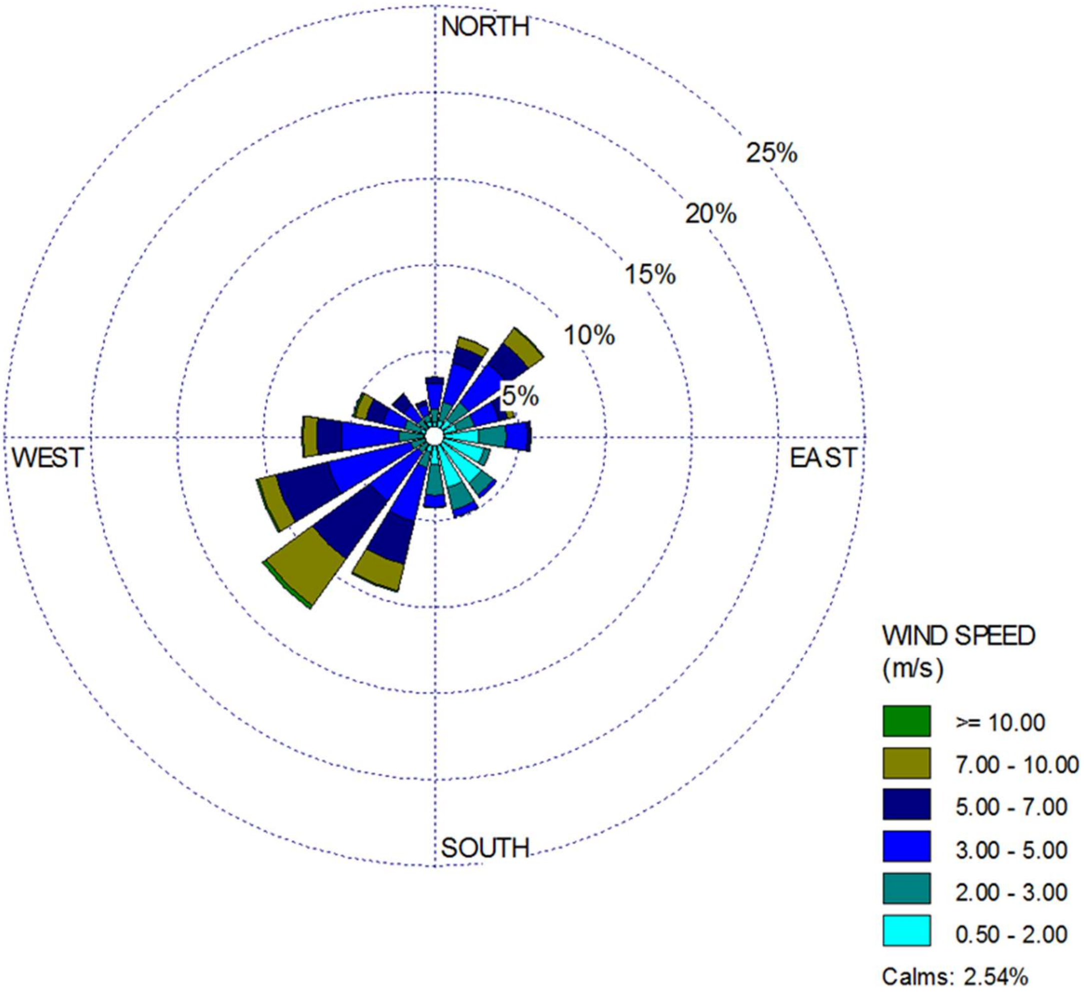

Figure 1.1:NZ Steel Training Centre (Site 3) wind rose (2020) at a 10m mast height

NZ Steel undertakes ambient air quality monitoring at a number of locations and for a range of key contaminants associated with discharges from the Steel Mill. Some of this monitoring is required as a condition of the Main Air Permit (see Section 1.2), however additional monitoring has been undertaken to provide a more complete understanding of the effects of discharges from the Site.

The main contaminants included in the ambient air quality monitoring programme are:

- Particulate – Total suspended particulate (TSP), particulate smaller than ten micron (PM_{10}) and particulate smaller than 2.5 micron ($PM_{2.5}$);
- Sulphur dioxide (SO_2); and
- Oxides of nitrogen – total oxides of nitrogen (NOx), nitric oxide (NO) and nitrogen dioxide (NO_2).

The ambient air quality assessment criteria used to evaluate measured ambient air concentrations and the results of dispersion modelling (where appropriate) is based on the hierarchy set out in Ministry for the Environment Good Practice Guidance[1] (GPG Industry), as follows:

- Ambient air quality standards set in the National Environmental Standards for Air Quality (NESAQ);
- The National Ambient Air Quality Guidelines (AAQG)[2];
- Regional targets such as Auckland Ambient Air Quality Targets (AAAQT) are set within the Auckland Unitary Plan (AUP) (unless more stringent than above criteria);
- World Health Organisation (WHO) air quality guidelines; and
- Where no guidelines are set by those bodies, reference exposure levels developed by the US Environmental Protection Agency or Texas Commission on Environment Quality have been used.

Stack emission testing data collected from key process stacks since 2008 has been used to determine representative stack emission factors for dispersion modelling. NZ Steel's Main Air Permit specifies a testing schedule for the largest stacks to monitor for TSP, carbon monoxide (CO), NO_X and hydrochloric acid (HCl), and in recent years additional monitoring has been undertaken to measure emission rates of SO_2, chlorine (Cl_2) and Volatile Organic Compounds (VOCs) from the relevant processes. Many of the stacks utilise wet scrubbing emission control equipment which makes size speciation of the particulate impossible. However, the size fraction that is PM_{10} and $PM_{2.5}$ has been undertaken at some of the processes that utilise baghouses. Where the size speciated data is not available, all TSP is presumed to be PM_{10} (and all PM_{10} is presumed to be $PM_{2.5}$) for conservative analysis within the dispersion modelling study.

A dispersion modelling study of the main stack emission sources at the Site has been carried out based on three years of meteorological data (2015 to 2017). The three continuous calendar years of meteorological modelling were selected to account for a reasonably wide range of meteorological variability, including consideration of El Niño/La Niña weather patterns.

The main objectives for the dispersion modelling study are to:

- Investigate whether the air quality monitoring locations provide data that is representative of worst-case impacts at sensitive receivers and to provide a basis for inferring likely air concentrations at other (un-monitored) locations if needed;
- Understand the relative impacts of different stack emission sources to measured air quality; and
- Provide a basis for assessing the effects of contaminants where air quality monitoring data is limited, or not available.
- Provide a basis for assessing the additive effects of discharges from the operation of proposed diesel generators.

Ambient monitoring site at 64 Glenbrook Beach Rd (Site 20) is broadly representative of levels experienced at the nearest residences on Reg Bennet Rd, Mission Bush Rd and Glenbrook Beach Rd. The model results suggest there may be slightly higher impacts of stack discharges at residences to the east of the Site, particularly for particulate matter. However, this does not make a material impact on cumulative concentrations of PM_{10} on the worst case days, as the predominant source contribution from the Site is fugitive dust emissions (which are not included in the model).

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[1] Ministry for the Environment. (2016). Good Practice Guide for Assessing Discharges to Air from Industry.

[2] Ministry for the Environment. (2002). Ambient Air Quality Guidelines.

Analysis of the relative contribution of the stacks has shown that the emissions from the point sources associated with the Iron and Steel Plants (as opposed to the Finishing Plant, Rolling Mills or other small ancillary processes) have the most significant point source contribution to all modelled contaminants, with the exception of HCl, Cl_2 and the VOCs, which are largely generated in the Finishing Plant.

The overall performance of the dispersion model has been evaluated by comparing the ranked modelled and measured annual datasets for SO_2 at Glenbrook School and 64 Glenbrook Beach Rd and NO_x at 64 Glenbrook Beach Rd. If the model were a perfect simulation of the interaction of contaminant emissions and local meteorology, the ranked modelled and measured data would show a 1:1 ratio, although this is rarely achieved. Overall, the model performs adequately at predicting 1-hour and 24-hour average concentrations of these pollutants. The model is particularly conservative for 1-hour average SO_2. Ignoring a single day with particularly high 24-hour average NO_2 concentrations, the model only slightly under-predicts the maximum 24-hour average concentrations of both SO_2 and NO_x. Overall, this means that the model can be relied on to predict off-site concentrations of contaminants for which there is no monitoring data..

The dispersion modelling study has been used to predict the air quality effects of CO, mercury, HCl, Cl_2 and VOCs. The predicted levels of these contaminants are shown to comply with all relevant health-based guidelines. A separate dispersion modelling study has been prepared in relation to discharges to air from 19 generators dispersed around the Steel Mill for alternative power supply. The emissions from the generators have been assessed as additive to the measured ambient off site levels for particulate, NO_X, SO_2, and PAHs, and additive to the modelled off site concentration of CO for the operation of the existing site. For all species, the off site concentrations are well below the assessment criteria for human health. Contemporaneous assessment of the modelled ground level PM_{10}/$PM_{2.5}$ concentrations with the background ambient measurements show that peak PM_{10} levels off site do not coincide with the peak off site impacts of generator emissions.

As mentioned above, ambient air quality monitoring has been undertaken for the main contaminants in discharges to air from the Steel Mill. In the case of particulate matter, this monitoring data spans over a decade and for most other contaminants there is at least 2 years monitoring data. This data provides the basis for a comprehensive understanding of air quality in the vicinity of the Site.

The ongoing ambient monitoring programme shows that the ambient levels of $PM_{2.5}$, NO_X and SO_2 at the 64 Glenbrook Beach Rd (Site 20) monitoring site comply with all relevant NZ standards and guidelines. Analysis of the deposition of metals has also found that rooftop drinking water collected at properties in the vicinity of the Steel Mill comply with the NZ Drinking Water Standards. Analysis of TSP filters collected at the NZS Northern Boundary (Site 4B) monitoring site for metals in suspended particulate has found that all metals are well below the long-term air quality criteria.

There are occasional exceedances (around two to four days per year) of the WHO guideline value for 24-hour average SO_2 at the monitoring site at 64 Glenbrook Beach Rd (Site 20). NZ Steel has sought the opinion of a public health specialist[3] (Dr Kelly), which concludes that "*the overall pattern and distribution of the data support a conclusion that exposure to 24 hour average values is consistent with minimal effects*". SO_2 air quality at the Glenbrook School (Site 17) monitoring site is well below the WHO guideline.

The 24-hour average NESAQ value for PM_{10} is periodically exceeded at 64 Glenbrook Beach Rd (Site 20), with a peak of 12 exceedances observed in 2017. These exceedances are observed to occur during the week and during dry conditions with high wind speeds from the direction of the Steel Mill, and hence fugitive sources are likely to be the primary contributor to these measurements

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[3] This is an independent assessment of effects on public health, prepared by Dr Francesca Kelly of Environmental Medicine Limited.

above the NES value. NZ Steel have been undertaking a programme of improvements to reverse the trend and minimise fugitive dust levels including:

- sealing and re-sealing roads and exits;
- installation of fixed water sprays;
- installation of a wheelbath;
- reduction in stockpile heights and volumes;
- fume suppression for molten metal pouring activities; and
- acquisition of new road sweeping plant to clear deposited dust from roadways.

The ambient monitoring programme is ongoing to evaluate the impact of these changes. Dr Kelly's analysis[3] concludes that the effects of infrequent and sporadic exposure to PM_{10} concentrations exceeding the NES value of 50 µg/m^3 as a 24-hour average are minor.

NZ Steel initiated an ambient monitoring programme for dioxins and PAHs at 64 Glenbrook Beach Rd (Site 20) in October 2019. Seven months of valid monitoring data has been collected to date. The reported concentrations are well below the assessment criteria. While all months analysed are representative of summer conditions when ambient levels of dioxin and PAH are lowest, it is not anticipated that the winter levels will approach the assessment criteria.

1 Introduction

1.1 Site overview

NZ Steel is the New Zealand-based subsidiary of Australasian company Bluescope Steel, producing steel slab, billets and a variety of processed steel products. NZ Steel owns and operates a Steel Mill at Mission Bush Road, Glenbrook, which is approximately 40 km south-southwest of Auckland CBD (by direct line of sight). NZ Steel holds resource consents (discharge permits) that authorise the discharge of contaminants to air from the Steel Mill, and this report has been prepared to support a resource consent application to replace those existing discharge permits, which are due to expire.

The operational area ("Operational Area") of the Steel Mill is within a wider landholding these terms are used throughout this report.

The NZS facility is a fully integrated steel mill that converts locally mined iron sand and coal to steel slab and a range of processed steel products. Commercial operations have been undertaken at the Site since 1968 and steel making began in 1970. A five-fold expansion of steel-making capacity occurred in 1986 and the hot and cold rolling mills were commissioned in 1987.

The iron and steel processing operations consist of the Iron Plant (which converts the iron sand and coal to iron), the Steel Plant (which converts the iron to steel and then into steel slab or billet), the Rolling Mills (where the cast slab is rolled to its finished size) and the Finishing Plant (where a range of finished products, including colour coated sheets are produced). A spatial overview of activities at the Steel Mill are shown on **Figure 2.2** and **Figure 2.3** in Section 2.1.

Steelserv Limited (Steelserv), a subsidiary of NZ Steel, conducts a range of ancillary activities related to both raw materials and co-products of the mill operation. Alinta ENZ Limited (Alinta Energy) operate all gas combustion energy cogeneration plants at the Site under the existing discharge permit.

1.2 Consent background

NZ Steel holds two air discharge permits (resource consents) for the Steel Mill, both of which expire on 1 November 2021:

- The "main" air discharge permit, which was granted on 29 November 2006 and authorises discharges to air from the production of iron and steel and associated activities (Auckland Council reference DIS80296529 [NRSI-14317]) ('Main Air Permit'); and
- A separate permit that was granted on 8 October 2020, which authorises discharges to air from commercial iron plating (Auckland Council reference DIS60363772) ('Commercial Iron Plating Air Permit').

Copies of both consents are provided in **Appendix A**. These consents include limits on stack emissions and requirements for ambient monitoring with investigative trigger levels for key contaminants. All stack emissions comply with applicable limits as discussed in Section 4.

NZ Steel also holds an air discharge permit for the operation of a landfill north of the Operational Area (permit 34752). This consent expires in 2033. Discharges to air from these landfilling activities (principally dust) do not form part of this application, however they have been considered with respect to cumulative effects.

An Air Separation Unit (ASU) owned and operated by BOC Ltd is also located on NZ Steel owned land~~.~~ The ASU supplies pipeline oxygen, nitrogen and argon to the Steel Mill for use in the steel making process. This activity is authorised by a separate resource consent and is not within the scope of the current application.

1.3 Report scope and purpose

NZ Steel is seeking replacement consents for the continuation of the discharges authorised by both the Main Air Permit and the Commercial Iron Plating Air Permit. The application is not seeking to authorise any changes in the nature or scale of discharges to air from the site compared to currently consented activities.

This Air Quality Assessment has been prepared to support the Assessment of Effects on the Environment (AEE) report for the application by NZ Steel for replacement resource consents to authorise the continued discharge of contaminants into air from the Site. The relevant reasons for consent and policy direction (objectives and policies) are set out in Assessment of Effects on the Environment (AEE) report. They have been taken into account in the preparation of this assessment. This report has been prepared as a variation to our letter of engagement dated 26 March 2019.

2 Site location and environmental setting

2.1 Site location

The Steel Mill is located at Glenbrook, south of Auckland, as shown in **Figure 2.1**. The Steel Mill borders the eastern shore of the Waiuku Estuary, which is a long and relatively narrow tidal arm of the Manukau Harbour. The Site is in a rural setting and the nearest townships are Waiuku, approximately five kilometres south-west of the Steel Mill, and a settlement at Glenbrook Beach approximately three kilometres to the north. There are two road access points to the Site: via Mission Bush Road and via Glenbrook Beach Road/Glenbrook Road.

The NZ Steel landholding is approximately 550 hectares. Within this, the Steel Mill occupies an operational site area of approximately 190 hectares, indicated on **Figure 2.2**. The wider NZ Steel landholding outside the Operational Area is farmed, with the exception of the area currently used as a landfill for waste materials generated at the site. The wider landholding provides a buffer between the mill activities and the surrounding farmland outside of the Site. **Figure 2.2** shows the boundary of the NZ Steel landholding (in orange, the “Site”) and indicates the location of the main processing areas described in the following sub-sections. Areas within the Operational Area that do not have a shaded activity indicated are used for activities not expected to contribute to discharges to air, such as stormwater ponds.

Figure 2.1: Location plan

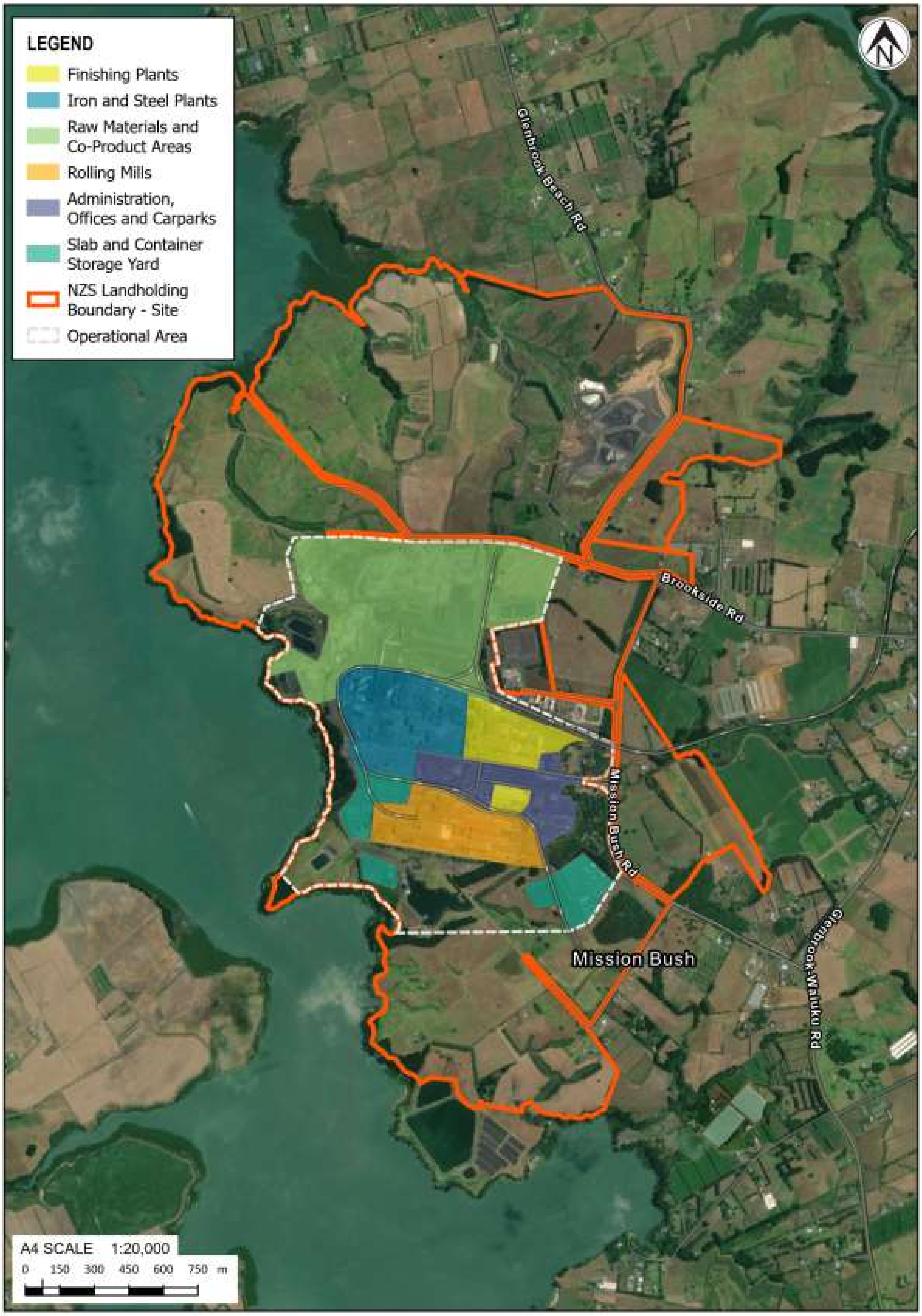

Figure 2.2: Layout of main activities of NZ Steel at the Site

2.2 Receiving environment

The land surrounding the Site is rural in nature, with farming as the main economic activity. NZ Steel also operates a 360-hectare farm surrounding the Site.

Within this rural environment, there are activities that have a relatively higher sensitivity to air quality impacts ('sensitive receptors') compared to farmland, where people are only present intermittently and for relatively short periods of time. The nearest identified sensitive receptors are as follows (see **Figure 2.3**):

- Dispersed rural residential dwellings in the Glenbrook area and at Waipipi on the western side of the Waiuku Inlet. The closest residential dwelling is located approximately 340 m southeast of the Operational Area. The closest dwellings in Waipipi, over the Waiuku Estuary to the west of the Site, are over 1.4 km away.
- Glenbrook School, located approximately 1.3 km to the east and the Wymer Road Rest Home, approximately 3.6 km east of the Steel Mill.
- The township of Waiuku, located approximately 2.3 km to the south and the smaller settlement of Glenbrook Beach, located approximately 3.4 km north of the Site.

Within the AUP, the Steel Mill is zoned as Business – Heavy Industry. The AUP describes that the Business – Heavy Industry Zone provides for large-scale industrial activities, such as the Steel Mill, that may produce objectionable odour, dust and noise emissions. Heavy traffic movements and storage or production of hazardous materials may also occur. A low level of air quality amenity is attributable to these areas[4].

People in industrial areas are typically present for less than 24 hours per day and are not using the area for recreation, worship, education or residential purposes. People who occupy or are located near industrial environments are more likely to tolerate adverse effects on amenity values, as long as the effects are not severe[5] and particularly if the source is associated with their employment or is typical of other industry in the area.

Figure 2.3 identifies the extent of the Site in orange (the Site) and the Operational Area boundary is indicated by a dashed white line. The nearest residences (See **Table 2.1**) and ambient air quality monitoring sites (See Section 2.4) are also illustrated on **Figure 2.3**.

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[4] AUP, Chapter H16.

5 Ministry for the Environment 'Good Practice Guide for Assessing and Managing Odour', 2016

Figure 2.3: NZ Steel landholdings and Steel Mill activities relative to nearest neighbours and ambient air monitoring sites

Table 2.1: Nearby residences and their distances to the Operational Area and Kiln stacks

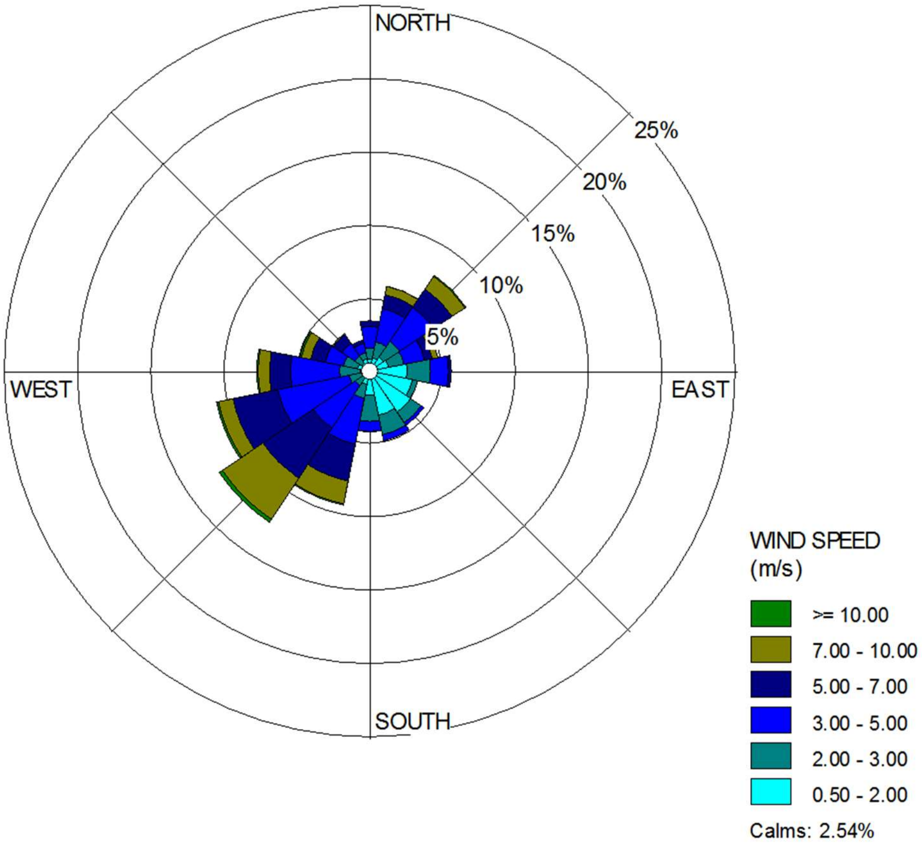
Address	Approximate distance from	
	Operational Area boundary (m)	Kiln stack (m)
60 Mission Bush Rd	415	1635
27 Williams Rd	340	1585
65 Williams Rd	500	1755
190 Mission Bush Rd	500	1150
17 Reg Bennett Rd	725	1440
29 Reg Bennett Rd	765	1485
78 Glenbrook Beach Rd	1070	1815
160 Glenbrook Beach Rd	1255	2000
159 Glenbrook Beach Rd	1190	1925
185 Glenbrook Beach Rd	1265	1995
459 Glenbrook-Waiuku Rd (Glenbrook School)	1320	2270
118 Glenbrook Beach Rd	1275	2030
134 Glenbrook Beach Rd	1235	1990
39 Williams Rd	335	1595
45 Williams Rd	350	1620
65 Williams Rd	420	1675
36C Waitangi Falls Rd	980	2225
122 Glenbrook Beach Rd	1340	2095
194 Waipipi Wharf Rd	1420	2035
203 Waipipi Wharf Rd	1500	2120
198 Mission Bush Rd	560	1265
17 Reg Bennett Rd	670	1465
27 Reg Bennett Rd	640	1480
413B Glenbrook-Waiuku Rd	960	1915
377 Glenbrook-Waiuku Rd	940	1940
127 Brookside Rd	630	1335
17 Reg Bennett Rd	630	1405
190 Mission Bush Rd	430	1215

2.3 Topography and meteorology

The topography of the surrounding area can broadly be described as flat, low-lying coastal terrain and is described in detail in Section 3.2 of **Appendix C**.

Historically, there was a meteorological station installed at the Site, however there are questions over the reliability of the data and therefore it has not been used in this assessment. A new meteorological monitoring station with a 10 m mast has been operated since June 2019 at the NZS Training Centre (Site 3) (see **Figure 2.5** for location).

A wind rose for the first year of data is shown in **Figure 2.4**. The wind patterns observed at the Training Centre are consistent with the dominant on-shore south-westerly airflows on the west coast of the Auckland region. Wind speeds at the Site tend to be relatively high, with a low frequency of calms (wind speeds less than 0.5 m/s). A more detailed discussion of these on-site measurements with longer term meteorological data and the meteorological dataset used for dispersion modelling is set out in **Appendix C**.



NZS Training Centre wind rose (2020)

Calms (wind speed of <0.5 m/s): 2.54%

Average wind speed: 3.74 m/s (wind mast at 10 m)

Figure 2.4: Wind rose for data from on-site meteorological station (NZ Steel Training Centre (Site 3), 2020)

2.4 Existing air quality

Given its rural nature, existing air quality in the area around the Site will be dominated by discharges to air from NZ Steel activities, for all contaminants other than particulate. There are no other appreciable industrial or commercial point sources of air contaminants in the area, however there may be low levels of combustion-related air contaminants from sources such as small-scale combustion equipment, domestic heating emissions (including emissions transported from Waiuku Township), horticultural glasshouse heating emissions, motor vehicle emissions and occasional rural open burning. The very low sulphur content of land transport diesel means that vehicles, including heavy trucks, are unlikely to be a significant background source of SO_2.

Other sources of particulate matter in the area are expected to be non-anthropogenic sources, such as marine aerosols and crustal matter (soil and sand), and dust generated by horticultural and other activities.

NZ Steel undertakes continuous ambient air quality monitoring at five locations in and around the Site (see **Figure 2.5**). The continuous monitoring is for the following key contaminants associated with discharges from the Steel Mill:

- Particulate matter – Total suspended particulate (TSP), PM_{10} and $PM_{2.5}$
- Sulphur dioxide (SO_2)
- Oxides of nitrogen – total oxides of nitrogen (NOx) and nitric oxide (NO) (from which nitrogen dioxide (NO_2) concentrations can be inferred)

Some of this monitoring is required as a condition of both the Main Air Permit and the Commercial Iron Plating Air Permit, however additional monitoring has been undertaken to support this application.

The available ambient air quality monitoring data is summarised in **Table 2.2** and a summary of the data collected in the ambient air monitoring programme is presented in **Appendix E**.

Table 2.2: Ambient monitoring programme

Site name	Site ID	Approximate distance and direction from nearest Operational Area boundary	Contaminant	Start Date	End Date	Period (full years)
Training Centre	3	~0.1 km northeast	TSP	Sept 2008	ongoing	12
			SO_2	March 2017	June 2018	1
NZS Northern Boundary	4B	~1.1 km north northwest	Metals deposition	September 2017	December 2019	2
			Suspended metals and black carbon	June 2018	June 2019	1
Glenbrook School	17	~2.0 km east	PM_{10}	Feb 2007	ongoing	13
		~1.3 km east	SO_2	June 2018	June 2020	2

Site name	Site ID	Approximate distance and direction from nearest Operational Area boundary [a]	Contaminant	Start Date	End Date	Period (full years)
Boundary Road	18	~1.4 km west	TSP	Sept 2008	ongoing	12
			Metals deposition	September 2017	December 2019	2
Sandspit Reserve	19	~2.3 km south	PM_{10}	June 2007	ongoing	13
64 Glenbrook Beach Road	20	~0.6 km northeast	PM_{10}	Dec 2008	ongoing	11
			$PM_{2.5}$	March 2018	February 2021	2
			SO_2	March 2017	June 2020	3
			NO_X	Nov 2018	ongoing	2
			Dioxins/PAH[b]	Dec 2019	February 2021	-
			Metals deposition	September 2017	December 2019	2

Notes:

a Operational Area boundary shown in **Figure 2.5**

b Data is not available for all months in this period.

The ambient air quality monitoring data represents the cumulative concentrations of air contaminants as a result of emissions from the Site including the NZ Steel landfill, along with background sources (both anthropogenic and non-anthropogenic). The term "background concentration" refers to the concentrations of contaminants that would occur in the absence of impacts from the Site.

Background concentrations of combustion products such as SO_2, NOx species and carbon monoxide (CO) will be negligible. Background concentrations of PM_{10} and $PM_{2.5}$ can be estimated from the monitoring data by extracting the measured concentrations at times when the wind is not blowing from the direction of the Steel Mill (see **Appendix E**). This may under-estimate the contribution of marine aerosols, as these sources will impact at the monitoring sites (64 Glenbrook Beach Rd (Site 20) and Glenbrook School (Site 17)) under the same wind conditions that direct emissions from the Steel Mill towards the monitoring sites. Using this approach, the estimated background concentrations of PM_{10} and $PM_{2.5}$ are as follows:

- PM_{10} – 11.3 µg/m^3 (annual average) and 15.2 µg/m^3 (24-hour average)
- $PM_{2.5}$ – 5.0 µg/m^3 (annual average) and 7.7 ug/m^3 (24-hour average)

Figure 2.5: Location of ambient air quality monitoring sites

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3 Description of activities

3.1 Introduction

NZ Steel is the country's sole producer of flat rolled steel products for the building, construction, manufacturing and agricultural industries. The NZ Steel Glenbrook plant is an integrated steel mill that includes the following key processes:

- iron making (conversion of ironsand to liquid iron);
- steel making (conversion of iron to liquid steel);
- casting (solidification of the liquid steel);
- slab rolling (reducing size of blocks); and
- product rolling (finished shapes).

The site also includes a metal coating line and paint lines to produce finished products for sale.

Steelserv Limited (Steelserv), a subsidiary of NZ Steel, conducts a range of ancillary activities related to both raw materials and co-products of the mill operation. Alinta Energy own and operate the cogeneration facilities at the Site, which utilise waste gases from the different processes to generate electricity. The description of activities undertaken at the site includes the activities of NZ Steel, Alinta Energy and Steelserv, all of which will continue to be managed under a single air discharge consent held by NZ Steel.

The following sub-sections describe the main activities at the Site that give rise to discharges to air. A unique identifier is used for each of the main stack emission sources (see **Table 3.1**). The locations of these stacks are shown on **Figure 3.1** below.

Table 3.1: Main stack emission sources and identifiers

Stack	Stack ID
MHF stacks (4)	IP1-IP4
Kilns stacks (4)	IP23-IP26
Metalside Baghouse (2)	IP33-IP34
Slagside Baghouse	IP32
Steel Plant Baghouse	SP4A-SP4F
KOBM Flarestack	SP1
Slab Reheat Furnace	HSM1
Pipe Mill Blowdown Scrubber[a]	PM3
Pipe Mill Galvanising Baghouse[a]	PM2
Pickle Line Scrubber	CSM1
Acid Regeneration Plant Scrubber	CSM3
Primary Concentrate Drier Baghouse	SR1
Paint Line Prime Oven	CCL3
Paint Line Finish Oven	CCL4

Notes:

a. these stacks are associated with the Pipe Mill, which was decommissioned in September 2020.

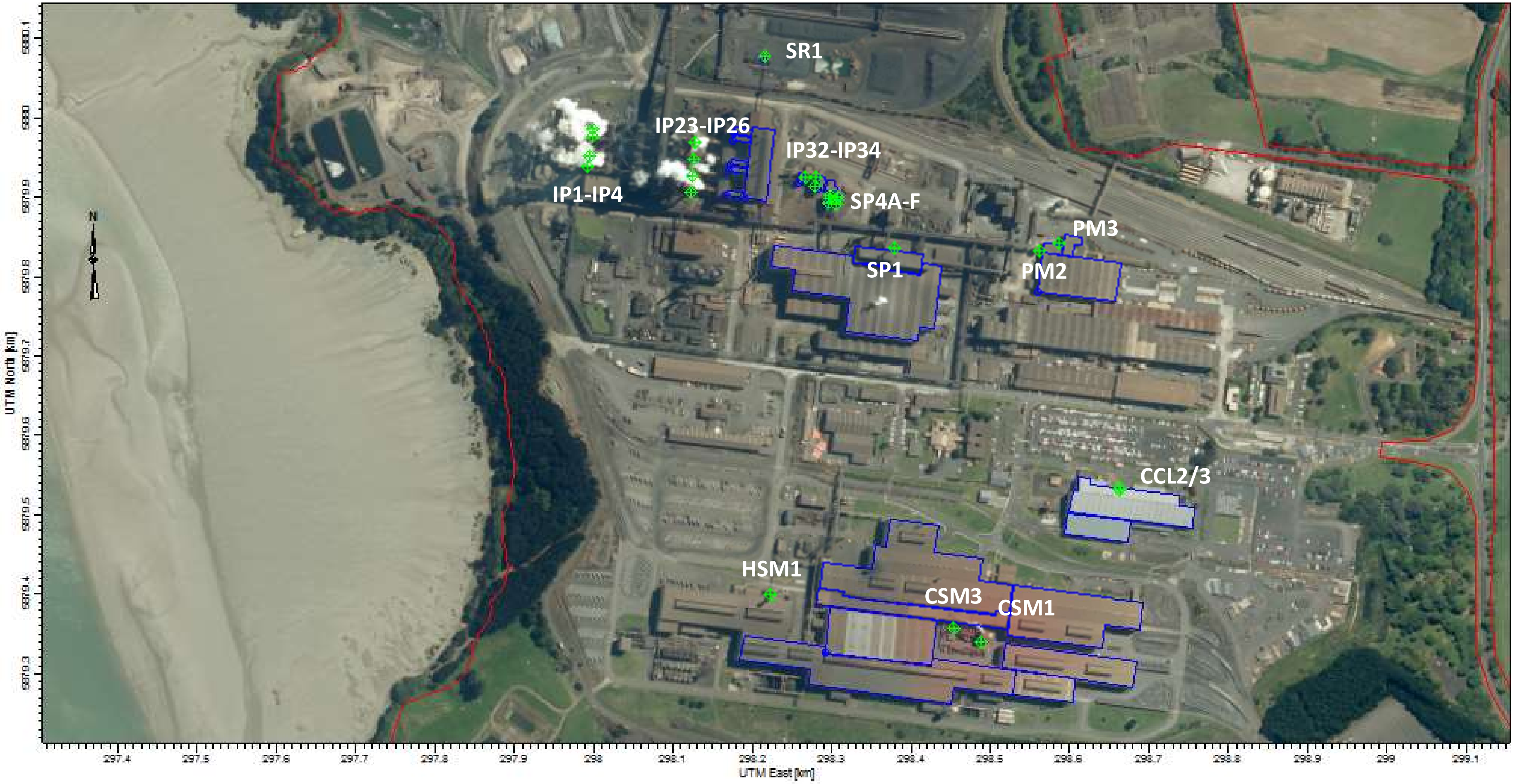

Figure 3.1: Main stack emission sources (green crosses). Note: the blue shapes indicate the buildings included in the model for the purpose of evaluating building downwash effects

3.2 Iron Plant

3.2.1 Overview

The Iron Plant is commonly referred to as the "front end" of the Steel Mill processes. The primary concentrate (concentrated ironsand), coal and limestone are heated and dried in one of four Multi-hearth Furnaces (MHFs). It is then fed into the four reduction Kilns, where it is converted to 80% metallic iron. Two Melters then convert this into molten iron.

The main sources of discharges to air from the Iron Plant are the four stacks on the MHFs (stacks IP1 to IP4) and the four Kiln stacks (stacks IP23 to IP26), which take off-gases from both the Kilns and Melters. Both sets of stacks are approximately 60 m tall (see Figure 3.2) and create a visible steam plume. Along with the Klocker Oxygen Blown Maxhutte (KOBM) Flarestack in the Steel Plant, these stacks are the main sources of combustion products and particulate matter at the Site.

Fume that is generated during metal and slag tapping operations in the Iron Plant is captured and treated through baghouses (IP32, IP33 and IP34) before being discharged to air.

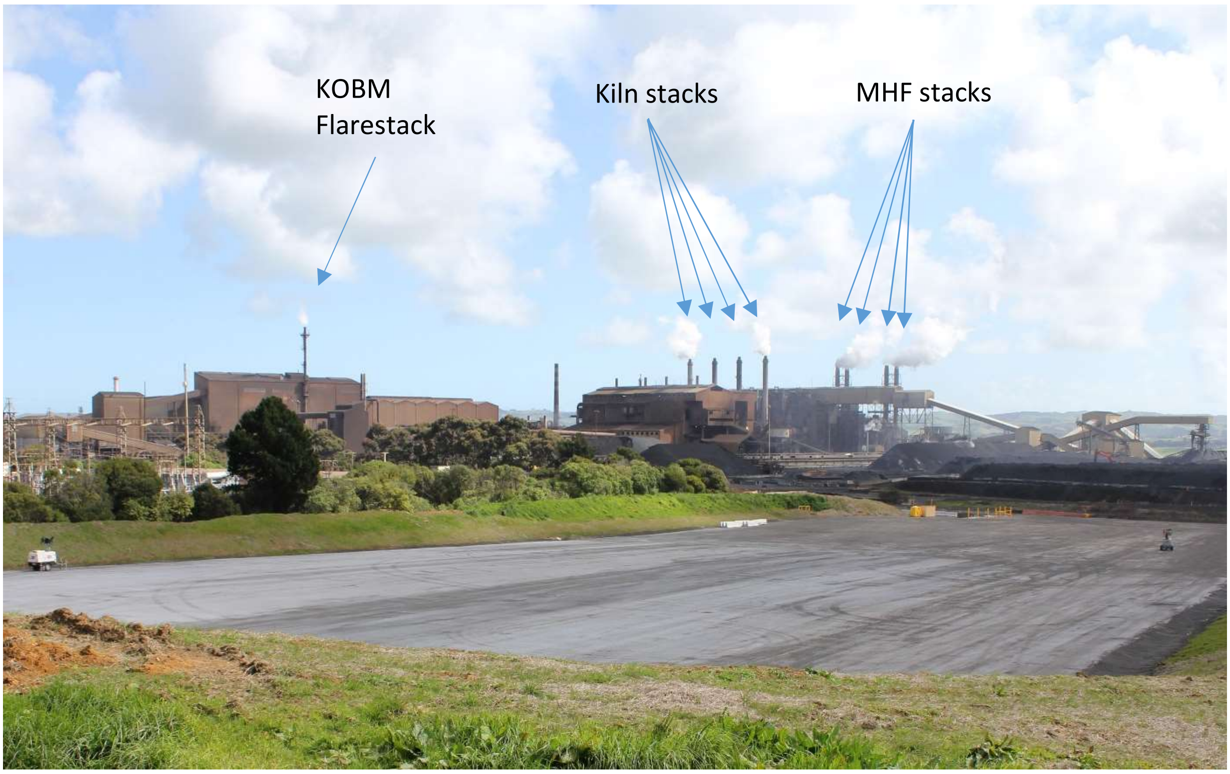

Figure 3.2: Image of Steel Mill showing MHF stacks, Kiln stacks and the KOBM Flarestack

3.2.2 Multihearth Furnaces

The four MHFs are the first process step in the direct reduction of primary concentrate (concentrated ironsand) by coal. The purpose of the MHF is to devolatilise the coal and preheat the kiln feed to around 650°C. Each MHF produces a mixture of hot dry primary concentrate and char (partially burned coal) from a mixture of primary concentrate, blended coal and limestone. Lime-rich slag from the KOBM may be substituted for limestone. Feedrates of coal are typically in the range of 20 to 40 tonnes per hour and of primary concentrate between approximately 30 to 40 tonnes per hour.

Combustion air is introduced to the MHFs to burn the waste gas in a reducing atmosphere to produce heat, with the waste gas flowing up over a series of hearths counter-current to the downward flow of solid feed material. The dry primary concentrate and char is discharged as a granulated material to the MHF pan conveyors for transfer to the kilns. There are minor fugitive dust and gas emissions at the discharge point of each MHF, which are collected and cleaned by the MHF pan conveyor fume extraction system and cleaned in a scrubber before discharge to atmosphere.

The waste gases from each MHF (essentially water vapour, hydrocarbons, nitrogen, soot, carbon dioxide and carbon monoxide) leave each MHF at about 400°C and pass through cyclones to remove coarse particulate matter which is returned to the MHFs. The gases are then combusted at temperatures above 900°C in the afterburners (one for each MHF) to burn off the fine soot particles, carbon monoxide and hydrocarbons released by the coal. The hot gases are then passed through a boiler, to generate steam and electricity. This is the main process route.

The waste heat generated by this process is recovered in a waste gas boiler (owned by Alinta Energy and operated under the terms of the Main Air Permit) and is used for steam and electricity generation. The gas stream is recirculated to the MHFs for attemperation or quenched by water sprays during maintenance of the boiler. The cooled waste gas then passes through a venturi scrubber to remove particulate and two cyclone droplet separators before being discharged to atmosphere via tall stacks known as the MHF stacks. This waste gas cleaning process is shown in **Figure 3.3** below.

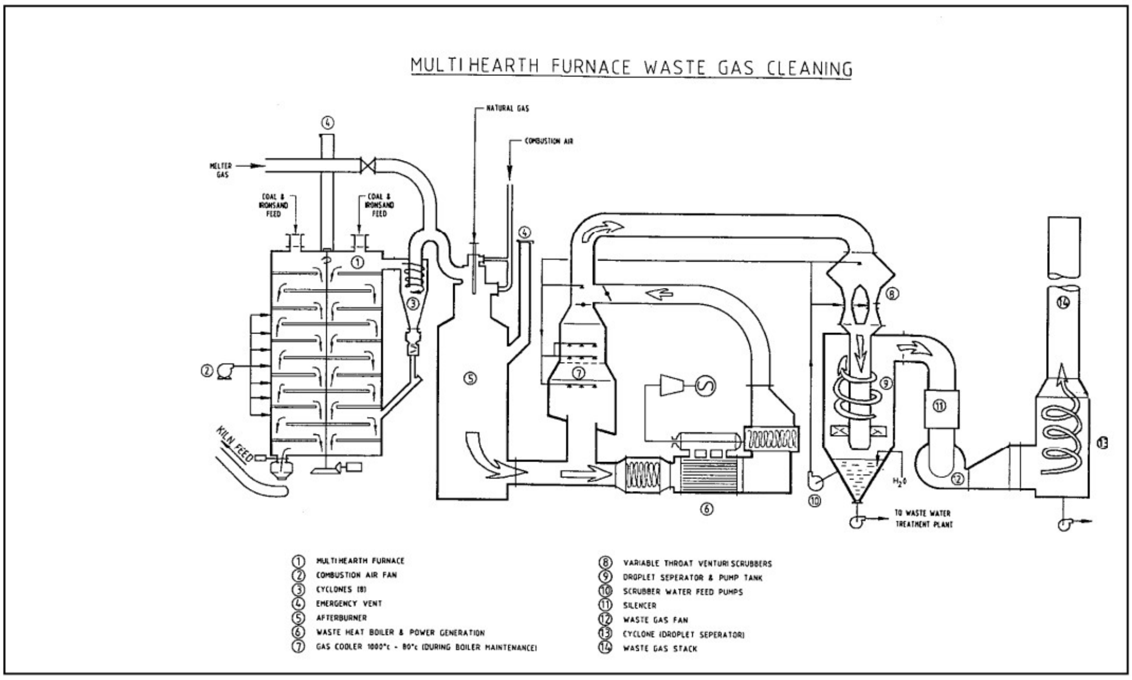

Figure 3.3: MHF waste gas cleaning system schematic

3.2.3 Kilns

The four rotary Kilns convert the preheated primary concentrate and char mixture from the MHFs to metallic iron by chemical reduction. The solids are fed into the Kilns and combustion gas passes counter currently over the solids. In the Kilns' reducing atmosphere, the carbon in the char is oxidised to carbon monoxide and carbon dioxide as the iron is reduced. The resulting product, called Reduced Primary Concentrate and Char (RPCC), is discharged from the Kilns to closed transfer containers for delivery to either the Melters or a 700 tonne buffer storage hopper. The discharge operation is sealed so that gases and dusts cannot escape to the atmosphere. The Kiln buffer storage hopper is equipped with a pollution control system which incorporates a single stage wet gas scrubber. The operation of the scrubber system is interlocked to the operation of the screw conveyors which transfer RPCC from Kiln to the hopper.

The Kiln process is counter-current and the waste gas leaves the system where the raw feed enters, creating potential for the waste gas to entrain fine feed particles. For this reason, a large chamber has been constructed around the Kiln inlet which acts as a drop out chamber. The velocity of the waste gas is lowered and heavy particles drop to the base of the chamber. The collected particles are recycled back to the Kiln feed tube. The treatment schematic is shown in **Figure 3.4** below.

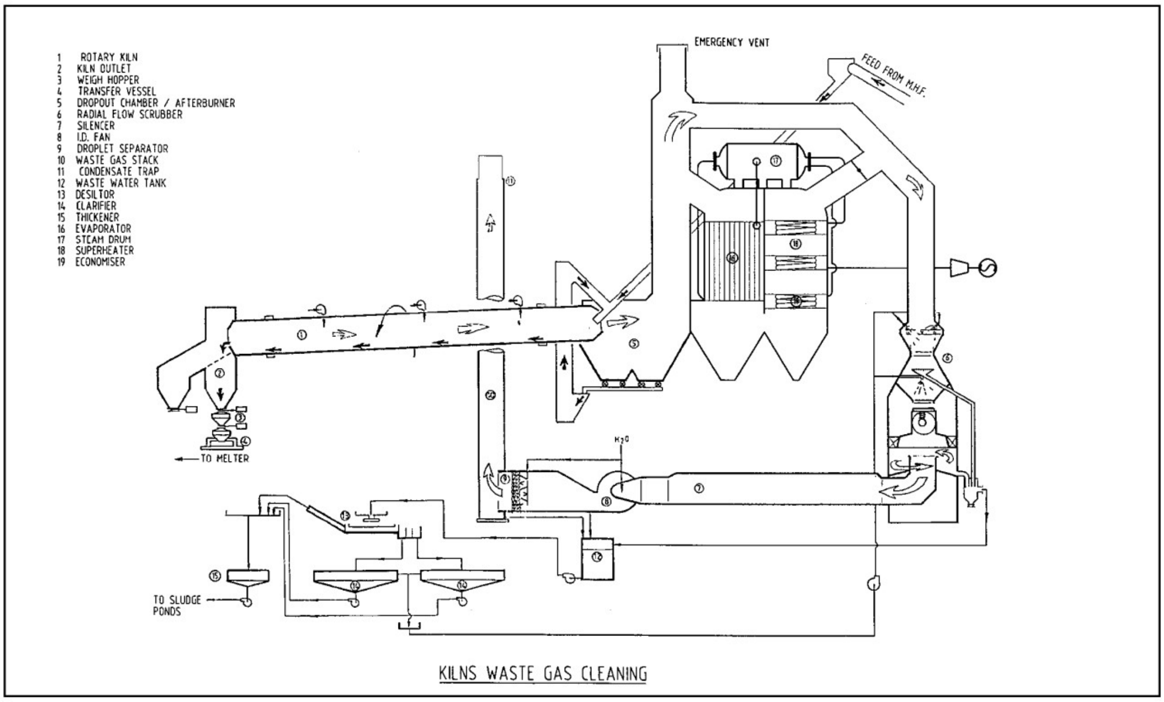

Figure 3.4: Kiln waste gas cleaning system schematic

The Kiln waste gas exiting the drop out chamber is comprised of nitrogen, carbon dioxide, carbon monoxide, hydrocarbons and the remaining fine particulate. This gas is directed to the Cogeneration unit known as the Kilns Cogeneration Plant, described in Section 3.2.5, which discharges to the Kiln's stack. If a boiler in the Kilns Cogeneration Plant has to be serviced, it can be bypassed and the Kilns' waste gas is discharged to the Kilns stack through an afterburner and radial flow scrubber without energy capture. Each afterburner is protected against over-pressure by an emergency vent.

3.2.4 Melters

The two Melters use an electrical current to complete the reduction of RPCC and to melt the solid RPCC (delivered from the Kilns) to produce molten iron and slag. Slag is a mixture of non-metallic and metal oxides that float above the molten iron. The Melters use a semi-batch operation with RPCC being delivered and melted continuously until a certain level of molten metal is reached. The Melter is then "tapped". Slag is tapped into a slag bowl and molten iron is tapped into an iron ladle. Each day approximately 20-34 ladles of hot metal are tapped from each of the two Melters. The molten iron is transferred to the Steel Plant for further processing to steel products (Section 3.4) or plated for commercial sale (Section 3.6.2). The slag is transferred by Steelserv to the slag handling area, where it is poured into pits and allowed to cool before further processing (also described in Section 3.6.2).

In the batch process of filling the Melter charging bins with RPCC, dust laden gas is generated. Each of the 24 charging bins is connected to an extraction duct and the collected gases are passed through a single stage venturi scrubber and dewatering cyclone to remove particulate matter before discharge to atmosphere.

Fume is generated during both metal and slag tapping operations; therefore each Melter has fume extraction both on the metal and slag tapping floors. The metal tapping fume is extracted from three ladle hoods, two iron tap holes, four ducts serving the upper launder area and four ducts serving the lower launder area on each Melter (the launder being the refractory lined channel through which the metal flows from the Melter). The collected gases are cleaned by the metal side bag filter unit before discharging to atmosphere. The slagside system collects fume from hoods over the two slag tapholes. The collected gases are ducted to the slagside bag filter unit before being discharged to atmosphere.

Due to the high temperature in the Melters and the fact that some chemical reduction is occurring, the Melters produce an off-gas which contains a high proportion of CO (> 80%), with the remainder comprised of carbon dioxide, hydrogen gas and nitrogen. This combustible waste gas is extracted and cleaned via a two-stage venturi scrubber and two cyclones. The Melters supply the cleaned gases to the MHF afterburners and Kilns Cogeneration Plant to generate additional electrical power. Surplus gas which is unable to be utilised is discharged via the Melter pressure control system to atmosphere from the flare stacks. The flaring of Melter off-gases is minimised by NZ Steel to optimise energy capture.

There will be small differences in the residual emissions to air from burning the scrubbed Melter off-gases in the flare, compared to burning them in the MHF afterburners or Kilns Cogeneration Plant. This includes differences in the destruction efficiency of the different devices in removing small amounts of organic compounds, such as PAHs, in the Melter off-gases, with open flaring likely to be the least efficient.

Work was undertaken in late 2018 to enable flue gas recirculation at the MHFs. This work included routing Melter gas to the MHF afterburner when it was not able to be utilised in the Kilns Cogeneration plant (typically when one kiln was out for maintenance). This has improved the energy capture of the processes and reduced the total amount of Melter gas flaring.

NZ Steel record the percentage of total Melter gas flared and report monthly to Auckland Council under Condition 22(a) of the Air Permit. Prior to 2018, approximately 25% of the Melter gas produced was flared as a monthly average. Since then, this has reduced to approximately 10% due to improved capacity to utilise the gas at the MHF afterburners.

3.2.5 Kilns Cogeneration Plant

The Kilns Cogeneration Plant was installed in 1997 to capture energy from the Kilns' waste gas. While nominally referred to as the "Kilns" Cogeneration Plant, the waste gas feed is from both the Kilns and the primary off-gas from the Melters. The operation of the Cogeneration Plant is supplemented by natural gas when waste gases are insufficient and additional power generation is required.

The gases are burnt in a separate radiation chamber before entering the super heater and economiser section of the associated boiler. The post-combustion gases from the boiler then pass through a radial flow scrubber prior to discharging to atmosphere via the Kilns stacks.

3.3 Steel Plant

3.3.1 Overview

The molten iron is first treated in the Vanadium Recovery Unit (VRU), where vanadium-rich slag is recovered, before being transferred to the oxygen steelmaking furnace (Klockner Oxygen Blown Maxhutte or KOBM). The KOBM is unusual compared to conventional oxygen steelmaking furnaces used in most steel mills internationally in that it blows oxygen through the bottom of the furnace as well as through a lance inserted from the top (most oxygen steelmaking furnaces are blown only using a lance). The KOBM operates in a batch-wise manner.

The primary off-gases from the KOBM are passed through a two-stage wet scrubbing system and discharged to air via the KOBM flarestack (SP1). For a short time during the oxygen blowing process in the KOBM, the off-gases contain a high concentration of carbon monoxide which is ignited and burnt off. For the rest of the cycle, the scrubbed gas is discharged to air without being burnt.

Fume generated around the KOBM that is not captured in the primary off gas system extracted and treated in the Steel Plant Baghouse (SP4) (sometimes referred to as the KOBM Baghouse). This is a large baghouse that is not fitted with a stack but discharges to air via six louvres on its sides.

The composition of the molten steel is adjusted at the Ladle Treatment Station (LTS) or Ladle Metallurgical Furnace (LMF) (depending on the final product) and then the steel is cast into slab or billets.

3.3.2 Vanadium Recovery Unit

The vanadium slag recovery process is currently carried out in only one of two original VRUs immediately prior to delivery of the molten iron to the KOBM. The second VRU was decommissioned in 1999. Molten iron is transferred from the Melters in a refractory lined charging ladle. On average, two ladles containing approximately 75 tonnes of iron arrive at the VRU every two hours. To maintain temperature a lid is placed on the ladles at the Melters. This is removed before the ladles enter the VRU and replaced after processing to conserve heat.

Vanadium is removed from the hot metal by controlled oxygen blowing over the surface of the hot metal using a top lance. Between 200 and 400 m^3 of oxygen is blown for each heat to oxidise the silicon, titanium and vanadium alloys in the iron. At the VRU, mill scale may be added to the incoming molten iron ladles from the Melters to aid in the recovery of vanadium in the slag. This reduces the volume of oxygen required at this stage, which in turn reduces the amount of waste gas produced at the VRU.

Nitrogen gas is used for stirring the hot metal through a submerged lance during the oxygen blowing for about 15 minutes. A complete treatment cycle takes approximately 30 minutes and the metal leaves VRU at around 1450°C. The resulting slag contains between 20 and 25% vanadium oxide equivalent and is mechanically skimmed and collected for subsequent processing.

During oxygen blowing, waste gas and fumes are produced consisting of air with traces of carbon monoxide, carbon dioxide, iron and other metal oxides. The waste gas and fume from the VRU are extracted via the Steel Plant ventilation system (see Section 3.3.3.3 below) into a water-cooled hood and flows through a knock-out system to remove sparks and large particles in order to protect the bag filter. The gas and fumes are then ducted to the Steel Plant baghouse, where dust is extracted and discharged into bins for disposal, and the treated gas stream is emitted from the six louvres of the unit (described in further detail in Section 3.3.3.3).

3.3.3 Oxygen Steel Making Furnace (KOBM)

3.3.3.1 Overview

The KOBM (steelmaking) converter produces steel by blowing oxygen into a mixture of molten iron and additives. The KOBM (a refractory lined steel vessel) has the capacity to produce batches of up to 80 tonnes of steel with each heat taking around 35 minutes.

As well as molten iron from the iron plant, some waste steel generated within the NZ Steel business is reprocessed by adding it to the KOBM. Examples of this internally produced waste steel (referred to as “steel scrap”) include trimmings of billet or coiled steel, or uncoated bar from the rolling mills at the Pacific Steel facility. The amount of steel scrap consumed in the KOBM is of the order of 70,000 to 80,000 tonnes annually. Periodically minor amounts of post-consumer scrap steel may be reprocessed. This imported steel scrap is relatively free of contaminants (it is estimated that about 1% may be painted). The use of small amounts of scrap steel is unlikely to materially alter the nature of the discharges to air from the KOBM.

The molten iron, together with steel scrap, is charged into the mouth of the KOBM vessel. Oxygen is blown into the metal from a top lance and oxygen and burnt lime are injected through six tubes (tuyeres) located in the bottom of the vessel. This process of blowing oxygen through the molten iron removes the impurities and reduces the carbon content of the iron converting it into steel. Carbon in the iron burns to CO and CO_2, providing the heat to raise the temperature of the steel to about 1600°C.

Once the liquid steel is ready for tapping, the KOBM rotates to allow the steel to be poured into a casting ladle. This ladle is positioned below the tapping stream by a transfer vehicle. After steel tapping, approximately four tonnes of KOBM slag is decanted into a slag ladle where it is tipped into an excavated pit and left to solidify before further processing. The ladle of steel is transferred to one of two LTS where ferro-alloy additions are made to bring the composition up to the required specification for slab casting. The temperature of the steel can also be raised using aluminium wire (as fuel) and oxygen. Following treatment, the ladle is taken by overhead crane to the Continuous Casting machine. Alternatively, if the steel is to be cast into billets rather than slabs, the ladle of steel is transferred from the KOBM to the LMF (see Section 3.3.6) for alloying. If heating is required at the LMF it occurs via use of electricity.

3.3.3.2 Primary off-gas emission control

During the KOBM conversion process, the combustible waste gas is extracted via a water-cooled hood and skirt. This provides a seal to minimise air ingress and loss of waste gas and fume into the building. This extraction is controlled by a pressure control system. The gases flow via a water-cooled duct in the off-gas system that uses two stage wet scrubbing to reduce the gas temperature from approximately 1400°C to around 70°C.

The first stage scrubber consists of a quenching and coarse cleaning stage with a fixed throat medium energy venturi. The second stage consists of a high pressure drop variable throat scrubber designed to remove the fine dust particles associated with the steelmaking process. The open area of the scrubber throat is varied throughout the blowing period in response to pressure signals from the waste gas hood. The remaining suspended water in the gas stream is removed in a high efficiency eliminator.

The gases exhaust to atmosphere through a tall stack incorporating flow measurement and a flare tip referred to as the KOBM flarestack. During approximately 30 percent of the oxygen blowing period the CO rich gases will be flammable and will be ignited at the flare tip. The pilot flare is protected by a flameout system. The stack discharge, after scrubbing and flaring, is mainly water vapour and carbon dioxide.

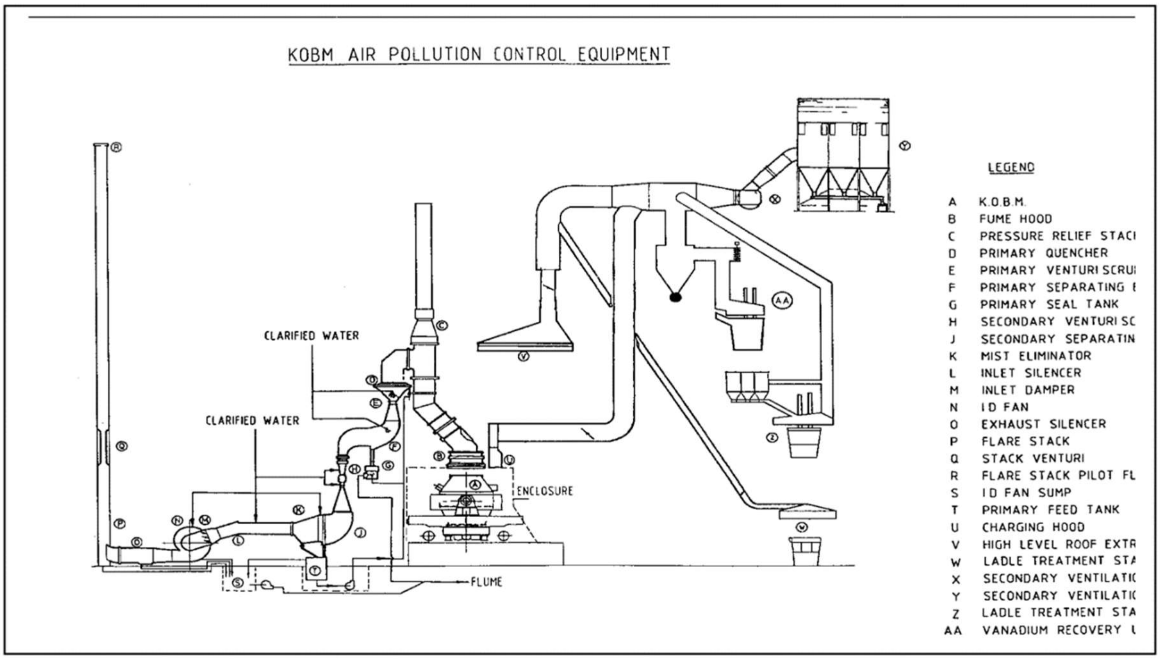

Figure 3.5: KOBM primary off-gas and secondary fume emission control systems schematic

The pressure relief stack (C) for the KOBM vessel shown on Figure 3.5 would open in the event of an explosion in the waste gas system upstream of the scrubbing system. Discharges from this stack are rare and would only occur for a relatively short duration (until the over-pressure has been released).

3.3.3.3 Steel Plant fume emission control

Fume that escapes the primary off gas system and that is generated by tapping is captured by the KOBM enclosure and extracted by the Steel Plant ventilation system. The Steel Plant fume collection system was designed to capture as much fume as possible, at or close to the source of generation. The major sources of fume arise during the extraction of vanadium and during the charging of hot metal to the KOBM.

The Steel Plant ventilation system also extracts fume from other processes where large volumes of oxide fumes are generated. The six extraction hoods in this system are:

- The KOBM charging hood
- The two LTS hoods
- The LMF hood
- The high-level roof extraction hood
- The water-cooled hood of VRU station hood

These collected fumes are passed through the secondary ventilation system, which consists of a positive pressure bag filter (Steel Plant baghouse) prior to discharge to atmosphere (the same unit referenced in Section 3.3.2).

3.3.4 Ladle conditioning

The ladle of steel produced at the KOBM is transferred to either the LTS or the LMF for alloying.

Ferro-alloys are added at the LTS to bring the steel composition to the required specification. Additional heat is provided at the LTS through addition of alumina wire and blown oxygen, which react to raise the temperature of the molten steel.

The function of the LMF is similar to the LTS, however the steel that will be sent to the Billet Caster is required to be alumina free, and therefore temperature control is provided using electricity (rather than aluminium wire/oxygen).

A water-cooled roof covers each ladle and reduces energy losses during arc heating, alloying and other operations as well as minimising the escape of fumes.

3.3.5 Continuous casting

Steel produced via the LTS is cast into slabs in a single strand continuous slab casting machine. After passing through the mould and water-cooling sections of the casting machine, the solidified slab is cut to specification length by automatic oxygen and natural gas torches. The slabs are then transferred to the cooling table and subsequently transported to the storage yard, prior to processing at the Rolling Mills.

3.3.6 Billet casting

The Billet Caster is a mould machine capable of casting square billets up to 11 m in length. The machine has a ladle turret, a refractory-lined tundish which the steel is discharged into via a ladle gate at the base of the ladle and an oscillating water cooled copper mould to form the steel strands. The system uses natural gas to cut the billet.

The steel billets are not processed further on Site, but instead are sent to Pacific Steel in Otahuhu, where they are manufactured into rod wire and bar.

3.4 Rolling Mills

3.4.1 Overview

The Rolling Mills consist of a hot and cold rolling mill and associated facilities that roll the steel slab into flat product. All of the steel slabs are processed via the hot rolling mills to produce coils. The main source of emissions to air at the Hot Strip Mill is the Slab Reheat Furnace Stack (HSM1), which discharges combustion gases after the heat has been recovered in the waste heat boiler.

A portion of the hot rolled coils are further processed at the Pickle Line in the Cold Strip Mill, and some of the remaining coils are processed in the Skin Pass Mill for customer orders. The balance of the hot rolled coils are processed into sheet and light plate.

The Cold Strip Mill is comprised of a Pickle Line, a cold reversing mill (six rolls), a reversing combination cold and temper mill (four rolls), and three annealing furnaces. Other facilities include a recoil line, a shear line, and dispatch facilities. Hydrochloric acid (HCl) solution is used to clean metal oxides from the steel at the Pickle Line. The Pickle Line Scrubber (CSM1) and the scrubber on the Acid Regeneration Plant (CSM3), where spent HCl is regenerated for re-use, are sources of HCl and Cl_2 emissions. Where oil is spray-applied to the metal at the Skin Pass Mill, at the end of the Pickle Line and the Reversing and Combination Mills, oil droplets are removed from the air streams by mist eliminators. These work by passing the air through a lattice of baffles causing the droplets to collect on the blades and drain back to the system. The function of a chevron-type mist eliminator is shown in Figure 3.6.

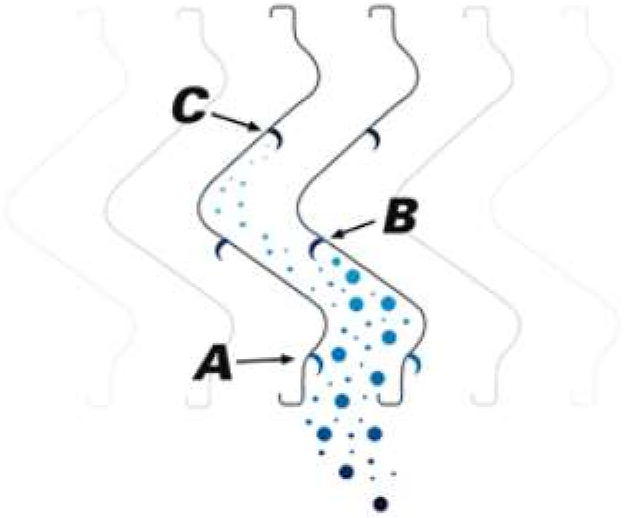

Figure 3.6: Example of a chevron-shaped mist eliminator for cleaning of oil mists from spray booth discharges. The centrifugal force from changes in flow direction and direct impact with the walls results in high recovery of oils.

3.4.2 Hot Strip Mill

The Hot Strip Mill processes slabs from the Steel Plant into hot rolled coils and plate for further processing in the adjacent Hot Skin Pass Mill, Cold Rolling Mills and Hot Rolled Cut-Up Line.

3.4.2.1 Slab Reheat Furnace

The slabs, up to 7.5 metres in length and weighing up to 20 tonnes, are fed into the first stage of the Hot Strip Mill – the natural gas-fired Slab Reheat Furnace. After heating to a rolling temperature of approximately 1250°C, the slabs are passed through a high pressure water spray to remove oxide scale and conveyed to a roughing mill. Hot combustion gas (mainly carbon dioxide, steam, nitrogen oxides, air) from the Slab Reheat Furnace goes through a recuperator to preheat the combustion air for the gas burners. The combustion air is then passed through a waste heat boiler (operated by Alinta Energy) to generate steam for the Site, and is finally discharged to atmosphere via the Slab Reheat Furnace stack.

In 2018, a new 10 MW natural gas burner was installed as an alternative heat source for the waste heat boiler, to produce steam for electricity. The natural gas burner is intended to be used intermittently; typically, during periods of high spot electricity prices, offsetting imported power during peak maximum demand periods, and as an alternate source of site steam when the MHF Cogen Plant is unable to export steam (either planned or unplanned).

3.4.2.2 Roughing, Finishing and Skin Pass mills

The reheated slabs are reduced in thickness to plates at the Roughing and Finishing Mills.

- The Roughing Mill reduces the slab thickness through multiple passes backwards and forwards over the mills and coiled in a coil box prior to further reductions in the Finishing Mill. Heavy plates up to 50 mm thick are produced by rolling to thickness in the roughing mill and finishing mill, by-passing the coil box and down coiler. The plates are gas cut then air-cooled, levelled, inspected and cut to final length.

- At the Finishing Mill, the leading end of the bar is cropped and fed through to further reduce the bar to the required thickness in a single pass. A water-cooling system cools the strip to the correct temperature. The coils are then transferred by conveyors to the hot coil cooling yard. It takes almost four days for the coils to cool to around room temperature before further processing can occur.
- In the Skin Pass Mill, hot rolled coils are processed through a single stand two-high mill to correct shape, improve surface finish and to avoid coil breaks during further processing. The Skin Pass Mill is equipped with an oil spraying booth to protect export coils against rust. The oil spraying booth has a fume extraction system and demister.

3.4.3 Cold Strip Mill

3.4.3.1 Pickle Line

The pickling process removes the fine layer of iron oxide scale that is generated during hot rolling and produces a strip surface suitable for cold rolling. Coils from the Hot Strip Mill are uncoiled and butt-welded to form a continuous strip before entering a series of pickling tanks containing hydrochloric acid solutions and wash water.

Hydrogen chloride fumes from the Pickle Line are collected by hoods over the top of the pickle tank, the rinse tank, the waste acid tank and the waste acid wash tank. The collected fume is scrubbed with water in a packed tower which uses 80% recirculated water and 20% fresh water. The Pickle Line Scrubber blowdown is treated in a waste acid treatment plant before discharging to atmosphere. The excess liquor goes to the weak waste acid system. The cleaned gases pass through a mist eliminator prior to being discharged to atmosphere via a stack.

After rinsing, the strip then proceeds to the line's delivery section where it is dried, edge trimmed to the required width, oiled and recoiled. Orders for hot rolled, pickled and oiled coil for customers are packed at this stage for dispatch. The oiling equipment is equipped with fume extraction hoods and mist eliminators.

3.4.3.2 Reversing and Combination Mills

Coils from the Pickle Line are reduced in thickness at either the Reversing Mill or the Combination Mill, described as follows:

- The six high reversing mill produces feedstock for the Metal Coating Line. The term “six high” refers to the number of rolls used in the process. Strip thickness is continuously measured using an x-ray gauge. The coil is then banded and labelled in readiness for transfer to the Metal Coating Line.
- The Combination Mill is a four high reversing mill that cold rolls pickled coil to the required thickness for annealing. The annealed coil is also rolled at the Combination Mill to customer requirements.
- During rolling at either mill, oil is sprayed on to the strip to provide cooling and lubrication. The spray combined with heat generated by the rolling process produces fumes, which are collected via an extraction hood and passed through a mist eliminator before discharging to air.

3.4.3.3 Recoil and Shear Lines

These facilities provide further forming and shaping of the rolled steel products as follows:

- The Recoil Line is a combination line with slitting, side trimming and recoiling facilities for cold rolled products. Coils are processed by uncoiling and removing off-gauge material, side trimming, slitting to width for customer requirements, inspecting, oiling and recoiling.

- The Shear Line receives cold rolled, annealed and temper-rolled coil which it levels, cuts to length, oils, piles and packs for dispatch as flat sheet. It has two levellers which ensure the sheet is perfectly flat on completion. A gamma-ray thickness gauge identifies off-gauge strip which is removed.

3.4.3.4 Acid Regeneration Plant

An important ancillary plant associated with the Pickle Line is the Acid Regeneration Plant (ARP) in which spent acid is recovered for re-use. Regeneration keeps the HCl consumption to a minimum and produces a high-quality iron oxide co-product.

Waste acid from the Pickle Line passes through a pre-concentrator. It is then sprayed into natural gas fired roasters in which the ferrous chloride is converted to ferrous oxide powder. The oxide from the roaster is pneumatically conveyed to a bag filter unit, where the oxide is collected for later dispatch. From the top of the roasters the HCl rich gas is cooled and saturated in the venturi pre-concentrator and finally enters an absorption column to produce fresh 18 - 20 % HCl which is then returned to the Pickle Line. The waste gas from the absorption column passes through a packed tower equipped with a sodium hydroxide dosing system, to enhance the removal of any residual HCL, before venting to atmosphere through a mesh mist eliminator. The scrubber vent gas contains minor amounts of HCl and chlorine gas.

3.5 Finishing plants

3.5.1 Overview

The Finishing Plants comprise a continuous Metal Coating Line and a Paint Line.

- The Metal Coating Line produces Galvsteel®, Zincalume® coil and flat sheet from full hard cold rolled coil. In the context of the Steel Mill, there are no significant discharges to air from the Metal Coating Line.
- Solvent-based primer and finishing coatings are used in the drying ovens at the Paint Line, which release VOCs when the coating is dried in the ovens. The VOCs in extracted air from the Prime and Finish Ovens are destroyed by incineration before being discharged to air (CCL3 and CCL4).

3.5.2 Metal Coating Line

The steel coil is cleaned, annealed, coated and surface treated in a continuous operation in the Metal Coating Line.

The process begins with the uncoiling and welding of the coils to produce a continuous steel strip. The strip enters a continuous cleaning section where degreasing occurs in a high current density electrolytic cleaner. Hot alkali solutions, roller brushes and hot water sprays remove oils applied during rolling. After rinsing, the strip passes through a hot pickle bath of HCl which removes traces of rust and lightly etches the surface. All the tanks are covered and the fume from the top of the tanks is extracted to a scrubber.

Next, the strip enters the heat treatment furnace where it is subjected to a controlled heating, soaking and cooling cycle. Depending on the grade of product being manufactured, the strip is either stress relieved to produce high strength steel or annealed to produce ductile grades. The furnace atmosphere is controlled by the presence of nitrogen and hydrogen gases. This ensures the strip surface is free of any oxides which would prevent a chemical bond between the steel and zinc.

The metal coating operation is performed by passing the steel strip directly from the exit of the annealing furnace into a bath of either molten zinc or Zincalume® (a mixture of aluminium and zinc). The bath composition is controlled to ensure that optimum coating characteristics are achieved. The strip leaves the bath vertically and passes between air “knives” which wipe off excess metal before it solidifies. Air from the knives is regulated to give the required coating mass on both sides of the strip to meet requirements. The strip is then cooled in a forced air-cooling section before passing through a combination skin pass and levelling process to produce a smooth surface for coating.

Typical hot dip bath galvanising processes produce a white fume that comprises mainly zinc and zinc chloride. Zinc has a low vapour pressure and therefore would not be expected to vaporise to any great extent from the galvanising bath. However, the steel strip is usually cleaned in a degreasing bath prior to dipping and the white fume is caused by mechanical entrainment of zinc in the steam or residual contaminants that are volatilised off the surface of the article. In the Metal Coating Line at the Steel Mill, the steel strip is degreased, rinsed, pickled and heat-treated prior to being coated. The strip passes directly from the annealing furnace into the bath of molten metal and is essentially free of moisture and contaminants. Consequently, unlike a conventional galvanising process, there is no fume created from the bath.

Once levelled, the strip passes through the coating section, where a dilute water-based chromate solution is sprayed to the strip surface to produce a passivation film which protects the coating. Excess spray droplets from the passivation section is collected and passed through a mist eliminator, before discharging to atmosphere. The water component of the film is dried indirectly by two small 60 kW natural gas burners, the active ingredients react with the surface of the steel sheet to provide a corrosion protective layer.

The chromated strip is then fed to a recoiler which rewinds the strip into coils of finished galvanised steel ready for packing and dispatch or for further processing on either a slitting, shearing or Paint Line.

3.5.3 Paint Line

The Paint Line applies paint or laminate to coils of hot-dipped Galvsteel®, Zincalume® and cold rolled steel in a continuous coil-to-coil operation to produce “Colorsteel®”.

At the entry section of the Paint Line, feed coils are uncoiled and joined using a mechanical press called a stitcher. Preparation of the surface for coating takes place in the cleaning and pre-treatment section, which includes mild alkali degreasing, brush scrubbing and a roll on pre-treatment followed by drying in a natural gas fired pre-treatment oven. The combustion gases from this oven are vented directly to atmosphere. The degreasing tank is provided with a fume extraction hood. The fumes, mainly water vapour and hot air, are vented directly to atmosphere.

The site has two Paint Line ovens, one for application of primer and one for the finish coat.

On the ‘Prime Line’, primer is applied to both sides of the strip on a roller coating machine. Paint fumes from the roller coating room are collected via an extraction hood and fan and blown into the drying oven air system. The strip then enters the primer baking oven in which the paint is baked according to a time-temperature criterion appropriate to the particular paint type.

The solvent laden air from the ovens is collected and incinerated to provide the hot air stream for the heat exchangers. The combustion gases from the incinerator are cooled in the heat exchangers and then vented to atmosphere.

On leaving the primer oven, the steel strip is cooled by air jets followed by water sprays. The cooling air is vented directly to atmosphere. The strip then travels to a second roller coating and oven baking operation where the finish coats are applied and baked, known as the 'Finish Line'.

The Paint Line also has a tension-levelling unit, (which enables final correction of shape or any undesirable mechanical properties, which may be present in the coated sheet), a removable film applicator, and a laminator. The laminator applies interior or exterior films as an option to paint finish coatings. The removable film unit applies low tack, clear polyethylene film for temporary protection. Finally, the coil is removed from the main line and may be slit into narrower widths or sheared into sheets.

There are several paint and solvent storage areas and clean up rooms equipped with fume extraction hoods for personnel protection. These vent low levels of solvent fumes directly to atmosphere.

3.6 Ancillary activities

3.6.1 Bulk raw materials storage and handling

The northern portion of the site is used for raw material stockpiling activities, including:

- Receiving and stockpiling Primary Concentrate (iron sand):
  - Primary Concentrate (PC) is pumped as a slurry from the Waikato North Head mine and is dewatered and stockpiled at the Site for use in the iron making process. While the majority is fed directly to the MHFs, Steelserv dries a small volume of the PC in a natural gas fired rotary drier (approximately 1 MW[6]) for direct addition to the Melters in the Iron Plant. As such, the drier has a target outlet temperature of 100°C for the PC. The combustion gases are contacted directly with the wet solids and pass through a baghouse (primary concentrate drier baghouse, SR1) before discharging to atmosphere. The emissions from natural gas combustion include NO_x and CO.
- Receiving and stockpiling coal:
  - Coal is delivered by trains adjacent to the stockpiling areas and discharged from the bottom of the train wagons into a ground-level hopper for transfer to the working stockpile (the supply to the Iron Plant). In addition, domestic and imported coal is delivered by truck and trailer units to the Site and stockpiled. Limestone and KOBM slag are added to the stockpiles to enable efficient separation out of impurities (such as sulphur) as slag in the Melters. Coal is mixed with primary concentrate and transported by a covered conveyor to the MHFs.

3.6.2 Co-product storage and handling

In order to avoid or minimise landfilling, NZ Steel has introduced recovery of a range of iron-rich materials which are generated in the manufacturing facilities. In addition, where co-products are generated in the iron and steelmaking process NZ Steel has developed markets to sell these products. Key activities associated with diversion of materials from landfill and co-product processing for commercial purposes are outlined in this section.

- Tipping molten Ironmaking Slag and processing:
  - Ironmaking slag generated at the Melters is tipped into excavated pits where it is allowed to cool and solidify. Addition of cooling water causes flashing of steam with some entrained particulate. Once the ironmaking slag cools down it is processed to

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[6] Gross heat output based on 2019 gas use of 17,900 GJ of natural gas over 5000 hours of operation.

recover iron and steel for return into the steel making process. Slag is generated at multiple different stages of the iron and steel making, and consequentially varies in composition, with some slags being particularly rich in vanadium (a high value co-product). Reclaimed ironmaking slag is stockpiled for weathering before being broken up further in crushers and by drop-balling. The material is screened and processed to produce a variety of aggregate products for sale. Slag has a medium fines content and is a dense material. However, the slag stockpiles can be very large. See Section 8.3.3 for more detail.

- Tipping molten Steelmaking Slag and processing:
  - In the Steel Plant two forms of slag are produced:
    - Vanadium Slag is raked off the iron ladle (following control oxygen blowing) into skips. After transfer to an area outside of the Steel Plant building the slag is tipped out for cooling. Once cooled it is transferred to the processing areas and then bagged for export sale.
    - KOBM Slag is transferred from the Steel Plant to be tipped into an open pit, to allow for cooling. It is then screened at the Metal Recovery Plant and a significant volume is placed onto the coal stockpiles to supplement purchased limestone as a raw material in the iron making process. The balance is either sold or landfilled.
- Mill scale recovery:
  - Mill scale, which is the term for flaked iron oxide generated on the surface of the steel during the cooling of slabs in the Rolling Mills. Mill scale is stockpiled for later addition in the iron and steel making processes.
- Steel scrap cutting:
  - Scrap steel (see Section 3.3.3.1) is graded, cut to size for recycling in the steelmaking process.
- Tipping and recovery of RPCC:
  - NZ Steel aim to minimise RPCC tipping, however, periodically the RPCC produced at the Kilns cannot be transferred directly to the Melters. In this situation, and because the Kilns cannot easily be stopped, the Kiln output is diverted to a buffer storage hopper fitted with a fume collection system. However, some RPCC tipping cannot be avoided, for example, when the buffer storage hopper is full, when the material is off-specification or when large boulder-like accretions are removed from the Kilns. These materials are cooled in the pits, then recovered, screened and crushed for return to the Iron Plant.
- Tipping molten iron and processing for recovery or sale:
  - Process iron that has been tipped to the plating beds is broken up and returned to the Steel Plant for remelting. Where iron is tipped for commercial plating (authorised in October 2020), the plates are recovered to be sold as a direct product.
- Recovery of works debris at the Metal Recovery Plant (MR Plant)
  - Works debris is a collective term for the debris that can be recovered from around the Primary Plants and consists of ferrous scrap, slag, launder sand, broken refractory brick and other residue from the iron and steel making process. The MR Plant screens crushes and grades these materials works debris to recover the ferrous and grade the remaining product, which may be used as a stabilised aggregate or used in the landfill for forming the cells to receive wet sludges or form the final contour of rehabilitated cells.

3.6.3 Site roads

Another key source of fugitive dusts at the Site are the vehicle access roads. Dust can be generated from vehicle movement on both paved and unpaved roads.

Most roads within the northern area of the site, which are associated with raw materials stockpiling and handling, are unpaved. The southern part of the site contains areas involved in the primary production, rolling, and finishing of steel. Most of these roads are also unpaved, with the exception of some paved roads within the Steel Plant and Melter area, coil storage areas and associated haul roads, and contractor areas.

3.6.4 Landfill

NZ Steel operates a landfill located to the north of the Steel Mill on Glenbrook Beach Road. The discharges to air from the landfill (principally dust) are authorised under a separate resource consent (Permit 34752) and do not form part of this application.

3.6.5 Electricity and heating

~~A~~round 2.2 PJ of natural gas per annum is used at the Site for heating and supplementary electricity generation at various plants and boilers. The largest consumer of gas at the Site is the Slab Reheat Furnace, which uses around 36% of the total, closely followed by the Cogeneration Plant (33%), with a further 10% at the Paint Line ovens. Together these three facilities account for over 75% of the Site’s natural gas use. The discharges to air from natural gas combustion mainly comprise NO_x and CO.

The Site has two emergency back-up generators (4.2 MW combined capacity) located at Building 60, west of the Iron Plant. These can be used when mains power from the grid is not available. Mobile generators are also sometimes used during maintenance to the transformers around Site.

A small 240 kW diesel-fuelled generator is installed at the Northside Outfall. It operates continuously to power water pumps to recycle treated water for dust suppression. Given its small size, and distance of approximately 1.5 km to the eastern boundary, the generator is expected to have a negligible impact off site.

In October 2021, NZ Steel lodged an application[7] to install and operate a number of diesel-fired generators (and to operate the two existing emergency generators for non-emergency supply) with a combined gross heat release of up to 62 MW under an interim short-term consent. The purpose of these generators is to provide NZ Steel with alternative electricity supply options to provide additional resilience for the Steel Mill, including enabling NZ Steel to respond to changes in the electricity market and to maintain continuity of supply where electrical connection is not feasible or when existing transformers are being serviced. It is proposed that the discharges to air from this activity be incorporated into the new main air permit for the Site sought by this application.

New generators will be established (either temporarily or permanently) and operated at seven locations around the Steel Mill. It is anticipated that some (if not all) of the new generators will be leased and brought on and off the Site as needed. Consequently, the rated output and specific model of generator(s) at each location may vary. For the purposes of assessing the effects of the proposed activity, a typical representative scenario has been presented, based on generator models currently available for lease that match the power supply requirements at each location (see Table 3.2). No individual generator will be more than 7 MW total gross heat release.

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[7] Tonkin & Taylor Ltd. Glenbrook Steel Mill – Generators and associated diesel storage. Resource consent application and assessment of effects on the environment. October 2021. (Council reference: BUN60388341)

Table 3.2: Proposed generator locations and sizing

Location ref.	Location	Number of generator units (maximum)	Total gross heat release (MW)	Status
1	Building No.60 (existing emergency generators)	2 (existing)	11.5	Existing
2	P&LP West Product Storage Yard	2	5.6	Proposed
3	Alinta Car Park	8	22.3	Proposed
4	Café Car Park (Southside ITA Catchment)	1	5.8	Proposed
5	North of 6 Hi Bldg	2	5.9	Proposed
6	Northside Outfall	1 (existing)	0.6	Existing
7	Central workshops (Southeast)	1	2.8	Proposed
8	Central workshops (Northwest)	1	2.8	Proposed
9	Metal Coating Line (South)	1	2.8	Proposed
Total	-	19 (3 existing and 16 new)	60.1	-

Preliminary calculations of the total gross heat release using the diesel usage rates and diesel calorific value have shown that the combined total gross heat release for the nine locations listed in the above table is approximately 60 MW. Dispersion modelling was undertaken on the basis of 62 MW of total gross heat release from 20 generators on site, rather than the 19 tabled above. An earlier proposal included two generators at Location 4 with a cumulative heat release of 7.8 MW, instead of the one 5.8 MW generator shown in the table. This change is not expected to materially alter the dispersion modelling results (attached as **Appendix D**).

The proposed generators at each location are expected to be operated on an intermittent basis and may not all operate simultaneously. The locations are indicated on the site plan in Figure 3.7 below.

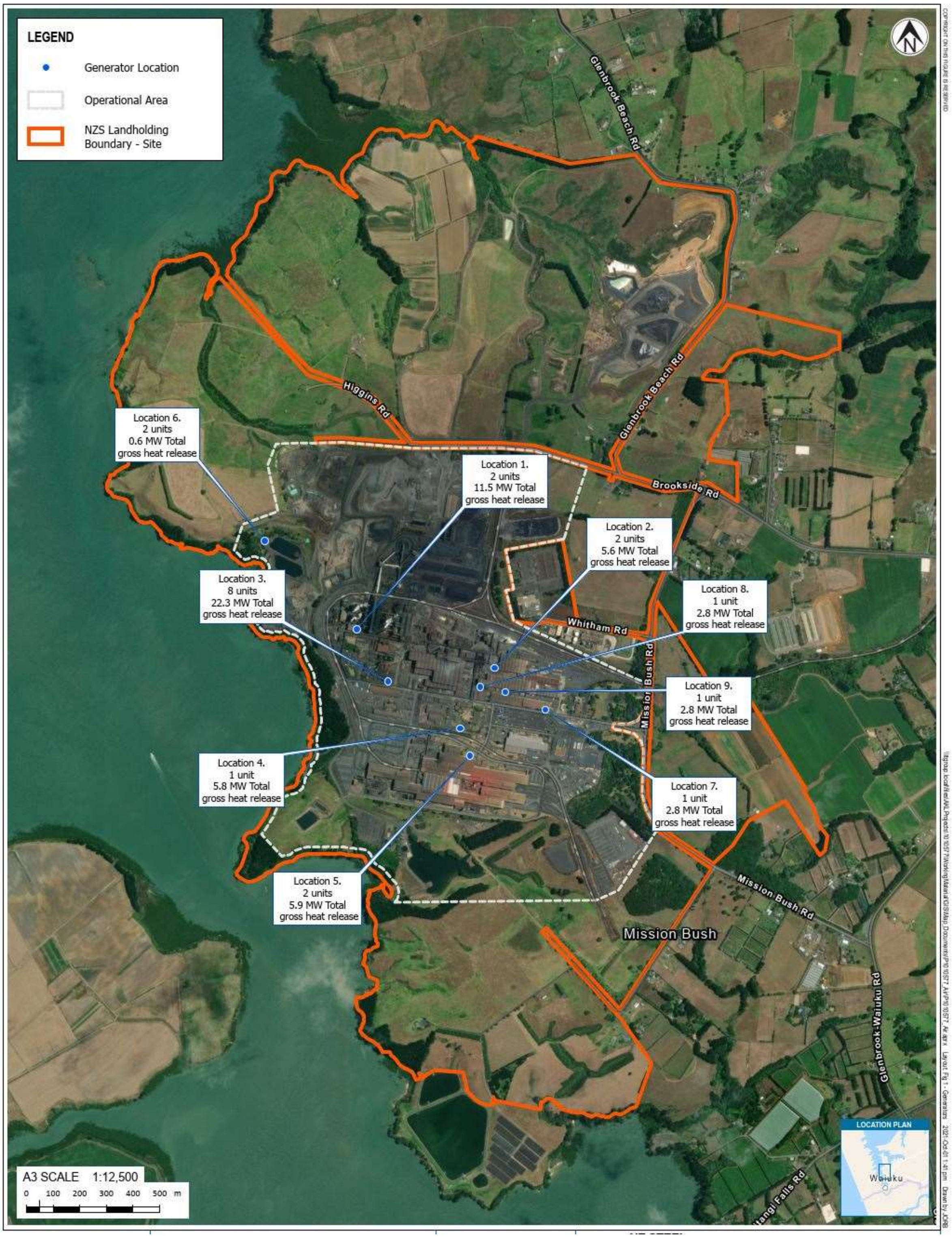

Figure 3.7: Proposed generator locations

3.7 Process changes since Main Air Permit was granted

NZ Steel is applying for a replacement consent to authorise the continuation of discharges to air from the Site. This application is not seeking to authorise any changes to the process or to change the nature or scale of air emissions compared to that authorised by the existing air permits (Main Air Permit and Commercial Iron Plating Air Permit).

For completeness, a description of changes to the process that are of relevance to discharges to air, which have occurred at the Site over the term of the two air permits (or were described in the historical applications for those permits but did not progress and are no longer proposed) are described below.

- Closure of the Pipe Mill:
  - The Pipe Mill (sometimes referred to as the ‘pipe and light plate’ or ‘hollow sections’ plant) was decommissioned in September 2020. The Pipe Mill produced a range of circular, square and rectangular tube products for agricultural, horticultural and structural applications, water reticulation, scaffolding and a variety of other uses.

    Discussion of emissions from the Pipe Mill are included in the stack emissions and dispersion modelling sections of this assessment. This is because the results of the dispersion model are validated using the ambient air quality data recorded by NZ Steel while the Pipe Mill was still a contributing source.
- Vanadium Converter:
  - The application for the Main Air Permit described plans (at that time) to install a process referred to as the Vanadium Converter. This development did not eventuate and is not part of this application.
- Commercial iron plating:
  - In 2020, NZ Steel commenced plating of iron to produce a product for sale, in addition to plating that has always been undertaken in the event of process disruption. The discharges to air from this activity are currently authorised by the separate Commercial Iron Plating Air Permit but will be included in the replacement air permit sought by this application.
- Rolling Mill annealing furnaces:
  - In April 2021, three annealing furnaces will close due to discontinuation of the product manufactured at these facilities.

4 Discharges to air

4.1 Introduction

This section identifies the contaminants of interest and their sources on site.

Where available, this section presents the results of stack emission testing. For the purposes of dispersion modelling, the average and maximum emission rates have been estimated by multiplying the average and maximum measured contaminant concentration by the average volumetric flowrate (see Appendix C of the Dispersion Modelling Study Report attached as **Appendix C** to this report). In some cases, this generates slightly different values to the average and maximum emission rates presented in the graphs in this section. However, these differences are so small that they do not have any effect on the conclusions of the assessment.

The emissions to air from the Site fall into two broad categories:

- Point sources – identifiable stationary sources of contaminant emissions, such as a stack or vent.
- Non-point sources – diffuse or “unconfined” releases of contaminants, such as wind erosion from an open area or stockpile. The terms non-point source and fugitive have been used interchangeably.

The potential effects of these contaminants on human health and relevant assessment criteria are discussed in **Appendix B**.

The addition of diesel-powered generators as alternative sources of electricity at the Site will add to the cumulative discharge of a number of key contaminants, which are also discussed where relevant in Section 4.8.

4.2 Identification of contaminants of interest

The Steel Mill is a large and complex industrial facility that can potentially give rise to a wide range of discharges to air. T+T have undertaken a comprehensive review of contaminants from international literature on steel mills, reviewing this information against more recent published information sources, such as the European “Best Available Techniques Reference Document for Iron and Steel Production”[8]. Based on this review, the key contaminants likely to be present in the discharges to air from the site are presented in **Table 4.1**.

It is noted that the list of metals in **Table 4.1** is not exhaustive and does not include some metals identified in European guidance. Emissions of metals will be related to the composition of raw materials, particularly iron sand and coal, which may differ at the site compared to European steel mills using primarily iron ore as a raw material. For completeness, the assessment has considered a broad suite of metal contaminants and is not restricted to those listed in the table below.

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[8] European Commission's Joint Research Centre (JRC), 2013, “Best Available Techniques (BAT), Reference Document for Iron and Steel Production, Industrial Emissions Directive 2010/75/EU (Integrated Pollution Prevention and Control)”, EUR 25521 EN, Adopted in March 2012 and published in 2013

Table 4.1: Likely emissions to air identified for the Steel Mill (from T+T, 2013)

Process and plants	Product used, transformed and created in the process	Potential contaminants
Raw materials Stockpiling and handling raw materials Vehicle movements	Primary concentrate (iron sand) Limestone Coal Slag	Particulates Metal oxides
Iron Plant MHFs (4) Kilns (4) Melters (2) RPCC tipping	Coal Limestone Primary concentrate RPCC Recovered RPCC and other iron co-products Molten iron Melter slag KOBM slag	Particulates Carbon monoxide (CO) Oxides of sulphur (SO_2 and SO_3) Carbon dioxide (CO_2) Hydrogen Sulphide (H_2S) Nitrogen oxides (NOx) Polycyclic aromatic hydrocarbons (PAHs) Hydrogen (H_2) Trace metals (Al, B, Co, Cu, Cr, Pb, Mg, Mn, Sr, Zn) Potassium (K) Iron (Fe) Polychlorinated dibenzo-p-dioxin and polychlorinated dibenzofuran (dioxins) Water vapour
Steel Plant KOBM VRU LMF LTS Plating Slag tipping Continuous slab caster Billet caster	Molten iron from the Iron Plant Metal scrap Mill scale Additives (e.g. Lime, ferrous silica) KOBM slag Vanadium slag	Particulates Carbon monoxide (CO) Carbon dioxide (CO_2) Oxides of sulphur (SO_2 and SO_3) Hydrogen Sulphide (H_2S) Iron (including Iron Oxide) Trace metals Nitrogen oxides (NOx) Polycyclic aromatic hydrocarbons (PAHs) Metal oxides Iron oxides fumes (plating) Polychlorinated dibenzo-p-dioxin and polychlorinated dibenzofuran (dioxins)
Rolling Mills Hot rolling mills Cold rolling mills Acid Regeneration Plant	Steel slab Oil Hydrochloric acid (HCl)	Particulates Nitrogen oxides (NOx) Calcium ($CaCO_3$, $Ca(HO)_2$, $CaSO_4$, $CaSi_3$) Iron (Fe_2O_3) Carbon dioxide (CO_2) Hydrogen chloride and chlorine (HCl and Cl_2)
Finishing Plants Metal Coating Line Paint Line	Steel sheets Surface treatment products Zinc Resin HCl	Particulates Chromium (Cr) Zinc (Zn) Aluminium (Al) Volatile organic compounds (VOCs) Nitrogen oxides (NOx) Hydrogen chloride and chlorine (HCl and Cl_2) Polychlorinated dibenzo-p-dioxin and polychlorinated dibenzofuran (dioxins)

Process and plants	Product used, transformed and created in the process	Potential contaminants
Ancillary Activities Plating and slag tipping banks Co-product screening and crushing Material recovery plant Waste handling	Molten iron (plate iron) RPCC Molten slag Ferrous scrap Works debris	Particulates Metal oxides
Generators	Diesel	Particulates Nitrogen oxides (NOx) Carbon monoxide (CO) Oxides of sulphur (SO_2 and SO_3) Carbon dioxide (CO_2) Polycyclic aromatic hydrocarbons (PAHs)

4.3 Fine particulate matter (PM_{10} and $PM_{2.5}$)

The particulate matter emissions of interest, with respect to potential for health effects, are those smaller than ten microns in aerodynamic diameter (PM_{10}) and the sub-set of even smaller particles less than 2.5 microns in aerodynamic diameter ($PM_{2.5}$).

Both the Main Air Permit and the Commercial Iron Plating Air Permit require the main stack emission sources of particulate matter to be tested for Total Suspended Particulate (TSP). TSP is a measure of the total concentration of particulate matter in the stack, including particles greater than 10 micron. Testing for TSP is the appropriate method for measuring particulate emissions in wet stacks, however as noted above, the contaminants of interest are the fine components. The performance of each monitored stack against the limit set in the permits for TSP are summarised in **Table 4.2** below.

Table 4.2: Comparison of TSP measurements with consent limits

Stack	Stack ID	Average concentration (mg/m^3)	Maximum concentration (mg/m^3)	Consent limit (mg/m^3)
MHF stacks	IP1-IP4	30.1	61.8	75
Kilns stacks	IP23-IP26	36.9	69.5	75
Metalside Baghouse	IP33-IP34	8.2	29.9	50
Slagside Baghouse	IP32	8.2	23.0	50
Steel Plant Baghouse	SP4A-SP4F	8.3	14.1	N/A
KOBM Flarestack	SP1	112.8	168.7	200 (peak) 160 (annual average)
Slab Reheat Furnace	HSM1	4.3	6.1	N/A
Pipe Mill Blowdown Scrubber[a]	PM3	25.2	52.6	125
Pipe Mill Galvanising Baghouse[a]	PM2	3.1	3.8	10
Acid Regeneration Plant[b]	CSM1	147.1	316.5	N/A

Stack	Stack ID	Average concentration (mg/m^3)	Maximum concentration (mg/m^3)	Consent limit (mg/m^3)
Primary Concentrate Drier Baghouse	SR1	4.7	7.9	125

Notes:

a. these stacks are associated with the Pipe Mill, which was decommissioned in September 2020.

b. Particulate testing at this stack uses non-standard method due to interaction with the acid testing method.

NZ Steel have undertaken additional stack emission testing to determine the size-speciated fractions for the large baghouse sources, specifically PM_{10} emissions from the Steel Plant baghouse and $PM_{2.5}$ emissions from the main baghouse sources (the Steel Plant Baghouse, Melter Metalside Baghouses and Melter Slagside Baghouse). It is not possible to undertake size-speciated testing on the stack emissions that are saturated with water vapour (the MHFs, Kilns and KOBM Flarestack discharges, which are controlled with wet scrubbers). This size-speciated information has mainly been used to determine indicative ratios of PM_{10} or $PM_{2.5}$ to TSP. This ratio can be used to infer $PM_{2.5}$ and PM_{10} emission concentrations from the larger historical TSP monitoring dataset. It has been assumed (probably conservatively) that all of the PM_{10} is present as $PM_{2.5}$.

The mass emission rates of PM_{10} from each of the measured stacks is shown in the box and whisker plot in **Figure 4.1** below, based on the last 12 years of monitoring for TSP and adjusted based on measured or assumed PM_{10}/TSP ratios. This illustrates that the KOBM Flarestack, MHF and Kiln stacks are the main stack sources of PM_{10} emissions at the Site. It has been assumed that all PM_{10} comprises $PM_{2.5}$ and therefore these relative emission rates are also assumed to apply to $PM_{2.5}$.

The emission rate presented for the ARP is based on testing for particulate using a non-standard method. There is some question about the accuracy of the particulate data at the ARP data due to the use of USEPA Method 26A for HCl testing at this source, which may compromise the reliability of USEPA Method 5 test for particulate. The particulate emissions from this stack have conservatively been included in the assessment.

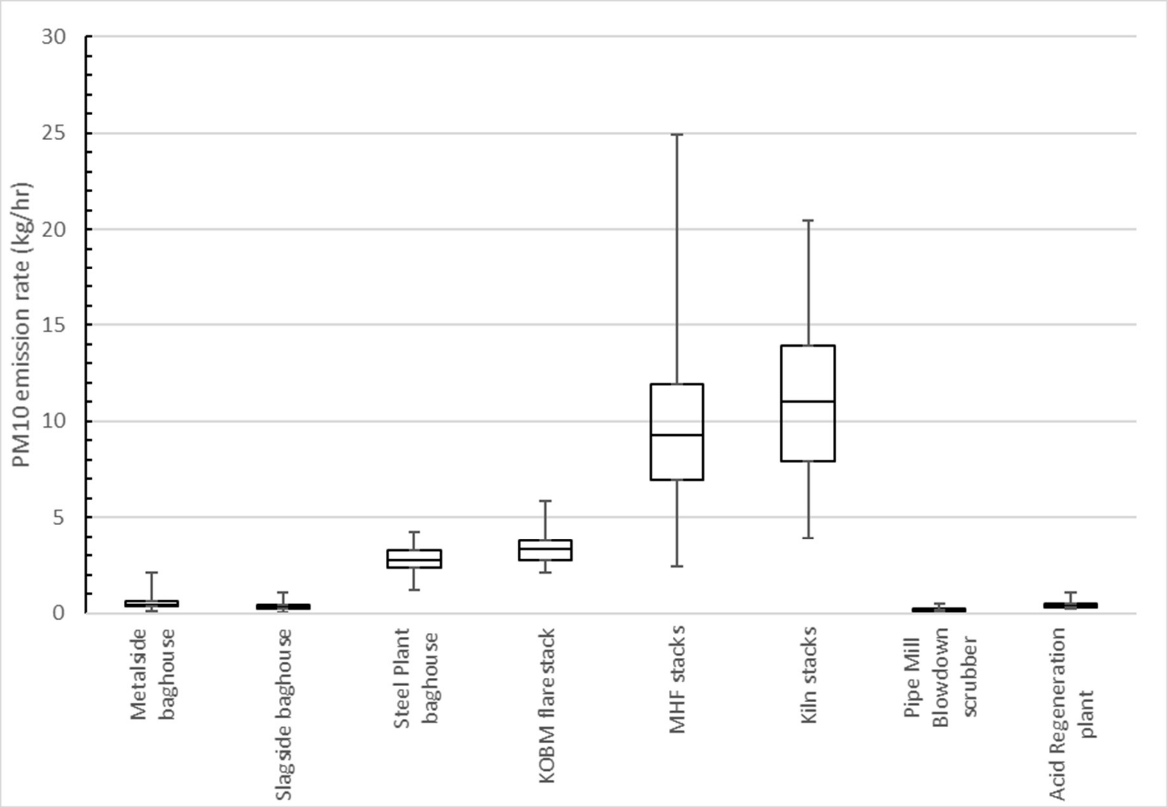

Figure 4.1: PM_{10} emission rates from main stack emission sources

In addition to these stack sources, fugitive dust emissions from raw materials and co-products stockpiling and handling will also contribute to PM_{10} emissions from the Site, as well as heavy vehicle movements on unsealed surfaces around the Site. These fugitive dust sources are discussed in Section 8.3.

4.4 Products of combustion

4.4.1 Summary of main stack emission sources of products of combustion

The products of combustion emitted from each monitored stack are listed in **Table 4.3**. Emission rates of these contaminants are discussed in the following sub-sections.

Table 4.3: Summary of main stack emission sources of products of combustion

Stack	Stack ID	Oxides of nitrogen	Carbon monoxide	Sulphur dioxide
MHF Stacks	IP1-IP4	✓	m	✓
Kiln Stacks	IP23-IP26	✓	✓	✓
KOBM Flarestack	SP1	✓	m	0
Slab Reheat Furnace	HSM1	✓	m	N/A
Paint Line Oven Incinerators	CCL3/CCL4	0	m	N/A

✓ - main source included in stack testing programme

0 - minor source but included in the dispersion modelling for completeness
m – minor source, not included in dispersion model
N/A – not a material source of this contaminant

Other significant combustion sources at the Site include (not an exhaustive list):

- Kilns refractory lining burner for preheating refractory lining replacements;
- Melter feed bin heat-up burner for pre-heating RPCC feed bin refractory to operating temperature after downtime;
- Ladle preheaters at the Melters and Continuous Casting line for maintaining the in-service ladles at operating temperature;
- Torch cutters at the Continuous Casting line;
- Supplementary boiler at the reheat furnace;
- Burner in the Acid Regeneration Plant;
- Paint Line Ovens; and
- Steelserv RPCC Drier.

4.4.2 Oxides of sulphur

Sulphur oxides are produced from the combustion of materials containing coal and therefore SO_2 emissions are a function of the sulphur content of the coal used in the Iron Plant. The stack emissions will contain principally SO_2 but may also contain lesser amounts of sulphur trioxide (SO_3). Recent stack emission measurements for SO_2 (not a requirement of the current air permits) have not included measurement of SO_3, which requires a different test method. There is a paucity of published data on SO_3 emissions from steel mills, however the ratio of SO_3 to total sulphur oxides is expected to be low (< 5%)[9]. NZ Steel has undertaken detailed mass balance calculations for sulphur, taking into account the stack emission testing and the sulphur content in the steel and various waste streams. This mass balance suggests that SO_3 emissions are likely to be minimal.

The main sources of SO_2 are the front-end coal-reduction processes that occur in the Iron Plant; in particular the MHFs, with the Kilns constituting a secondary source. Potential for SO_2 generation is limited by coal-purchasing agreements to use low sulphur coal in the process (<0.5%) per Condition 16 of the Main Air Permit.

SO_2 concentrations from the MHF stacks and Kiln stacks (waste gases from the Kilns and Melters) have been measured on a six-monthly basis since 2017, using a barium-thorin titration method[10]. There are infrequent test results from prior to this period, some collected as early as 2013, measured with a combustion gas analyser.

Six measurements have been taken at the KOBM Flarestack since 2015. Readings of SO_2 are typically very low from this point source, as expected given that the majority of releases are from the Iron Plant processes.

The SO_2 emissions from each MHF and Kiln stack are shown in the box and whisker plot in **Figure 4.2** below.

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[9] Ricardo Energy & Environment. (2016). Continued improvements of inventory methodologies: Task 4.1 Improving the quality of SOx/SO2 estimates and reporting. European Commission

[10] United State Environmental Protection Agency (USEPA) Method 6 for determination of sulphur dioxide emissions from stationary sources

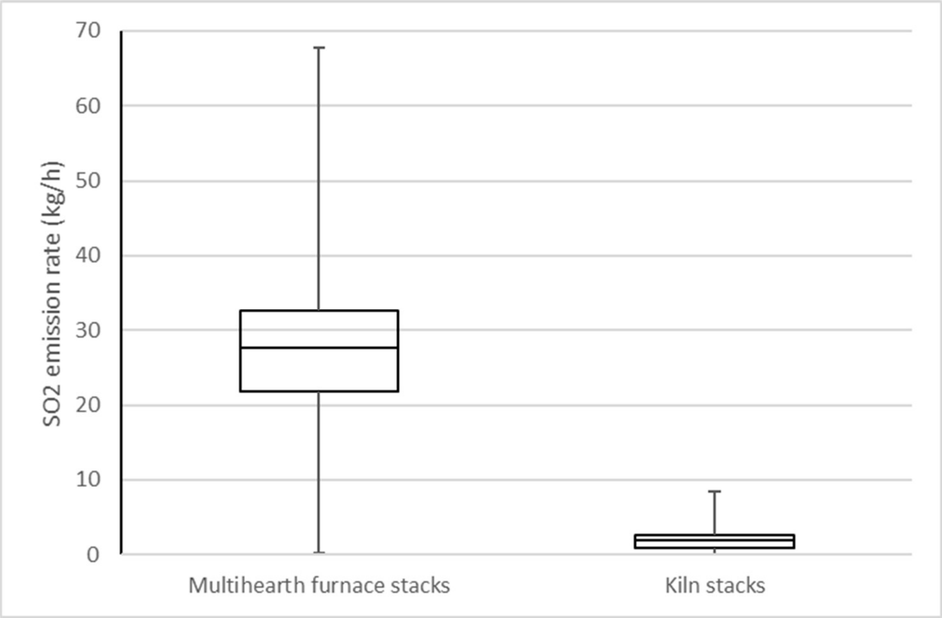

Figure 4.2: SO_2 emission rates from the individual MHF and kiln stacks

4.4.3 Oxides of nitrogen

Nitrogen oxides (NO_X) is a collective term used to refer to nitrogen monoxide (nitric oxide or NO) and nitrogen dioxide (NO_2). NO_X are produced from combustion processes, and can be divided into three paths of formation:

- Thermal NO_X – formed when nitrogen and oxygen in the combustion air combine with one another at high temperature.
- Fuel NO_X - formed by the reaction of nitrogen bound in the fuel with oxygen in the combustion air (it is usually not an issue with gaseous fuels due to low nitrogen content).
- Prompt NO_X - formed from molecular nitrogen in the air combining with fuel in fuel-rich conditions.

The main sources of NO_X emissions at the site are associated with combustion of waste gases in the iron plant, primarily in the four MHF stacks, with the four Kiln stacks and the associated cogeneration plant as a secondary, but still significant, source. Other existing sources of NO_X at the site include various natural gas combustion processes, such as the Slab Reheat Furnace.

The NO_X discharge is largely composed of NO and to a lesser degree the more toxic NO_2. For external combustion appliances, such as the sites furnaces, NO_2 typically comprises 10 % of total NO_X at the discharge point.

Stack testing for NO_X using a combustion gas analyser has been routinely undertaken in the MHF stacks, the Kiln stacks, the KOBM Flarestack (upstream of the flare) and the Slab Reheat Furnace. A non-routine test of the Paint Line Incinerator has also been evaluated for determination of an emission rate. The combustion gas analyser detects NO_X and NO and, for the purposes of this assessment, the balance has been assumed to be NO_2.

Modelled emission rates for the monitored stacks have been derived from the maximum measured NO_X concentration from the stack testing data. Because the maximum values are used, the results are expected to be conservative when assessing against criteria with a long-term averaging period.

Additionally, the post-flare NO_x concentration is not able to be measured by stack testing, but has been estimated using flaring emission factors from USEPA, AP-42, Chapter 13.5, Industrial Flares.

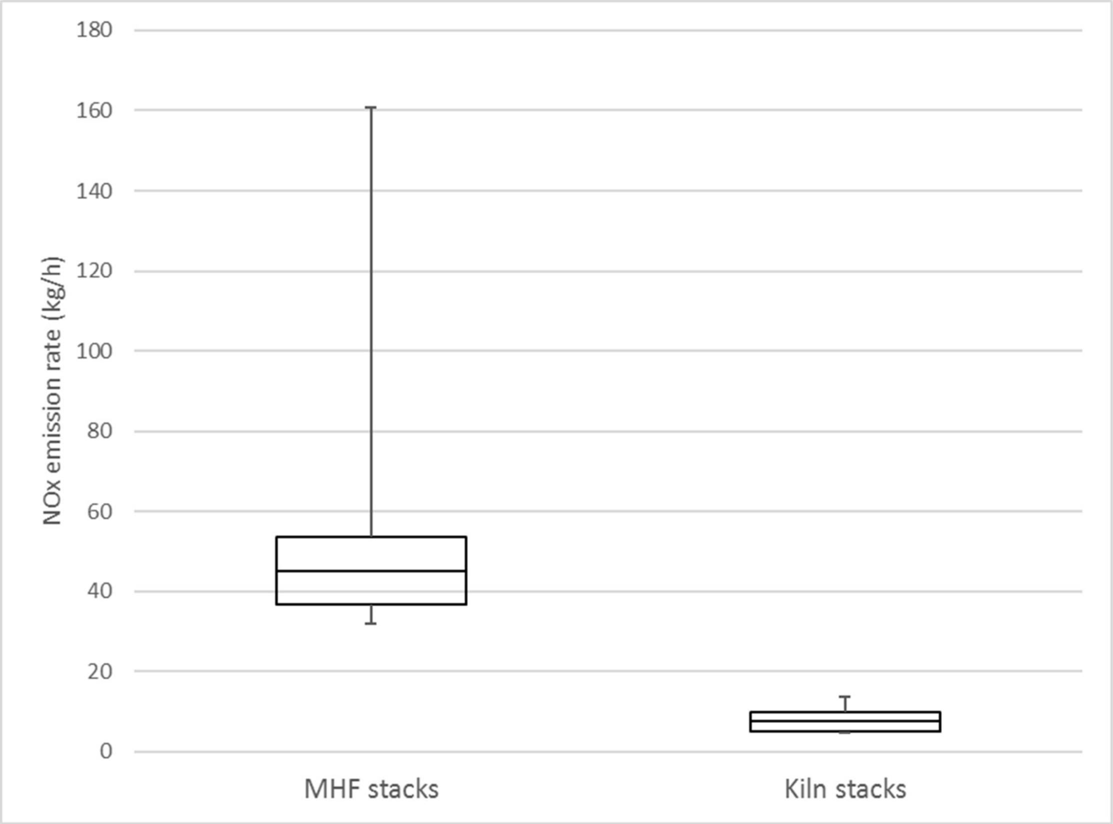

Figure 4.3: NO_X emission rates from the MHF and Kiln stacks.

4.4.4 Carbon monoxide

CO is a component of the waste gas generated at the MHFs, Kilns, Melters and in the KOBM.

Waste gases from the Kilns and Melters, which contain a high proportion of CO from the reduction of the char, are combusted in the Kilns Cogeneration Plant (to recapture energy) and discharged via the Kilns stack. A small amount of Melter waste gas may also be flared via the Melter flare stacks as a pressure control mechanism. CO emissions from the Kiln stacks have been measured by combustion gas analyser as part of the stack testing programme, with 18 test results collected since 2014. The Kiln stacks are considered the most significant mass emission source of CO at the Steel Mill, as there is potential for non-combusted waste gas from the Kilns and Melters to leak at the damper at the boiler inlet. Damper performance is monitored by operators using a combustion gas analyser and the damper on each Kiln is replaced regularly as part of the maintenance schedule.

Waste gases from the MHFs are burnt for energy generation in the MHF afterburners. The different configuration of the older MHF afterburners mean that there is no potential for waste gas to bypass the afterburner for those stacks.

The cleaned waste gas from the KOBM is combusted via the flarestack which is ignited by three pilot flares once the mixture reaches the lower flammability concentration of approximately 12%. Plots of the KOBM waste gas composition during a heat show that the concentration of the waste gas is lower than 12 percent (and therefore venting to atmosphere without combustion) for a negligible amount of time, approximately two 30 second periods in the hour.

The performance of the Kiln stacks monitoring shows consistent compliance with the limit set in the Air Permit as shown in **Table 4.4**.

Table 4.4: Comparison of CO measurements with consent limits

Stack	Stack ID	Concentration (mg/m^3)		
		Average	**Maximum**	**Consent limit**
Kiln stacks	IP23 - IP26	1603	3714	3750

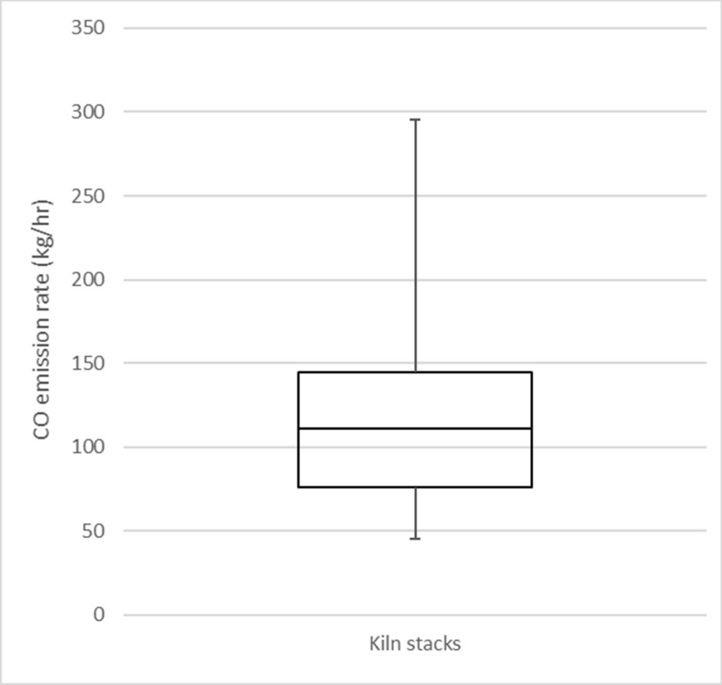

Figure 4.4: CO emission rates for the Kiln stacks (2014-2020).

4.5 Other contaminant discharges from iron and steel processes

4.5.1 Metals

As discussed in Section 4.2, there is a wide range of metals that may be present in discharges to air from the Steel Mill. These metals are naturally occurring in the raw materials used at the site (such as iron sand, coal and limestone) and are typically released as a component of particulate matter in both stack and fugitive emissions.

Stack concentrations of metals are not measured by NZ Steel. The effects of metals emissions (other than mercury) have been assessed based on an ambient monitoring programme that considers metals concentrations in both airborne and deposited particulate matter. Unlike other metals, mercury emission rates can be readily estimated based on the mercury inputs in the raw materials, specifically coal and limestone, and assuming all mercury is volatilised and released from the stacks (see Appendix C Section C1.9). This is a conservative assumption as some of the mercury will be trapped in the air emission control equipment.

Activities at the landfill, which are authorised under a different consent, are also a potential source of metal deposition in the area. There is no practical way to differentiate between metals emissions from the landfill and the main Steel Mill site in the monitoring data.

Combustion of diesel in the generators will produce low levels of metal particulate, however this is not expected to be significant in the context of the Steel Mill activities.

4.5.2 Dioxins and PAHs

The term "dioxins" is used to collectively describe a group of compounds with a similar chemical structure. These compounds belong to three closely related families: the polychlorinated dibenzo-p-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), and certain polychlorinated biphenyls (dioxin-like PCBs). This specific congeners within this group of compounds are distinguished by the number and position of chlorine atoms around the core structure. In total there are 75 possible PCDD congeners and 135 possible PCDF congeners. Of these, only 17 have significant toxicity. When reporting the results of dioxin monitoring the quantities of all congeners are converted to a single Toxic Equivalent (or TEQ) value, which reflects the overall toxicity of the mixture in terms of the most toxic congener; 2,3,7,8-tetrachlorodibenzo-p-dioxin (which, for simplicity is usually referred to as TCDD).

There are few natural sources of dioxins (forest fires and volcanic activity are examples of the few that do exist). Dioxins are generally produced unintentionally as a by-product of some industrial processes and combustion processes.

Dioxins are likely to be emitted from a variety of combustion processes at the Steel Mill. They are also produced from other combustion sources in the general neighbourhood such as domestic fires and motor vehicles. The Dioxin Inventory (MfE, 2014) notes that releases of dioxins from ferrous metal production are due to incomplete combustion of organic material in the primary production processes.

Dioxin emissions factors for NZ Steel in the MfE inventory were estimated using stack test results undertaken in 1995 at MHF3, Kiln3, the KOBM Flarestack, and the Steel Plant Baghouse. The average air emission factor used was 0.134 µg TEQ per tonne of steel produced. Given the uncertainty in this emission factor, assessment of dioxins is based on the ambient monitoring rather than dispersion modelling.

PAHs are compounds naturally occurring in coal (and crude oil and gasoline). They are primarily released as products of incomplete combustion, in the presence of chlorine, and are therefore most likely to be produced in the front end of the Iron Plant where coal is processed. The Steel Mill is expected to be the main source of PAHs in the area, however there may be other small sources of PAHs locally such as local burning of rubbish, and transport emissions. These are expected to be minor.

No stack monitoring for PAHs or dioxins has been undertaken recently, however an ambient monitoring program has been established at the monitoring site at 64 Glenbrook Beach Rd (Site 20) (**Appendix E**) to assess the cumulative effect of the Steel Mill emissions on the surrounding area.

4.6 Contaminant discharges from the Finishing Plants

4.6.1 Hydrogen chloride and chlorine

HCl and Cl_2 emissions are associated with the Pickle Line process where HCl solution is used to clean metal oxides from steel products prior to surface finishing. The spent HCl solution from the Pickle Line is regenerated in the Acid Regeneration Plant (ARP) where the scrubber vent contains residual levels of HCl and Cl_2.

Monitoring has been undertaken at the ARP on a quarterly basis and the Pickle Line scrubber on an annual basis under the current consent. The performance of each monitored stack against the limit set in the Main Air Permit for HCl are summarised in **Table 4.5** below.

Spurious exceedances of the HCl consent limit at the ARP are understood to be caused by droplet carry-over from the scrubber, which is not representative of the actual emissions from the stack[11]. Stack testing at the ARP is carried out upstream of the final pseudo-droplet separator, which coalesces the fine droplets of liquid prior to the final discharge from the stack. The random high emission readings are most likely the result of capturing these droplets prior to their removal at the separator. In any case, the highest reading has been used in the dispersion modelling to evaluate effects.

Table 4.5: Comparison of HCl measurements with consent limits

Stack	Stack ID	Concentration (mg/m^3)		
		Average	Maximum	Consent limit
Acid Regeneration Plant (ARP)	CSM1	21	103	45
Pickle Line scrubber	CSM3	0.8	2	20

The emission rates from the ARP have been presented in a box and whisker plot in **Figure 4.5** below. There are too few data points collected for the Pickle Line scrubber to present a meaningful plot, however notably the results for the Pickle Line scrubber are far lower than those measured at the ARP.

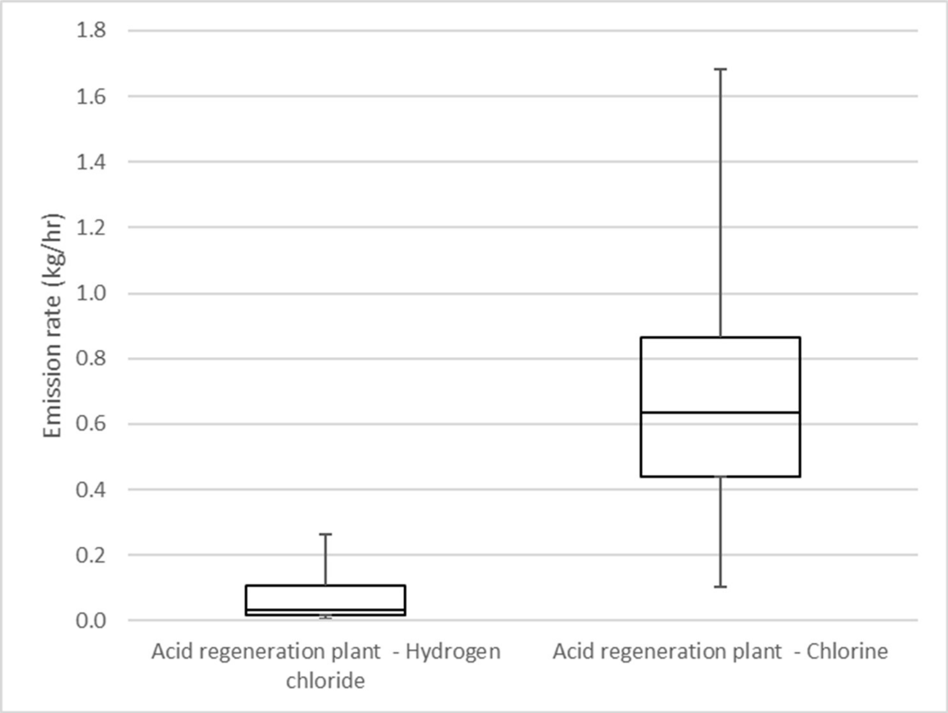

Figure 4.5: HCl and CL$_2$ emission rates measurements at the acid regeneration plant, 2009-2020.

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[11] NZ Steel, Acid regeneration Plant Investigation – Air Discharge Non-Compliance. August 2009.

4.6.2 Volatile Organic Compounds (VOCs)

VOCs include a variety of aromatic hydrocarbons, some of which have short- and long-term adverse health effects. VOCs may also react with nitrogen oxides emitted mainly from vehicles and industrial activities to form ozone, which in turn helps the formation of fine particulates.

The Paint Line at the Finishing Plants includes a separate prime line and finish line for application and baking of solvent paints to steel products. The emissions to air from the drying ovens are treated through incinerators to reduce emissions of VOCs at the outlet. Condition 21 of the Main Air Permit requires these two incinerators to be operated at a minimum of 650°C in excess air for 0.5 seconds for the oven at the finish line, and 750°C in excess air for 0.5 seconds for the prime line.

The potential effects of exposure to different VOCs are human health effects and nuisance effects from odour. The specific VOCs treated in the incinerator are dependent on the particular paints and coatings used within the prime and finishing line.

Emission testing has been undertaken annually on the Prime Oven and Finish Oven Incinerator stacks since 2014 for a suite of VOCs to validate the incineration efficiency. VOC results will vary depending on the paint product being used at the time of the testing. The representative emission rates are provided in **Appendix C**. These emission rates have been modelled as continuous discharges from the Paint Line Prime and Finish Oven Incinerator stacks, when in reality there are turnaround times between applications of different coatings. NZ Steel are considering upgrading the spray heads at the Paint Line to a dual-head system which would enable painting to continue through the current delay periods. The mass emission rate from each stack will remain the same. This scenario is accommodated in the dispersion modelling of VOCs, which conservatively assumes continuous operation of the Paint Line.

4.7 Odour

Although there may be small amounts of potentially odorous compounds present in some of the discharges to air from the Steel Mill, e.g. hydrogen sulphide in the MHF stack and residual VOCs from the Paint line incinerators, in practice there are no significant sources of odour at the site. Localised odours can also occur in the vicinity of very hot processes. However, odour has never been identified as an issue around the Site and it is therefore considered reasonable not to address it as part of this assessment.

4.8 Generator operations

In addition to existing emissions, the effects of the proposed generators have been considered via a dispersion model. The emission sources (vents) of the proposed diesel generators considered in the dispersion modelling study are summarised in the Air Dispersion Modelling Report (**Appendix D**).

Aside from the Northside Outfall generator whose purpose is to continuously power recycle water pumps, the other diesel generators would provide an alternative power source and hence would only operate for limited hours rather than continuously. While the hours will vary, the hours that have been assumed for the purposes of modelling (for a total of 8 hours/day) are:

- Morning peak hours: between 6 am and 9 am (3 hours)
- Evening/night peak hours: between 6 pm and 11 pm (5 hours).

There may be occasions that require operation of up to 11 hours/day (for example, during exceptional demand on the grid). However, this duration is expected to be infrequent. Operation of 8 hours/day is considered to be representative of the upper end of the normal operational regime of the proposed generators.

The modelling for the generators has been undertaken based on emission rates estimated from the respective power output (at 100% capacity, 50 Hertz) of the generators, and hence can be considered as a maximum emission rate modelling scenario. All generators are considered as 4-stroke combustion engines. As a worst-case assumption for modelling, all the generators are assumed to be emitting simultaneously at the rates specified in Table 4.6 below.

Table 4.6: Modelled emission rates of generator vents

Location ref.	Diesel generator locations	Emission rates (kg/hr)					
		CO	NO_x[b]	PM_{10}	$PM_{2.5}$	SO_2	PAHs
1	Building No. 60 generators	6.9	16.6	0.88	0.90	1.03×10^{-2}	1.26×10^{-7}
2	P&LP west product storage yard	1.4	2.4	0.048	0.048	1.84×10^{-3}	2.40×10^{-8}
3	Alinta car park	1.4	2.4	0.048	0.048	1.84×10^{-3}	2.40×10^{-8}
4	Café car park	2.5	4.5	0.14	0.14	3.43×10^{-3}	4.20×10^{-8}
5	North of 6 Hi-Building	0.58	4.6	0.040	0.040	3.92×10^{-3}	4.80×10^{-8}
6	Northside outfall	0.22	0.83	0.0064	0.0064	1.18×10^{-3}	1.44×10^{-8}
7	Central workshops (Southeast)	1.4	2.4	0.048	0.048	1.84×10^{-3}	2.40×10^{-8}
8	Central workshops (Northwest)	1.4	2.4	0.048	0.048	1.84×10^{-3}	2.40×10^{-8}
9	Metal coating line (South)	1.4	2.4	0.048	0.048	1.84×10^{-3}	2.40×10^{-8}

Notes:

a Derivation of emission rates provided in Appendix A of the modelling study attached as Appendix D.

b The modelled emissions are assumed to comprise 7.5% NO_2

The emissions from the diesel generators are not expected to have any material impact on ambient off-site concentrations of metals, VOCs, HCl, Cl_2, dioxins or black carbon.

4.9 Non-point source emissions

4.9.1 Introduction

The following sub-sections provide a brief overview of the non-point source emissions (i.e. fugitive emissions) from the Site. These emissions are intermittent and are difficult to quantify. Non-point source emissions have not been considered in the dispersion modelling assessment but form part of the overall Site emissions that are measured in ambient air quality monitoring data. Fugitive sources of dust and particulate matter are considered in more detail in Section 8.

4.9.2 Flap lifts

The Kilns, MHFs and their respective afterburners have explosion flaps which lift or open for the purpose of pressure relief. A “flap lift” occurs when the gas pressure in the system reaches or exceeds a safe level for the equipment, opening the emergency vent and releasing hot un-scrubbed waste gas directly to atmosphere. The duration of a flap lift is typically very short, of the order of minutes.

When a flap lift occurs, the process is interlocked to cut the feed of material into the MHF or Kiln. The duration of flap lifts varies, as does the frequency of occurrence. However, the intensity of the emission is greatest within the first few minutes and is limited by the cut-off of the feed material. It is not possible to accurately calculate the emissions to air from flap lifts. Because the duration of flap lifts can be from less than a minute to more than ten minutes, the number of flap lifts is not necessarily proportional to the quantity of emissions air from a flap lift event.

Flap lifts are unavoidable and are a necessary safety precaution, however efforts to improve process stability, particularly process control improvements in the Iron Plant, are an ongoing focus for NZ Steel to minimise production losses. NZ Steel keep records of pressure relief flap lifts in order to monitor performance and identify issues. The project to introduce flue gas recirculation to the MHF afterburners (described in Section 3.2.2) has noticeably improved afterburner stability and pressure regulation. NZ Steel maintains a record of the incidence of flap lifts, so they can track performance and initiate continual improvement. There has been up to 40% reduction in the number of flap lifts annually between 2018 and 2020.

4.9.3 Tipping of hot materials

There is a variety of reasons why it is necessary to tip molten iron, slags and RPCC in the open air. Tipping these hot materials can generate fine particulate matter, including metal oxides, which can rise high into the air because of their high thermal buoyancy. These emissions will contribute to off-site dust and fine particulate and, particularly in the case of RPCC losses have been associated with nuisance dust effects.

4.9.4 Spontaneous combustion of coal

Spontaneous combustion (without an external heat source) of coal within the outdoor stockpiles can be a source of fugitive emissions to air. Coal self-heating is influenced by a number of factors as shown in **Figure 4.6** below.

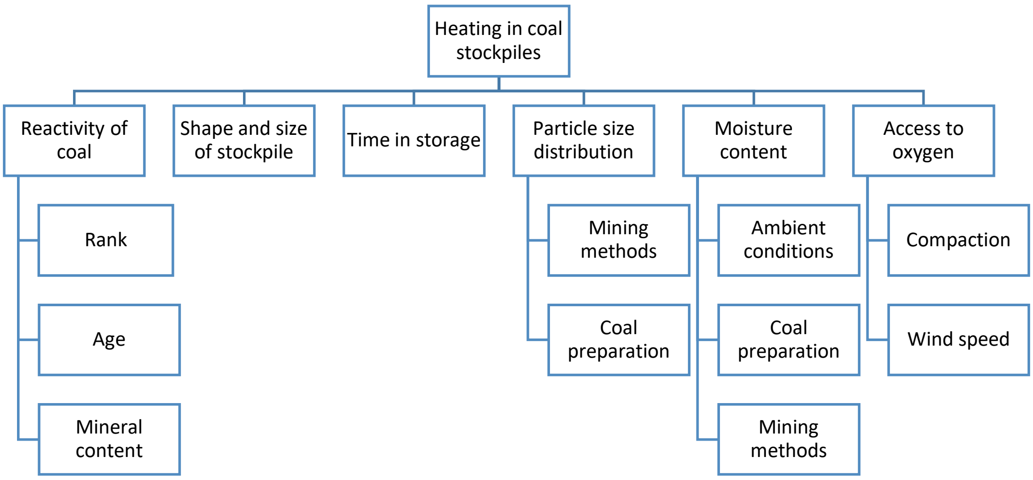

Figure 4.6: Risk factors for heating in coal stockpiles *Source: NZ Steel Procedure "Control of fires in coal stockpiles"*

Prior to spontaneous combustion, there is a build-up period of gases and heat before any flame arises. NZ Steel have procedures to detect and prevent coal ignition through regular inspection of stockpiles and early identification of self-heating events. Operators are trained to assess the severity of the event and implement the appropriate response. If self-heating is detected early, combustion can generally be prevented by moving the heated section with a loader and spreading it out flat to cool. If the spontaneous combustion is severe (flames observed), the NZ Steel emergency response group is engaged to respond.

NZ Steel is incentivised to minimise occurrence of spontaneous combustion as it results in risks to worker health and safety, causes uncontrolled emission of fine particulate and results in loss of a critical raw material.

4.9.5 Wind and mechanically-generated dust

Fugitive dust emissions from the Site can be characterised as being predominantly from three main sources:

1. Dust generated from vehicles travelling over site roadways, particularly unpaved roads;
2. Windblown dust from stockpiled materials and handling and processing of dry co-products; and
3. Fugitive dust generated from primary operations, processing plants and associated activities.

The activities that are considered the most significant contributors to fugitive dusts impacts off-site are located in the northern yard of the site and are depicted in **Figure 4.7** below.

Figure 4.7: Key sources of fugitive dust and indicative locations of permanent stockpiles

5 Approach to assessment

5.1 Existing Site

NZ Steel has operated at the Site for over 40 years, so there is a long performance history in terms of quantitative data from stack testing and ambient monitoring, council compliance inspections and community experience.

Given the large number of actual and potential sources of some contaminants, especially particulate matter, the assessment of effects of these contaminants has relied on monitoring data where it is available. In the case of PM_{10}, this monitoring data spans over a decade and for most other contaminants there is at least 2 years monitoring data. This real-world data provides the basis for a comprehensive understanding of air quality in the vicinity of the Site.

The monitoring data has been supported by a dispersion modelling study (**Appendix C**) of the key stack emission sources at Steel Mill. The objectives of the modelling study are to:

- Investigate whether the air quality monitoring locations provide data that is representative of worst-case impacts at sensitive receivers and to provide a basis for inferring likely air concentrations at other (un-monitored) locations if needed;
- Understand the relative impacts of different stack emission sources to measured air quality, particularly for PM_{10}; and
- Provide a basis for assessing the effects of contaminants where air quality monitoring data is limited, or not available (CO, Cl_2, HCl, mercury and VOCs).

Air quality monitoring data, or model results, have been compared to relevant assessment criteria. These assessment criteria are based on New Zealand-specific criteria, where available, or appropriate international criteria selected in accordance with the recommended good practice. The assessment criteria consider a range of effects including:

- The protection of human health, including the National Environmental Standards for Air Quality (NESAQ), Ambient Air Quality Guidelines (AAQG) and Auckland Ambient Air Quality Targets (AAAQT) set in the AUP;
- The protection of sensitive terrestrial ecology; and
- Trigger levels set to avoid effects of nuisance dust.

The assessment approach is summarised in **Table 5.1**.

Table 5.1: Summary of available data and assessment technique by contaminant

Contaminant	Available data		Evaluation summary
	Ambient monitoring	Stack emission data	
PM_{10}	✓	✓	Evaluation of continuous ambient monitoring data in comparison with assessment criteria.
$PM_{2.5}$	✓	✓	Evaluation of continuous ambient monitoring data in comparison with assessment criteria.
TSP	✓	✓	Evaluation of continuous ambient monitoring data in comparison with trigger levels for nuisance dust.
SO_2	✓	✓	Evaluation of continuous ambient monitoring data in comparison with assessment criteria for human health and ecological effects.

Contaminant	Available data		Evaluation summary
	Ambient monitoring	Stack emission data	
NO_2	✓	✓	Evaluation of continuous ambient monitoring data in comparison with assessment criteria.
HCl	-	✓	Worst case stack emissions modelled and compared with assessment criteria for human health.
Cl_2	-	✓	Worst case stack emissions modelled and compared with assessment criteria for human health.
CO	-	✓	Worst case stack emissions modelled and compared with assessment criteria for human health.
VOC		✓	Worst case stack emissions modelled and compared with assessment criteria for human health.
PAH/dioxins	✓	-	Evaluation of ambient monitoring data in comparison with assessment criteria.
Metals	✓	-	Evaluation of ambient monitoring data in comparison with assessment criteria, with the exception of mercury.
Mercury	-	✓	The ambient monitoring methods used for evaluation of other metals were not suitable for mercury. Worst case stack emissions modelled and compared with assessment criteria for human health.

5.2 Generators

NZ Steel propose to operate up to 19 generators for alternative power supply at the Site. The potential impacts of the operation of these generators have been considered cumulative with the impact of the existing Site operations.

The contaminants included in this modelling are CO, PM_{10}, $PM_{2.5}$, SO_2, NO_2, PAH. Ambient concentrations of air contaminants (aside from CO) are measured at the Glenbrook Beach Road (Site 20) monitoring station. These measured concentrations include the current air quality impacts from the Steel Mill operation and other background sources[12].

In order to assess the cumulative effects of the emissions from the generators, the modelled GLCs for each contaminant are added to existing concentrations. In the case of PM_{10}, there is continuous PM_{10} monitoring data available for the same years as the dispersion modelling. Therefore, daily model predictions and background concentrations can be added together giving a contemporaneous assessment of cumulative effects for the 24-hour average concentration. For the annual average, the highest annual average for PM_{10} (19.3 $\mu g/m^3$) recorded at the monitoring site was used for the background concentration.

For other contaminants where monitoring is not available for the modelled years, it is necessary to adopt a "representative" background concentration. Apart from PM_{10} and CO (which is not monitored), the 99th percentile of the measured concentrations has been adopted as the representative background concentration for this assessment (see Table 4.2 of **Appendix D**). These values will be conservatively high because the highest background concentrations of contaminants

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[12] The emissions from the two existing diesel generators at Building 60 will have negligible impacts upon the measured concentrations at Glenbrook Beach Road, when compared to the other major emission sources at NZ Steel.

are likely to be associated with the effects of emissions from the tall stacks at the Steel Mill. The worst-case dispersive conditions for these tall stacks will differ from those for the short generator stacks, and therefore, at a given location, the worst case modelled GLCs and background concentrations are unlikely to occur at the same time.

As described in Section 2.5 of **Appendix D**, the "Proxy method" for allowing for the oxidation of emitted NO to NO_2 is not considered to be applicable in this case due to assumed 'exhaustion' of ambient O_3 concentrations from conversion of NO from the main Steel Mill stack emissions. Hence the background NO_2 concentration in Table 4.2 of **Appendix D** is added to the NO_2 modelled GLCs (i.e. the NO_2 fraction which is directly emitted, i.e. denoted as $[NO_X]_{mod} \times F(NO_2)$).

6 Dispersion modelling study

6.1 Introduction

A dispersion modelling study of the main stack emission sources at the site has been carried out based on three years of meteorological data (2015 to 2017). A detailed description of the model set up and outputs is included in **Appendix C**.

The model results have been used as the basis for assessing the effects of contaminants where ambient air quality monitoring data for the existing operations is not available (CO, HCL, Cl_2, VOCs and mercury) in Section 7 of this report.

A supplementary modelling study has been provided in **Appendix D** for the anticipated emissions from the proposed generators. The results of this study have been used to assess the effects of CO, PM_{10}, $PM_{2.5}$, NO_2, SO_2 and PAHs cumulative with the effects of the existing mill operation.

6.2 Evaluation of model performance

The performance of the dispersion model has been evaluated by comparing the model predictions with measured concentrations of SO_2 and NO_2 (see Section 6 of **Appendix C**). The dispersion modelling of SO_2 emissions provides the most useful basis for evaluating the performance of the model as there are no other significant sources in the area that will contribute to the monitored concentrations and SO_2 monitoring data is available at two different monitoring sites (64 Glenbrook Beach Rd (Site 20) and Glenbrook School (Site 17)).

The modelling of PM_{10} emissions does not provide a good basis for evaluating model performance as the measured PM_{10} concentrations will include contributions from fugitive sources at the site (not included in the modelling) as well as background sources.

Overall, the dispersion model conservatively over-predicts the measured concentrations of SO_2 (at 64 Glenbrook Beach Rd (Site 20) and Glenbrook School (Site 17)) and NO_2 (at 64 Glenbrook Beach Rd (Site 20)). The model tends to over-predict by a greater margin at Glenbrook School compared to at Glenbrook Beach Road. This is most likely due to the way that the model simulates building downwash effects.

The overall conclusions are that the model performance is adequate and that it provides a useful and somewhat conservative tool for the purpose of predicting GLCs for contaminants where air quality monitoring data is not available.

6.3 Representativeness of 64 Glenbrook Beach Rd (Site 20) monitoring site

A comprehensive suite of air quality monitoring has been undertaken at the 64 Glenbrook Beach Rd (Site 20) monitoring site. The extent to which this location is representative of air quality likely to be experienced at sensitive receivers around the Steel Mill can be evaluated using the dispersion modelling predictions.

The dispersion model predicts greater impacts of stack emission sources on 24-hour average concentrations (but not annual average concentrations) of PM_{10} and SO_2 at several receptors to the northeast and east of the Site compared to the model predictions at the 64 Glenbrook Beach Rd (Site 20) monitoring location. The difference in GLCs is related to the way the model simulates the effects of building downwash on the dispersion of stack emissions.

A detailed analysis of the features of the Site in relation to the building downwash algorithm and taking into account that the model has been shown to over-predict to a greater degree at receptors east of the site, suggests that these effects are likely to be overstated. However, the possibility of stack emissions resulting in higher 24-hour average PM_{10} concentrations at some locations compared to at 64 Glenbrook Beach Rd (Site 20) needs to be considered.

The percentage differences set out in **Table 6.1** (from Table 6.1 in **Appendix C**) provide a basis for adjusting the measured PM_{10} concentrations at 64 Glenbrook Beach Rd (Site 20) to infer likely concentrations at other locations. However, it is important to note that this only applies to the stack emission component of the measured concentrations (not the total measured concentration, which will include contributions from a variety of sources). This is discussed in more detail in Section 7.2.

Table 6.1: Comparison of PM_{10} model predictions at 64 Glenbrook Beach Rd (Site 20) and discrete receptors

Location	**PM_{10} concentration (µg/m^3, 24-hour average)**	
	Maximum modelled GLC 24-hour average[a]	**Difference compared to 64 Glenbrook Beach Road (Site 20) GLC**
64 Glenbrook Beach Road (Site 20)	6.9	-
190 Mission Bush Rd (R6 and R54)	10.6	54% 37%
17 Reg Bennett Rd (R8 and R53)	7.6	11% 13%
29 Reg Bennett Rd (R9)	8.9	30%
198 Mission Bush Rd (R31)	9.2	34%
27 Reg Bennett Rd (R37)	8.5	24%
30 Reg Bennett Rd (R38)	8.5	23%
127 Brookside Rd (R48)	8.2	20%

Notes:

a. Average of the maximum 24-hour average modelled concentrations over the 3 modelled years (2015 to 2017).

7 Assessment of potential health effects

7.1 Approach to selecting assessment criteria and locations where they apply

The basis for the assessment criteria used to evaluate potential health effects is set out in Appendix B. The selection of assessment criteria is based on the hierarchy set out in Ministry for the Environment Good Practice Guidance[13] (GPG Industry), as follows:

- NESAQ;
- AAQG;
- Regional targets such as the AAAQT as set out within the AUP (unless more stringent than above criteria);
- WHO air quality guidelines; and
- California reference exposure levels (acute and chronic) and US EPA inhalation reference concentrations and unit risk factors (chronic) – Acute and chronic reference exposure levels from California Office of Environmental Health Hazard Assessment (OEHHA)[14] have been used.

The air quality assessment criteria for the contaminants considered in this assessment are set out in **Table 7.1**.

In relation to SO_2, the WHO has adopted an air quality guideline of 20 µg/m³ (24-hour average), which is substantially lower than the New Zealand AAQG of 120 µg/m³ (the previous WHO guideline value).[15] The Auckland Council considered adopting the WHO 24-hour average SO_2 guideline as an ambient air quality target in the Proposed Auckland Unitary Plan. However, following extensive discussions and expert conferencing, it was not adopted. Notwithstanding this, the WHO guideline has been considered in evaluating the potential effects of exposure to SO_2.

Table 7.1: Summary of assessment criteria for potential health effects

Contaminant[a]	**Concentration (µg/m³)**			
	1-hour average	8-hour average	24-hour average	Annual average
PM_{10}	-	-	50	20
$PM_{2.5}$	-	-	25	10
SO_2	570/350	-	120	40
NO_2	200	-	100	40
CO	30,000	10,000	-	-
HCl	2,100	-	-	-
Cl_2	210	-	-	-
Benzo[a]pyrene	-	-	-	0.0003
Dioxins				0.00004
Mercury[b]	-	-	-	0.33

Notes:

a. Assessment criteria for metals and VOCs are not included for brevity – they are described in Appendix B

b. Inorganic mercury

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[13] Ministry for the Environment. (2016). Good Practice Guide for Assessing Discharges to Air from Industry.

[14] https://oehha.ca.gov/air/general-info/oehha-acute-8-hour-and-chronic-reference-exposure-level-rel-summary

[15] WHO. (2006). Air Quality Guidelines Global Update 2005

The GPG Industry sets out guidance on the locations where ambient air quality standards and guidelines set for different averaging periods apply, which reflects the locations where people might be exposed over the relevant averaging period (**Table 7.2**). For this assessment, the 1-hour average assessment criteria and, conservatively, the 8-hour average assessment criterion for CO, have been used to assess potential effects anywhere beyond the Site. The 24-hour and annual average criteria have been considered in evaluating the potential for health effects at residential dwellings.

Table 7.2: Applicability of ambient air quality assessment criteria

Averaging period	Locations where assessment against the ambient standards should apply	Locations where assessment against the ambient standards should not apply
1-hour	This includes any outdoor areas where the public might reasonably be expected to spend one hour or longer, including pavements in shopping streets, as well as accessible facades (e.g., balconies, terraces).	Any industrial premises that have resource consents (for that pollutant)[16].
8-hour	This includes all outdoor locations where members of the public are likely to be exposed for eight hours as well as the facades of residential properties, schools, hospitals, libraries, etc.	Any industrial premises that have resource consents (for that pollutant). Any location where people are not likely to be exposed for eight hours – for example roads and footpaths.
24-hours	This includes all outdoor locations where members of the public might reasonably be exposed for 24-hours.	Any industrial premises that have resource consents for that pollutant. Any location where people are not likely to be exposed for 24-hours – for example roads, footpaths and industrial areas where residential use is not allowed.

7.2 Fine particulate matter

7.2.1 Assessment criteria

The NESAQ sets an ambient air quality standard for 24-hour average PM_{10}. The AAQG include an annual average guideline value, which is also included in Chapter E14 of the AUP as an AAAQT.

There is consultation currently underway to set $PM_{2.5}$ standards in the NESAQ for 24-hour average and annual averaging periods. The proposed values are the same as the WHO guidelines and are included in the AUP as AAAQTs.

The relevant air quality criteria for evaluating the effects of particulate matter are set out in **Table 7.3**.

Table 7.3: Assessment criteria for particulate

Substance	Averaging period	Value (µg/m^3)	Source of standard/guideline
PM_{10}	24-hour	50*	NESAQ
	Annual	20	AAQG / AAAQT

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[16] Within the Site, the health of workers is managed by the Workplace Exposure Standards.

Substance	Averaging period	Value (µg/m^3)	Source of standard/guideline
$PM_{2.5}$	24-hour	25	Proposed NESAQ / AAAQT
	Annual	10	Proposed NESAQ / AAAQT

* The NESAQ allows for 1 exceedance of the concentration limit in a 12-month period

7.2.2 Evaluation of PM_{10} and $PM_{2.5}$ concentrations against assessment criteria

7.2.2.1 Monitoring data at 64 Glenbrook Beach Rd

PM_{10} has been monitored for over a decade at three monitoring sites (64 Glenbrook Beach Rd (Site 20), Glenbrook School (Site 17) and Sandspit Reserve (Site 19)) and $PM_{2.5}$ has been monitored at 64 Glenbrook Beach Rd (Site 20) since March 2018. PM_{10} and $PM_{2.5}$ monitoring is undertaken using Beta Attenuation monitors (BAMs) in accordance with NESAQ-compliant monitoring method AS 3580.9.11:2008.

There is no evidence of influence from NZ Steel activities in the PM_{10} concentrations at the Sandspit Reserve monitoring site in Waiuku.

Although there may be a small influence of emissions from the Steel Mill at Glenbrook School, this is largely indiscernible from the influence of marine aerosols under westerly winds. There have been a small number of occasions where the PM_{10} NESAQ value has been exceeded at Glenbrook School (Site 17), but none of these are attributable to emissions from the Steel Mill. Elevated concentrations at the school can be explained by large scale influences (e.g. impacts of Australian fires and dust storms that were seen across the region) or what appear to be short duration local sources (possibly agricultural burning).

As shown in **Table 7.4**, there have been no exceedances of the PM_{10} annual average assessment criterion (20 µg/m^3) at 64 Glenbrook Beach Rd (Site 20), nor the proposed 24-hour and annual average standards for $PM_{2.5}$. However, there have been occasional exceedances of the PM_{10} ambient air quality standard (set in the NESAQ) since about 2012.

Table 7.4: Evaluation of measured concentrations of particulate matter a 64t Glenbrook Beach Rd against assessment criteria

Metal	Assessment criterion (µg/m^3)	Averaging period	Maximum concentration (µg/m^3)	% of guideline
PM_{10}	50	24-hour average	See discussion	>100%
	20	Annual average	19.5	98%
$PM_{2.5}$	25	24-hour average	22.3	89%
	10	Annual average	6.5	65%

The number of days in each calendar year where the measured concentration exceeded the PM_{10} NESAQ is shown in **Figure 7.1**. This shows an increase in days with high PM_{10} concentration (relative to the NESAQ) since around 2011. Annual average concentrations (see **Figure 7.2**) do not show the same trend.[17] Overall, this suggests a higher number of “peak” exposure days but with long term exposure remaining relatively consistent over time.

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[17] Note: higher annual average concentrations in 2019 were seen across almost all Auckland Council monitoring sites and are not considered attributable to the Steel Mill.

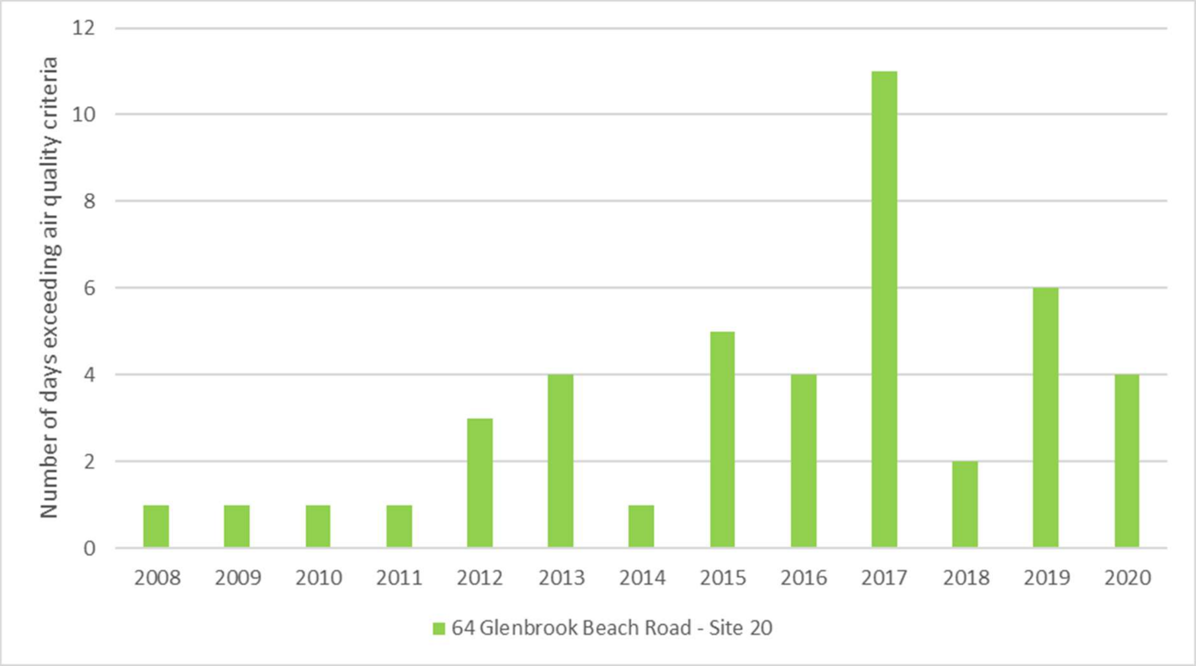

Figure 7.1: Count of days exceeding NESAQ 24-hour average concentration by year at 64 Glenbrook Beach Rd (Site 20) (2020 data current to October)

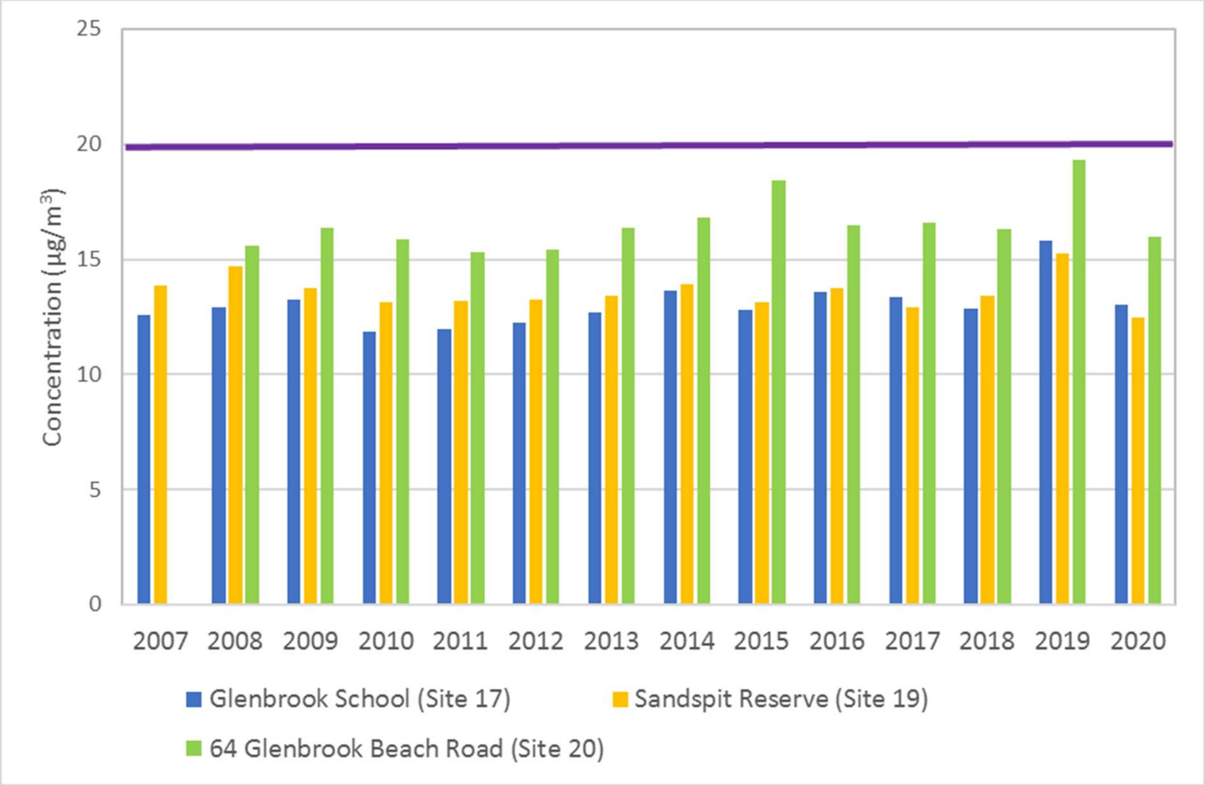

Figure 7.2: Annual average PM_{10} concentrations

7.2.2.2 Evaluation of likely concentrations at other locations

The dispersion modelling suggests that stack emissions, mainly the Kiln and MHF stack emissions, could contribute up to 6.9 µg/m^3 PM_{10} as a 24-hour average at the 64 Glenbrook Beach Rd (Site 20) monitoring site. The background concentration of PM_{10} has been estimated at 15.2 µg/m^3. This gives a cumulative concentration of 22.1 µg/m^3 (24-hour average) or 44% of the NESAQ.

The maximum and second highest 24-hour average concentrations measured at 64 Glenbrook Beach Rd (Site 20) each year since 2014 are shown in **Table 7.5**. Taking into account the estimates of contributions from stack and background sources, this suggests that the impact of fugitive dust emissions on these worst-case days was of the order of 40 to 60 µg/m^3 (ignoring the worst daily concentration of 95 µg/m^3).

Table 7.5: Maximum and second highest PM_{10} concentrations recorded at 64 Glenbrook Beach Rd (Site 20)

Year	PM_{10} concentration (µg/m^3, 24-hour average)	
	Highest	Second highest
2014	54	47
2015	68	64
2016	61	59
2017	78	71
2018	56	54
2019	79	64
2020	95	73

The dispersion model has been shown to be performing reasonably well and generally tending to over-predict measured concentrations at 64 Glenbrook Beach Rd (Site 20). Therefore, it appears unlikely that stack emissions would be a significant contributor to the measured exceedances of the NESAQ. Also, stack emissions have not changed to any great extent over time (based on regular stack testing) and therefore do not explain the increased number of days with high PM_{10} concentrations relative to the NESAQ since about 2011.

A detailed evaluation of temporal (hourly, daily, weekly and seasonal) patterns in the data suggests that while stack emissions are the main sources of $PM_{2.5}$ at 64 Glenbrook Beach Rd (Site 20), fugitive emissions are a more significant contributor to PM_{10}. PM_{10} concentrations at 64 Glenbrook Beach Rd (Site 20) are directly correlated to wind speed and are highest in the summer (which would be consistent with higher dust generation and transport under dry windy conditions), while $PM_{2.5}$ concentrations show an inverse relationship with wind speed (consistent with better dispersion of stack emissions under higher wind speeds) and a close relationship with SO_2 concentrations, which are largely from the MHF and Kiln stacks (also the main particulate matter stack emission sources). A recent study of particulate levels measured downwind of the coal stockyard at the Lyttelton Port Company[18] showed that the contribution of coal dust to $PM_{2.5}$ levels is very low, and that coal dust is mostly in the coarse fraction of PM_{10} greater than $PM_{2.5}$.

For the reasons set out above, fugitive emissions are thought to be the main source of particulate on days with high PM_{10} concentrations. A discussion of the different fugitive dust sources, and factors that have influenced changes in fugitive dust emissions over time, is set out in Section 8.3.

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[18] Coal Stockyard, Air Quality Assessment, Tonkin &Taylor Ltd for Lyttelton Port Company, August 2021. Source apportionment analysis by GNS Science.

As discussed in Section 6.3, the dispersion model predictions for PM_{10} at some receptors northeast and east of the site are higher than at 64 Glenbrook Beach Rd (Site 20). The location with the greatest difference in modelled PM_{10} concentrations from stack sources is 190 Mission Bush Rd (10.6 µg/m^3 compared to 6.9 µg/m^3 at 64 Glenbrook Beach Rd (Site 20)). The higher concentration attributable to stack sources of approximately 4 µg/m^3 is small compared to the contribution from fugitive sources on the worst-case days (40 to 60 µg/m^3). Alongside this, it is likely that the contribution of fugitive sources at locations east of the Site will be relatively lower than at 64 Glenbrook Beach Rd (Site 20) because of the relatively low frequency of westerly winds compare to the more dominant southwesterly winds (see **Figure 2.4**). This difference is even greater when the incidence of strong winds, which are the worst case for fugitive dust emissions, is considered (see **Figure 8.5**). Therefore, on balance it is considered unlikely that areas to the northeast and east of the site would experience materially higher PM_{10} concentrations that at 64 Glenbrook Beach Rd (Site 20). This means that the monitoring data at 64 Glenbrook Beach Rd (Site 20) provides a reasonable basis for assessing the potential effects of exposure to PM_{10} at the closest dwellings to the site.

7.2.3 Impact of proposed generator emissions

The modelling study attached as **Appendix D** shows that the modelled concentrations of PM_{10} and $PM_{2.5}$ from the operation of the generators are at or below 10% of the assessment criteria and cumulative concentrations are dominated by the existing impact of the existing Steel Mill operation. The cumulative 24-hour average PM_{10} concentrations have been estimated using contemporaneous background concentrations from the monitoring data at 64 Glenbrook Beach Rd (Site 20). This has demonstrated that the worst-case effects of the generator emissions do not occur under the same conditions as worst-case measured concentrations. The additional impact of the generator emissions would not materially alter the off-site PM_{10} concentrations under these worst-case conditions. Under the conditions that result in peak existing measured PM_{10} concentrations, the incremental contribution from the operation of all proposed generators is estimated at 0.1 ug/m^3 (24 hour average).

7.2.4 Secondary particulate

Emissions of NO_X and SO_2 can lead to the formation of nitrate and sulphate in the atmosphere, which are a component of $PM_{2.5}$ (referred to as secondary $PM_{2.5}$ as they are not caused by direct emissions of $PM_{2.5}$).

The formation of secondary particulate from precursor gases occurs over a period of hours to days, and is influenced by humidity, atmospheric catalysts and intensity of solar radiation. Secondary particulate is therefore not of concern with respect to localised effects on nearby sensitive receptors but is of interest in terms of how it may affect wider ambient air quality in the Auckland Urban Airshed.

$PM_{2.5}$ concentrations in the Auckland region generally meet the proposed NESAQ values. Source apportionment studies have found that secondary sulphate comprises 15% of $PM_{2.5}$ across the Auckland monitoring sites (Khyber Pass Road, Queen Street, Takapuna, Henderson and Penrose) and 9% of the average PM_{10} concentration[19]. $PM_{2.5}$ concentrations, and the contribution of sulphur compounds to $PM_{2.5}$, decreased in urban Auckland over the period 2006 to 2015. This is mainly attributed to changes in motor vehicle fuel composition in over this period (particularly the lower sulphur content in diesel).

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[19] Source apportionment and trend analysis of air particulate matter in the Auckland region. Prepared by the Institute of Geological and Nuclear Sciences Ltd, GNS Science for Auckland Council. Auckland Council technical report, TR2017/001

Overall, therefore, it is concluded that secondary particulate from the Steel Mill's emissions represents only a very small contribution to the low and reducing levels of ambient $PM_{2.5}$ in the Auckland Urban Airshed.

7.2.5 Discussion and conclusions

The monitoring data shows that concentrations of PM_{10} exceed the 24-hour air quality standard set in the NESAQ on a number of occasions each year at 64 Glenbrook Beach Rd (Site 20). This site is considered representative of air quality that may be experienced at dwellings close to the Site.

Concentrations measured at Glenbrook School (Site 17) are typically lower and generally meet the air quality standard. Where there are occasional elevated PM_{10} concentrations at Glenbrook School (Site 17) these are demonstrably not related to the emissions from the Steel Mill.

NZ Steel has been actively seeking to improve fugitive dust controls as discussed in Section 8.4.4, with the intention of ensuring that the site does not cause PM_{10} off-site concentrations to exceed the NESAQ.

NZ Steel has sought the opinion of a public health specialist (Dr Kelly) in relation to the potential effects on people health of these occasional exceedances of the PM_{10} NESAQ value. Dr Kelly's analysis concludes that the effects of infrequent and sporadic exposure to PM_{10} concentrations exceeding the standard of 50 $\mu g/m^3$ as a 24-hour average are minor (see **Appendix F**).

While the addition of generators to the site will increase the number of point sources of particulate matter, the worst-case effects of the generator emissions do not occur under the same conditions as peak off-site measurements downwind of the Steel Mill. The modelling study shows that the emissions from the generators will not materially alter the peak off-site concentrations of PM_{10} or $PM_{2.5}$.

7.3 Products of combustion

7.3.1 Assessment criteria

Assessment criteria for combustion products are based on the ambient air quality standards set in the NESAQ, the AAQG and AAAQT, as summarised in **Table 7.6**.

In relation to SO_2, the WHO has adopted an air quality guideline of 20 $\mu g/m^3$ (24-hour average), which is substantially lower than the New Zealand AAQG of 120 $\mu g/m^3$ (the previous WHO guideline value). [20] The Auckland Council considered adopting the WHO 24-hour average SO_2 guideline as an ambient air quality target in the Proposed Auckland Unitary Plan. However, following extensive discussions and expert conferencing, it was not adopted. Notwithstanding this, the WHO guideline has been considered in evaluating the potential effects of exposure to SO_2.

Table 7.6: Assessment criteria for combustion products

Substance	Averaging period	Concentration ($\mu g/m^3$)	Source of standard/guideline
SO_2	1-hour average	570[a]	NESAQ
	1-hour average	350[a]	NESAQ
	24-hour average	120	AAQG / AAAQT
	Annual average	40	WHO

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[20] WHO. (2006). Air Quality Guidelines Global Update 2005

Substance	Averaging period	Concentration (µg/m³)	Source of standard/guideline
NO_2	1-hour average	200	NESAQ
	24-hour average	100	AAQG / AAAQT
	Annual average	40	AAQG / AAAQT
CO	1-hour average	30,000	AAQG / AAAQT
	8-hour average	10,000	NESAQ

Notes:

a. The NESAQ provides for no allowable exceedances of 570 µg/m³ and 9 exceedances of 350 µg/m³ in a 12-month period.

7.3.2 Air quality monitoring for sulphur dioxide and nitrogen dioxide

Ambient air monitoring for SO_2 was carried out at the 64 Glenbrook Beach Rd (Site 20) monitoring site (March 2017 to June 2020) and Glenbrook School (Site 17) (June 2018 to June 2020) monitoring sites. SO_2 monitoring was carried out using a UV fluorescence analyser in accordance with the NESAQ compliant method AS 3580.4.1:2008.

Ambient air quality monitoring for NO_X was carried out at the 64 Glenbrook Beach Rd (Site 20) monitoring site from November 2018 to February 2021. Monitoring was carried out using a chemiluminescent analyser in accordance with the NESAQ-complaint method AS 3580.5.1:1993. This method directly measures NO and NO_X and assumes that the balance of NO_X (that is not NO) is NO_2.

The ambient air monitoring results are discussed in more detail in **Appendix E**.

7.3.3 Dispersion modelling of carbon monoxide

There has been no monitoring of ambient concentrations of CO in the vicinity of the Site because the impacts of the emissions from the Site are expected to be low compared to the relevant assessment criteria. The main emission sources of CO are the Kilns and KOBM Flarestack, with much smaller scale contributions from the other combustion sources including the Slab Reheating Furnace and the Paint Line incinerators and the proposed diesel generators.

The effects of CO emissions have been evaluated using dispersion modelling of the emissions from the Kiln stacks and KOBM Flarestack in **Appendix C**. The concentrations for the existing operation presented in Table 7.9 are based on modelling using the highest measured CO emission rates (which are the same as the limit in the Air Permit) from all four Kilns simultaneously and estimated emission rates from flaring at the KOBM Flarestack. The model predictions are for the worst-case concentration at any off-site location. The dispersion modelling is discussed in more detail in **Appendix C**.

7.3.4 Evaluation against assessment criteria

7.3.4.1 NO_2 and SO_2

The measured concentrations of SO_2 and NO_2, as a result of existing activities at the Site are compared with relevant assessment criteria in **Table 7.7.** The modelled contribution of the generators to short term average concentrations is shown in **Table 7.8**. In all cases, the measured/predicted concentrations are well below the relevant assessment criteria. Based on this, there are not expected to be any adverse effects on people's health from exposure to these contaminants.

Table 7.7: Evaluation of measured concentration of NO_2 and SO_2 against assessment criteria

Contaminant	Assessment criterion (µg/m^3)	Averaging period	Maximum concentration[a] (µg/m^3)	% of guideline
SO_2	350	1-hour average	101.2	29%
	120	24-hour average	31.7	26%
	40	Annual average	3.0	8%
NO_2	200	1-hour average	57.0	29%
	100	24-hour average	27.9	28%
	40	Annual average	6.2	16%

Notes:

a. Based on monitoring at 64 Glenbrook Beach Rd (Site 20).

For the assessment of emissions of NO_2 and SO_2 from the generators, it is assumed that the peak contribution from the generators will coincide with the measured peak off site concentrations influenced by the existing sources. This is highly unlikely, as the meteorological conditions that cause peak impacts for the tall Iron Plant sources will not produce the same dispersion pattern for the short generator stacks.

In assessing the effects of NO_x emissions from the generators, it has been shown that at the times peak NO_2 concentrations are measured off-site, ambient ozone has been exhausted by atmospheric reactions. Therefore, the contribution of the generators under these conditions will only be from the direct emissions of NO_2 and there will be negligible atmospheric conversion of NO emissions to NO_2.

It is not possible to reliably model the effects of the generator emissions on annual average concentrations of NO_2 and SO_2 because of their intermittent operation. However, because they only operate intermittently, the impact on annual average concentrations of these contaminants is expected to be low.

Table 7.8: Modelled cumulative impact of generator emissions

Contaminant	Averaging period	Assessment criteria (µg/m^3)	Maximum NO_2 (directly emitted from generators) GLC (µg/m^3)	Existing peak concentration (µg/m^3)	Total GLC (µg/m^3)
NO_2	1-hour average (99.9th percentile)	200	42.3 (21% of criterion)[b]	32.3 (16% of criterion)	74.6 (37% of criterion)
	24-hour average	100	7.7 (8% of criterion)	27.9 (28% of criterion)	35.6 (36% of criterion)
SO_2	1-hour average (99.9th percentile)	570	0.8 (0.1% of criterion)	31.0 (5% of criterion)	31.8 (6% of criterion)
		350	0.8 (0.2% of criterion)	31.0 (9% of criterion)	31.8 (9% of criterion)
	24-hour average	120	0.08 (0.07% of criterion)	19.4 (16% of criterion)	19.5 (16% of criterion)

7.3.4.2 CO

CO is not monitored downwind of the Steel Mill, and as such, representative values of existing air quality have been adopted from dispersion modelling of the effects of the emissions from the Steel Mill. The modelling is based on the highest measured CO emission rates. This approach is likely to over-predict actual CO concentrations as it is unlikely that all existing sources will be emitting at the maximum possible rate at the same time. The modelled concentrations from existing sources have been added to the default background concentrations recommended for rural areas in the Good Practice Guide for Assessing Discharges to Air from Industry (2016) (GPG Industry).

To assess the additional effects of the proposed generators, the maximum ground level concentration produced by the operation of all generators has been added to the 'existing' concentration to provide a cumulative off-site concentration for each averaging period. This approach adds further conservatism to the assessment, as the peak off site impacts from the tall stack sources on site are not expected to coincide with the peak off site impact of the relatively short generator stack emission sources. The results are presented in Table 7.9 below and show that, even with this very conservative approach, the off-site CO concentrations are predicted to be well below the respective criteria.

Table 7.9: Evaluation of predicted concentration of carbon monoxide against assessment criteria

Assessment criterion (µg/m³)	Averaging period	Maximum concentration at ground level (µg/m³)		
		Modelled existing air quality (incl background)	Generators	Cumulative total
30,000	1-hour average	7270[a] (24% of criterion)	579 (1.9% of criterion)	7849 (26% of criterion)
10,000	8-hour average	3180[b] (32% of criterion)	175 (1.8% of criterion)	3355 (34% of criterion)

a. Includes assumed background concentration of 5000 µg/m³

b. Includes assumed background concentration of 2000 µg/m³

7.3.5 Discussion and conclusion

The dispersion modelling study (**Appendix C**) found that 64 Glenbrook Beach Rd (Site 20) is likely to be reasonably representative of worst-case impacts of SO_2 and NO_2 at discrete receptors, although the possibility of slightly higher 24-hour average SO_2 concentrations at 190 Mission Bush Rd cannot be discounted. Even if existing concentrations of SO_2 and NO_2 were slightly higher at other locations compared to the measured concentrations at 64 Glenbrook Beach Rd (Site 20) they would remain well below the relevant New Zealand air quality standards and guidelines.

The 64 Glenbrook Beach Rd (Site 20) monitoring site has occasionally recorded exceedances of the 24-hour WHO guideline, of the order of one to four days per year and, at worst, no greater than 32 µg/m³ compared to the guideline of 20 µg/m³. NZ Steel has sought the opinion of a public health specialist (Dr Kelly), which concludes that "*the overall pattern and distribution of the data support a conclusion that exposure to 24 hour average values is consistent with minimal effects*" (see **Appendix F**).

The contribution of SO_2 and CO from the generators is less than 1% and 2% respectively, of the assessment criteria. The modelled cumulative concentrations of CO and SO_2, , are also well below the respective assessment criteria. Therefore, effects of SO_2 and CO emissions from the generator sources are considered negligible.

The effects of NO_x emissions from the generators on ambient 24-hour average NO_2 concentrations are insignificant. Using very conservative assumptions about the coincidence of peak effects, NO_x emissions are predicted to cause cumulative 1-hour average NO_2 concentrations that are up to 37% at the (eastern) Site boundary location where it is accessible to the public.

7.4 Metals

7.4.1 Exposure pathways

Metals emissions from the site are generally associated with particulate matter (i.e. they are not in the gas phase, with the exception of mercury which has a relatively low vapour pressure) and people could be exposed via direct inhalation or from deposition and subsequent ingestion.

The potential for health effects has been evaluated in the following ways:

- For inhalation exposure, based on analysis of TSP filter samples from the NZS Northern Boundary monitoring site (Site 4B) and comparison with assessment criteria.
- For deposition exposure, by measuring deposition rates of metals and evaluating potential impacts related to ingestion of roof collected drinking water.

7.4.2 Inhalation exposure

7.4.2.1 Evaluation against assessment criteria

The potential for exposure to metals by inhalation has been assessed by evaluating airborne concentrations of metals in TSP at the NZS Northern Boundary monitoring site (Site 4B). The TSP samples are collected using a partisol sampler, which captures airborne particulate on a filter over a 24-hour period on a 1 in 6-day basis (i.e. monitoring is undertaken every sixth day). The filters were collected over the period 17 June 2018 to 18 June 2019 (**Appendix D**).

The results were corrected for the analysis of the blank filters to remove the influence of the metal content of the borosilicate glass filters. The blank-adjusted concentrations are compared with the assessment criteria in **Table 7.10**. For all the metals considered, the blank-adjusted concentrations are well below the relevant assessment criteria for inhalation exposure.

Table 7.10: Evaluation of metals in total suspended particulate against assessment criteria

Metal	Assessment Criterion (µg/m³)	Averaging period	Blank-adjusted concentration	
			Concentration (µg/m³)	% of guideline
Arsenic (inorganic)	0.0055	Annual average	0.001	9.8%
Cadmium	0.3	Annual average	0.000011	0.004%
Chromium	0.11 (Cr III)	Annual average	See note 1.	-
	0.0011 (Cr VI)	Annual average		-
Lead	0.2	3-month rolling average	0.0013	0.6%
Manganese	0.15	Annual average	0.009	6.2%
Nickel	0.0025	Annual average	See note 1.	-
Vanadium	1	24-hour average	0.025	2.5%
Zinc	2	Annual average	0.036	1.8%

Note 1: The filter media contains chromium and nickel. Once the analytical results are adjusted for the metal in the filter media, the measured concentration of chromium and nickel in suspended particulate is effectively zero.

7.4.2.2 Cumulative effects of inhalation exposure

The assessment set out in the previous sub-section considers the potential effects of exposure to low concentrations of individual metals. Two of the metals measured on the TSP filters are known to be carcinogenic: arsenic and cadmium. Therefore, a further evaluation has been carried out to consider the potential effects of cumulative exposure to these two metals (at the same time).

The effects of exposure to these metals are expressed as the ''incremental lifetime cancer risk''. This is an estimate of the incremental (i.e. increased) risk of developing cancer over a lifetime from exposure to a substance continuously over a 30 year period. The incremental risk is calculated by multiplying the concentration in air by an assessment criterion expressed as the “unit risk” for that substance.

The unit risks for cadmium and arsenic are related to the air quality guidelines shown in Table 7.10. For example, the New Zealand ambient air quality guideline for arsenic of 0.0055 $\mu g/m^3$ is based on a unit risk of 0.0015 $(\mu g/m^3)^{-1}$ and an acceptable increased lifetime cancer risk level of 1 in 100,000.

The unit risk value for cadmium, published by the US EPA, is 0.0018 $(\mu g/m^3)^{-1}$.

For exposure to two or more substances at the same time, the incremental risks are added together. This combined (cumulative) risk can be compared to a value of 1 in 100,000 (which can also be expressed as 10 per million), which has been accepted as an acceptable level of increased lifetime cancer risk in New Zealand.[21]

An assessment of the risk from cumulative exposure to arsenic and cadmium is shown in Table 7.11. To make it easier to read, the risk from exposure to the measured concentration in air (fourth column) is expressed on a per million basis. The cumulative risk from exposure to arsenic and cadmium is 1.52 per million, which is an order of magnitude below the acceptable risk level of 10 per million. This means that the levels of arsenic and cadmium measured in the air at sensitive receptors are not of concern with respect to cumulative exposure, even if a person were exposed continuously over a 30-year period.

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[21] Ministry for the Environment (2011) Toxicological Intake Values for Priority Contaminants in Soil. p4

Table 7.11: Assessment of cumulative exposure to arsenic and cadmium

Metal	Unit risk (µg/m^3)$^{-1}$	Concentration in air[a] (µg/m^3)	Incremental lifetime cancer risk (per million)
Arsenic	0.0015	0.001	1.5
Cadmium	0.0018	0.000011	0.02
Cumulative risk (calculated)			1.52
Acceptable risk			10

a. This is the 'blank adjusted' concentration which is found by subtracting the metal mass reported when a blank unused filter is tested. This step removes the influence of the metal content of the borosilicate glass filters.

7.4.3 Ingestion exposure

7.4.3.1 Monitoring deposition rates of metals

Monitoring for deposited metals was undertaken at three locations in the vicinity of the Site to identify the extent to which discharges to air from the Steel Mill may contribute to deposition rates of metals. Deposition gauge samples collected between September 2017 to December 2019 were analysed by an accredited laboratory.

The 64 Glenbrook Beach Rd (Site 20) and NZS Northern Boundary (Site 4B) monitoring sites are representative of deposition rates at off-site locations downwind of the predominant wind direction at varying distances from the Site. The Boundary Rd site (Site 18) lies across the Waiuku River and is a background site, where air quality is expected to be largely unaffected by NZ Steel's activities.

7.4.3.2 Identification of metals of interest

The deposition monitoring results have been used to evaluate the contribution of discharges to air from the Site by comparing the measurements at the downwind monitoring sites with the background monitoring site (see Section 9 of **Appendix E**). This analysis was further refined by considering the relative quantity and toxicity of these metals using a screening approach. The screening approach estimated an equivalent concentration in roof-collected water (based on the measured deposition rate and annual rainfall) and compared this to the relevant Maximum Allowable Value (MAV) in the Drinking Water Standards for New Zealand 2005 (revised 2018), or international guidance.

The screening assessment identified vanadium as the only contaminant where discharges from the Site are anticipated to have an impact with respect to drinking water MAVs.

7.4.3.3 Monitoring roof-collected drinking water

Further to the screening assessment, the impact of emissions from the Site on roof-collected drinking water has been assessed by taking samples of roof-collected water from 4 houses in the vicinity of the Site and a shed located within the NZ Steel landholding. The results from these locations have been compared to samples from a background house over 8 km east of the Site. The monitoring programme and results are presented in **Appendix I**.

In evaluating the results, it is important to note that roof collected drinking water can be influenced by metals associated with roofing material, pipes and fittings.

The concentrations of metals in all the roof-collected water samples were below the MAVs, with two exceptions:

- an exceedance of the criterion for lead at House 3 (the 'background' house) in one of the three samples. Inspection of this property by NZ Steel staff suggests that this result may have been due to low rainfall and lead nails on an old section of the roof.
- an exceedance of the criterion for vanadium at Shed 6 in round 3 of the sampling (115% of the MAV). The average of the three sampling rounds was 84% of the criterion. Shed 6 is situated within the Site and is 160 m east of the Operational Area.

With regard to the metals identified in the screening assessment as potentially having a material influence from the Steel Mill based on deposition monitoring results:

- The testing supported that there was a measurable influence of discharges from the Steel Mill on vanadium levels in roof-collected water. Vanadium levels were highest at the shed within the NZ Steel landholding which had one exceedance of the MAV and were otherwise below the MAV at all locations.
- Cadmium was rarely detected in any of the samples, except for House 5, which showed consistently elevated levels of cadmium (average 51% of the MAV) and zinc (average 31% of the MAV). This is considered likely to be to be due to the roofing materials or plumbing fittings. It is considered unlikely to be related to emissions from the Steel Mill as House 5 is co-located with House 4 (two buildings on the same property), which did not show any evidence of elevated levels of cadmium or zinc.
- Slightly elevated levels of manganese compared to the background house (6% of the MAV) were detected in roof collected water from the shed on the NZ Steel landholding. This suggests an influence of the Steel Mill, but not at levels that would pose a concern for human health.
- Iron was present in all samples (including from the background house) at low levels that do not pose a concern for human health or aesthetics.

Table 7.12: Evaluation of metals of interest in drinking water

Metal	MAV mg/L	Average concentration in drinking water as a percentage of the MAV					
		House 1	House 2	House 3 (background)	House 4	House 5	Shed 6
		1.5 km E	0.5 km S	8.6 km E	2.4 km NE	2.4 km NE	0.2 km E
Vanadium	0.015	48%	35%	10%	64%	31%	84%
Cadmium	0.004	2%	2%	1%	1%	45%	2%
Manganese	0.4	2%	3%	3%	1%	4%	6%
Iron	2.0	1%	4%	4%	1%	2%	1%

7.4.4 Mercury

Mercury is more volatile than other metals and is more difficult to measure because it tends to re-volatilise while it is being sampled, or while samples are being stored and transported. For this reason, the potential for effects from exposure to mercury have been assessed based on dispersion modelling. It has been conservatively assumed that all of the mercury in the coal and limestone raw materials is volatilised and released to air via the MHF stacks.

The assessment criterion for mercury is the AAQG, which is also adopted as an AAAQT in Chapter E14 of the AUP. The predicted annual average mercury concentration at the worst-case sensitive receptor is less than 1% of the assessment criterion, as shown in **Table 7.13**. Therefore, it is concluded that mercury emissions from the Site will not cause effects on people's health.

Table 7.13: Evaluation of predicted mercury concentration against assessment criteria

Metal	Assessment criterion (µg/m³)	Averaging period	Concentration (µg/m³)	% of guideline
Mercury	0.33	Annual average	0.0002	0.05%

7.4.5 Discussion and conclusions

The effects of metals emissions from the Steel Mill have been assessed by considering potential exposure via inhalation and ingestion of roof-collected drinking water. There are other potential ingestion pathways, such as deposition onto soils and subsequent ingestion of homegrown produce, however ingestion of roof-collected drinking water has been adopted for the initial assessment because it is a relatively simple pathway to assess and is particularly relevant to the rural dwellings around the site. If the potential for ingestion exposure via drinking water was found to be significant, then the other ingestion pathways would need to be considered.

Vanadium was identified as the metal contaminant of greatest interest with respect to potential for exposure via both inhalation and ingestion exposure. The drinking water MAV for vanadium was derived based on a Tolerable Daily Intake of 0.0021 mg/kg-day and assuming 20% of exposure occurred via drinking water.

The total daily exposure to vanadium via inhalation and ingestion of drinking water can be estimated and compared with the Tolerable Daily Intake as follows:

Airborne exposure = 0.025 µg/m^3 x 22 m3/day x 0.001 mg/µg = 0.00055 mg/day

Drinking water exposure = 0.0126 mg/L x 2L/day = 0.0252 mg/day

Total daily exposure adjusted for body weight

= (0.00055 + 0.0252) mg/day / 70 kg

= 0.00037 mg/kg-day

= 17.5% of the Tolerable Daily Intake

Cumulative exposure to vanadium is well below the Tolerable Daily Intake and is therefore not of concern with respect to human health. Exposure to other metals, as a percentage of their Tolerable Daily Intake, will be lower than for vanadium. Based on evaluation of exposure to airborne metals and deposited metals in drinking water collected, there is not expected to be any adverse effects on people's health from exposure to metals emissions from the Site.

7.5 PAHs and dioxins

7.5.1 Assessment

The effects of dioxins and PAHs have been assessed based on ambient monitoring undertaken at the monitoring site at 64 Glenbrook Beach Rd (Site 20). Due to challenges with the operation of the monitoring equipment, impacts of COVID-19 on sample collection and the need to change to an Australian laboratory, only seven months of monitoring data is available at the time of writing and this does not include the winter period, where the contribution of these substances from domestic heating sources may be greater.

Mixtures of dioxins and furans (PCDD/F) have been expressed as Toxic Equivalents using the WHO Toxic Equivalence factors (i.e. concentration expressed as WHO-TEQ).

Mixtures of PAHs have been expressed as the Benzo[a]pyrene (BaP) equivalence concentration based on Potency Equivalence Factors for different PAHs previously (i.e. concentration expressed as BAP_{eq}).

Concentrations of both PCDD/F and PAHs are so low that the concentrations can be expressed as a lower, middle or upper bound depending on how non-detects are treated. For this assessment, the middle bound concentration has been presented, which adopts a concentration of half the detection limit for compounds that non-detects.

The assessment criteria are set as follows:

- Dioxins: California OEHHA guideline of 0.00004 µg WHO-TEQ /m^3 or 40,000 femtograms WHO-TEQ per cubic metre (fg/m^3) as an annual average.
- PAHs: AAQG value of 0.0003 µg/m^3 (annual average) set for BaP_{eq}.

The assessment criteria for dioxins and PAHs are expressed as an annual average. The available data (seven months total) does not allow the calculation of an annual average concentration. However, the average over all the results has been compared to the assessment criterion to provide some context for the results. The average measured middle-bound concentrations are compared with assessment criteria in **Table 7.14** and **Table 7.15**.

Table 7.14: PCDD/F concentration comparison with assessment criteria

Parameter	Assessment criterion (fg WHO-TEQ/m^3, annual average)	Average measured concentration (middle bound) (fg WHO-TEQ/m^3)	% of criteria
Dioxins (WHO-TEQ)	40,000	9.1	0.023%

Table 7.15: BaP_{eq} concentration comparison with assessment criteria

Parameter	Assessment criterion (pg/m^3, annual average)	Average concentration over sampling period (middle bound) (pg/m^3)	% of criteria
Benzo[a]pyrene equivalent	300	11.2	3.7%

Modelling of emissions of PAHs from the operation of the generators shows a negligible impact on off-site concentrations, with an additional contribution of 0.03% of the Benzo[a]pyrene annual average criterion.

7.5.2 Discussion and conclusions

The average concentration of dioxins (WHO-TEQ) at 64 Glenbrook Beach Rd (Site 20) is 0.023% of the assessment criteria, and the average concentration of BaP_{eq} is 3.7% of the assessment criteria. Given this, there are not expected to be any adverse effects on people's health from exposure to these contaminants. Notwithstanding the limited sampling period, the measured concentrations of both dioxins and PAHs are so low compared to assessment criteria that it is unlikely that undertaking wintertime monitoring would alter the conclusions of the assessment.

7.6 Hydrogen chloride and chlorine

7.6.1 Assessment

The effects of HCl and Cl_2 emissions have been assessed using dispersion modelling. The background concentration of these contaminants is assumed to be zero as there have been no other sources identified in the area. The assessment criteria have been derived from:

- California OEHHA for 1-hour average criteria; and
- Ontario (Canada) 24-hour average ambient air quality criteria.

The modelled emissions are based on the maximum measured concentrations in both of the stack sources. This is a particularly conservative assumption for HCl as the maximum stack concentration in the main source (ARP Scrubber) is likely to be carry-over from the scrubber, which is not representative of the actual emissions from the stack.

The predicted concentrations are compared to assessment criteria in **Table 7.16**. The 1-hour average concentrations are based on the maximum predicted ground level concentrations anywhere off-site and the 24-hour average concentrations are the worst-case at any sensitive receptor.

Table 7.16: Evaluation of modelled ground level concentrations of HCl and Cl_2 against assessment criteria

Contaminant	Assessment criteria (µg/m³)	Averaging period	Predicted concentration (µg/m³)	% of criterion
HCl	2100	1-hour	3.7	0.2%
	20	24-hour	0.43	2%
Cl_2	210	1-hour	14.3	7%
	10	24-hour	1.6	8%

7.6.2 Conclusions

The predicted concentrations of HCl and Cl_2 are low relative to the assessment criteria and therefore there are not expected to be any adverse effects on people's health from exposure to these contaminants.

7.7 Volatile Organic Compounds

7.7.1 Assessment basis

Emissions of VOCs from the Paint Line Oven Incinerator stacks have been assessed based on dispersion modelling. Representative VOC emission rates have been developed based on stack testing on the Prime Oven Incinerator and Finish Oven Incinerator stacks. The emissions from these ovens are treated by incineration, which is a highly effective method of destroying VOCs and consequently emission rates are very low. The emissions are conservatively modelled as continuous discharges from the stacks although, at present, they do not operate continuously. In future NZ Steel may upgrade the application systems so that it can operate through the usual downtimes, which will increase the operating time of the Paint Line over the course of the year. This change will not increase the mass emission rate used in the model, and because the model has assumed continuous operation, this change will not alter the outcome of the assessment.

The AAQG sets annual average limit for benzene of 3.6 µg/m^3 (annual average), which is also adopted as an AAAQT in the AUP. The remainder of the assessment criteria have been adopted from the OEHHA and Texas Commission on Environmental Quality.

7.7.2 Conclusions

The modelling predicts that off-site VOC concentrations for all relevant averaging periods are less than 1% of the relevant assessment criteria, and in many cases orders of magnitude below the criteria (see Table 8.4 in **Appendix C**). For example, the maximum predicted ground level concentration of benzene, at any sensitive receptor (assuming continuous benzene emissions) is 0.03 µg/m^3 (annual average), which is 0.9% of the AAQG. On this basis, emissions of VOCs are assessed as negligible.

8 Assessment of nuisance dust effects

8.1 Introduction

There are a number of operational activities associated with handling raw materials (particularly coal) and co-products that can generate dust at the Operational Area through typical mechanical disturbance activities, including:

- Handling of materials – Movement, loading and conveyance of raw materials are handled on site using excavators, loaders, conveyors and tipped from trucks.
- Crushing of materials – Pulverisation and maceration of dry material has the potential to generate dust and reduces particle size of the material (allowing particles to be more easily entrained and transported in wind).
- Screening of material – Disturbance during screening also generate dust, in particular finer fractions.

Movements of trucks over unsealed surfaces or where material is spilled or deposited on sealed surfaces can generate dust. In addition to raising dust, vehicles may have a pulverising effect on surface material, thereby reducing particle size of the material surface. During transport dust particles may be lifted from exposed surfaces and sucked into the turbulent wake behind the vehicles. Dust can also be generated through the turbulence caused during excavation or movement of materials.

Tipping of very hot materials, such as molten iron, RPCC or slags is also a fugitive source of fine particulate that can contribute to offsite nuisance dust.

Although this section of the report focuses on nuisance dust effects, the assessment of PM_{10} emissions shows that fugitive dust emissions from these sources also materially contributes to PM_{10} concentrations.

8.2 Assessment approach

The following assessment approach has been used to assess the effects of fugitive dust emissions from the Site:

- Identification of the main dust generating activities at the site and the environmental factors that can influence dust generation;
- Description of the measures used to manage dust emissions and mitigate potential environmental effects and comparison with recommended methods in good practice guidance;
- Evaluation of the monitoring data at the Training Centre (Site 3) and 64 Glenbrook Beach Rd (Site 20) monitoring sites to review the impact of Steel Mill activities on the measured dust levels;
- Assessment of separation distances and location of nearby sensitive receptors, and the likely exposure of those sensitive locations to winds from the direction of the site (Section 8.5.2);
- Review of the history of complaints related to discharges to air; and
- An assessment of the potential dust effects using the FIDOL factors (Section 8.6) for those sensitive locations in the area.

The assessment approach is consistent with the guidance in the Ministry for the Environment's Good Practice Guide for Assessing and Managing Dust (GPG Dust) (MfE, 2016a). The GPG Dust sets out a toolkit of assessment techniques for evaluating the impact of dust emissions.

8.3 Dust generating activities

8.3.1 Tipping of hot materials

8.3.1.1 Iron plating

Plating of molten iron from the Melters currently occurs in two circumstances: plating due to process disruption ('process iron plating'), and plating for commercial sale ('commercial iron plating'). Process plating is a contingency measure due to process issues such as plant break down, out-of-specification metal, scheduled or unplanned maintenance activities, or other process reasons. Given the process iron plating activities are related to process interruptions which are not always predictable, they occur on a sporadic basis – sometimes more than once a day and sometimes not for many days. Given the contingency basis on which this process iron plating is undertaken, its practice is minimised as far as practicable (as reflected by the existing resource consent conditions). Annual tipping rates of molten iron in recent years have been 35,800 tonnes (2018) and 28,000 tonnes (2019).

In October 2020, the Commercial Iron Plating Air Permit was granted, enabling NZ Steel to verify the commercial viability of producing plate iron in sufficient quantities to allow customers to test the material in their processes (e.g., electric arc furnaces) such that it meets the quality standards of the products' end user. Limits on the volume and frequency currently apply to commercial iron plating under that Permit, as follows:

- No more than seven ladles per day; and
- No more than three ladles per hour.

One ladle is approximately 70 tonnes of molten iron at about 1200°C. When the molten iron is poured on the ground in the tipping beds, a large surface area of molten metal is exposed to oxygen in the air. The rapid oxidation (by oxygen in the air) of the liquid iron at high temperatures forms iron oxide (ferric oxide or Fe_2O_3) fume. The thermal lift created by the hot metal lifts the plume into the air, creating a characteristic orange brown "cloud" that is dissipated by the wind.

Because of the height of the 'cloud', the iron oxide fume has previously been highly visible from off-site immediately after an iron plating event (see Figure 8.3). The rate of dispersion of the cloud is highly dependent on the meteorologically conditions at the time of tipping.

The Air Quality Assessment prepared to support the Commercial Iron Plating Air Permit application included an investigation into the measured impact of plating events[22] at the Training Centre (Site 3) monitoring site for TSP and 64 Glenbrook Beach Rd (Site 20) monitoring site for PM_{10} and $PM_{2.5}$. Both monitoring sites are downwind of the tipping beds. The investigation found there was minimal measured impact at the monitoring locations associated with plating, i.e, on average, each ladle of iron contributed approximately 2 µg/m3 to the measured 1-hour average PM_{10} concentration, and 7 ladles in 24 hours would contribute approximately 0.6 ug/m^3 to the 24-hour average concentration, a negligible impact.

Given the findings of the investigation into the off-site effects of plating during Alert Level 4, the contribution of iron plating to off-site PM_{10} and TSP levels is expected to be a small contribution to total measured levels.

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[22] Air Quality Assessment – Commercial Plating at the Glenbrook Steel Mill, September 2020, Tonkin & Taylor Ltd. Ref:1010577.3000

8.3.1.2 Slag tipping

Slag tipping involves the pouring of hot molten metal impurities produced at the Melters in the Iron Plant, and the KOBM at the Steel Plant. The slag from these processes is poured into pits adjacent to the Material Recovery (MR) Plant area, generally in the northwestern portion of the yard as shown as **Figure 4.7**. Slag tipping may occur at any time, as slag is generated at the continuous operations in the Iron Plant.

A continuous water stream is applied to the tipping area to aid cooling of the slag materials, and results in flashing of steam with some entrained particulate.

During Alert Level 4, tipping of slag from the Melters occurred in sync with iron plating. The findings of the review of the impact of iron plating at downwind monitoring sites is therefore also relevant to slag tipping as a cumulative impact. As discussed in Section 8.3.1.1, the measured impact of the activities during Alert Level 4 at the Training Centre (for TSP) and Glenbrook Beach Road (for PM_{10} and $PM_{2.5}$) monitoring sites were found to be negligible. Based on that analysis, the contribution to off-site PM_{10} and TSP and levels from slag tipping is expected to be low.

8.3.1.3 RPCC losses

In the Iron Plant at NZ Steel, four sets of MHFs and Kilns are used to dry, de-volatilize and pre-reduce the primary concentrate, blended coal and limestone. The product of the Kiln process is the RPCC which is supplied to the two Melters where final reduction of the RPCC takes place to produce iron.

The continuous nature of the iron making process means that there is a need to discard some of the RPCC produced in the Kilns, for the reasons outlined below. In recent years, in line with NZ Steel's continual improvement philosophy and aim to maximise yield, considerable reduction in RPCC losses have been achieved. This has included lowering the Melter acceptance metallisation rate, reducing losses following kiln start-up (after maintenance shutdowns) and improved process control. In addition, trial work is underway for accretion crushing and direct addition of crushed-accretion to the Melters, which would avoid open tipping (the feasibility of this method is yet to be fully assessed).

During planned maintenance of the ironmaking or steelmaking plants, the kilns feed is reduced accordingly to minimise, or avoid RPCC losses. RPCC losses are transported in a ladle and tipped into excavated pits to be cooled, before recovery. Tipping of the hot RPCC results in emissions of fine particles, carried up in the buoyant steam plume, which may travel beyond the boundary of the Site.

There are three main reasons why RPCC needs to be discarded:

- Accretions: Large boulders of RPCC, referred to as accretions, form in the rotary kilns. This is unavoidable and therefore a small amount of RPCC is lost daily from removal of accretions. Although the amount of material lost in accretions is relatively small (5 – 15 tonnes at a time), cumulatively they make up around half of the annual RPCC losses.
- Off-specification product: Periodically, the RPCC produced in the kilns does not meet the specification for the Melters and must therefore be discarded. Off-specification product will typically arise whenever a production stream is re-started, following a planned or un-planned delay. RPCC is classified as reject if the level of metallization is below 60%.
- Prime RPCC: When direct feed to the Melters is not possible, due to capacity, then Prime RPCC will firstly be fed to a 700 tonne storage hopper for later addition to the Melters. However, on occasion, the capacity of the hopper is exceeded and it is necessary to discard some Prime RPCC.

Off-specification and Prime RPCC tipping occurs sporadically, sometimes not for weeks. However, when it does occur, it can involve large volumes of material.

The average annual quantity of tipped RPCC material is 30,000 to 35,000 tonnes.

Under adverse meteorological conditions, the hot, dust-laden cloud from RPCC losses can be transported some distance from the Site. The thermal and physical properties of this hot plume are complex as it involves condensation and re-evaporation of steam, which alters the density of the plume, as well as agglomeration of the particulate matter. This makes it difficult to predict the behaviour of the plume as it disperses. On most occasions, the visible plume disperses rapidly within the NZ-Steel landholding. However, NZ Steel staff have observed that, on occasion, material can be transported long distances aloft (RPCC fallout is most commonly observed within 2 km from the Operational Area) and will then ‘drop’ over a relatively small area, estimated to be in the order of 50 m^2, based on inspections of properties when RPCC dust is reported to NZ Steel. As noted in Section 8.5.4, these events of RPCC ‘drop out’ can result in complaints from time to time. NZ Steel responds to all complaints to verify RPCC drop out and facilitate clean-up of the material, as appropriate.

8.3.2 Iron and steel manufacturing process fugitive emissions

Fugitive dust can be generated through processes or activities where the process is not completely enclosed and may handle light and/or dry materials. Sources can include uncovered conveyor systems, dust generated during maintenance of equipment, open ventilation of systems and co-products of chemical reactions. Many of the sources in the Iron and Steel Plant are controlled using conveyor covers, extraction systems, and hoods on ladles, which enable capture of these fugitive dust sources. Examples include the covered conveyors for primary concentrate and coal delivery to the MHFs (known as the MHF pan conveyor) which are covered and extracted to a wet scrubber, and the Melter Metalside and Slagside Baghouses which extract fume via the hoods over the Melter ladles.

NZ Steel’s evaluation of fugitive sources undertaken in late 2020 has identified occasional fuming from the VRU building as a fugitive process emission with potential for off-site impacts due to the height of the building and size of the fume particle. The fuming does not occur with every ladle processed at the VRU but is noticeable during conditions that cause winds to blow through the building’s large vehicle access doors. This occasional fume within the building also has been identified as a worker exposure issue, and NZ Steel are currently developing a solution to improve fume capture in this area and prevent these occurrences, possibly by repurposing the disused emission control equipment from the closed pipe mill.

Flap lifts at the Kiln or MHF waste gas systems can also occur for the purpose of pressure relief. A “flap lift” occurs when the gas pressure in the system reaches or exceeds a safe level for the equipment, opening the emergency vent and releasing hot un-scrubbed waste gas directly to atmosphere.

The contribution of most of these process sources to the total fugitive emissions from the site is expected to be relatively small overall due to the relative scale and frequency of the emissions.

8.3.3 Wind and mechanically-generated dust

8.3.3.1 Melter slag processing and storage

The slag processing undertaken on site by SteelServ in the preparation of roading and drainage aggregates includes stockpiling, reclaiming, crushing and grading and loading activities. The aggregate crusher has a capacity of 150 tonnes per hour and is fitted with water sprays to reduce particulate generation. Melter slag is processed in the northwestern portion of the yard adjacent to the Melter slag stockpile (see **Figure 4.7**).

Slag aggregate is stockpiled for weathering prior to further processing. This stockpile is up to 20 m in height above the ground level. Although the slag aggregate is a dense material, due to the size and height of the stockpile there is potential for some fugitive dust generation, particularly under high wind conditions. Analysis of mean TSP and PM_{10} levels at the downwind monitoring sites (Appendix D Section 6) indicates that elevated fugitive dust levels are highest during the Monday-Friday period. Continuous sources such as wind erosion from stockpiles are therefore considered to have a lower contribution to ambient dust levels than activities that occur during the week, such as the crushing and grading of slags.

Overall, slag stockpiling is expected to have limited off-site impact on TSP and PM_{10} levels because the slag stockpile is located a considerable distance from off-site receivers and the slag aggregate is a coarse, heavy material.

8.3.3.2 Iron reclamation

Iron reclamation activities occur in the north-western portion of the yard. These activities mainly involve screening of heavy materials to recover iron from dried settled sludges for reuse in the steelmaking process. The material handled in this area is dense and has a low propensity for generating fines. This area is also located on the westernmost part of the yard, with more than 1 km from sensitive off-site receivers.

The contribution to off-site PM_{10} and TSP levels from this activity is expected to be small, given the density of the material and the considerable distance of the activity to the site boundary.

8.3.3.3 Metal recovery plant

The crusher in the Metal Recovery (MR) Plant is operated by Steelserv and used to break down work debris and slags to produce aggregates and to recover residual metallics for re-use in the steelmaking process. The MR Plant has a capacity of 100 tonnes per hour. As with processing of Melter slag, this operation also includes grading, stockpiling and loading activities.

The crusher in the MR Plant is operated on a semi-regular basis with operation several times per week and utilises water sprays for dust suppression. The dust generated during operation of the crushing and screening process has a high fines content and is released at height. Although the plant is a large distance from sensitive receivers (at the far western side of the yard), there is potential for off-site effects due to the fines content and height of release, as well as its contribution to dust on site roads. This activity is estimated to have a moderate contribution to off-site PM_{10} and TSP levels.

8.3.3.4 Coal storage and handling

Prior to 2013, all coal used at the Site was from the opencast Rotowaro mine and the underground Huntly East mine. In recent years, imported coal from Indonesia has become a permanent source, constituting up to 50% of the coal purchased annually, due to decline in production of coal suitable for NZ Steel ironmaking process in New Zealand. The Indonesian coals are equal to, or slightly better, than the Huntly coals in terms of ash and sulphur content. Over 2017 to 2019 the average annual coal use was approximately 670,000 tonnes (dry basis).

Domestic coal delivered by rail from the Huntly Coal Mines is discharged from bottom dumping rail cars and transferred by conveyor to the working stockpile. It is from the working stockpile that the MHF is fed, travelling via the reclaim conveyor. Limestone or KOBM Slag is placed on the working stockpile and may generate some dust during its placement. A small volume of domestic-sourced coal is also delivered by truck due to limited coal terminals at some local mines.

Imported coal is delivered by truck from the Port of Auckland. Coal delivered by truck is unloaded and placed into a number of smaller stockpiles within the northern Operational Area (see Figure 4.7). Coal brought onto the Site by truck and stockpiled is subject to more handling (lifts and drops) compared to rail delivery using bottom dumping cars. There is also increased heavy traffic on internal roads compared to importation of coal by rail.

Coal shipments are larger and less frequent than domestic deliveries. Therefore, overall, it is necessary to store greater volumes of coal at the Site compared to the time when almost entirely domestic coal was used. The configuration of coal stockpiles within the Operational Area in terms of their location, height and extent changes over time depending on operational and logistic requirements.

Increasing quantities of coal being stockpiled increases the surface area available to wind erosion. However, dust emissions are not simply a function of the quantity of coal stored. The height of the stockpile(s) and their orientation to the prevailing winds, as well as any natural or constructed wind breaks (including other stockpiles) will all influence the amount of dust generated. The effects of dust emissions are also related to separation distance to sensitive locations.

Although the impact is difficult to quantify, the increased amount of imported coal being stockpiled and handled is likely to be a contributing factor to the increased number of days with high PM_{10} concentrations measured at 64 Glenbrook Beach Rd over the last 10 years (see Figure 7.1). However, an investigation of the daily patterns of PM_{10} concentrations suggests that wind entrainment of dust from stockpiles (which would not be expected to show weekday/weekend variations) is not the main contributor on the days with the highest measured PM_{10} concentrations.

8.3.3.5 Handling waste and co-products

There is a variety of activities associated with the handling of dry waste and co-product materials. These activities can include loading dump trucks with works debris, slags, etc and screening materials through the grizzly bars to the north of the iron tipping banks. Individually these sources are expected to be relatively minor, however can contribute to cumulative effects.

8.3.3.6 Sealed and unsealed roads and yards

There are a number of unsealed roads for access to the raw material stockpiles, slag tipping areas and Steelserv's processing operations at the northern areas of the Operational Area. A number of roads within the Iron and Steel Plant are also unsealed. Traffic movements over these surfaces may occur at any time but are most frequent during the day shift hours. During the weekend there is a lower frequency of raw material deliveries and the landfill is closed for receipt of process waste, hence there is reduced traffic to the northern yard.

Dust can be generated from vehicle movement on both paved and unpaved surfaces. The primary mechanism to cause dust is from the lifting of materials from the road by the vehicle's wheels and the turbulent wake of air behind the vehicle. Vehicles also cause the breakdown of materials into finer particles over time, making the materials more prone to vehicle pickup. Paved surfaces may accumulate dusty materials from windswept materials from other parts of the Site or through tracking of dusty material by vehicles travelling from unpaved areas of the Site. Unpaved roads can generate dust through the pulverisation of materials on the road surface.

Efforts to minimise the height of coal stockpiles (and hence exposure to higher wind speeds) can result in a larger number of shorter piles. This can, in turn, result in more transitions of vehicle traffic from sealed to unsealed areas which, under dry conditions, can contribute to greater fugitive particulate emissions. Adjustments to stockpile layout and internal road layouts remain necessary for operational flexibility and can be managed through the methods set out in Section 8.4.3.

As noted in Section 8.3.3.4, there has been an increase in truck movements in the northern Operational Area, since around 2013 largely related to the increased use of coal delivered by truck (rather than by rail). Also, for a period there was some contribution from exporting ironsand from the Site (which has reduced more recently). Although the impact is difficult to quantify, the increased amount of truck movements on unsealed or poorly maintained roads, is likely to be a factor in the higher PM_{10} concentrations observed on weekdays compared to weekends. Therefore, overall truck movements around the raw materials and co-products are likely to be a contributing factor to the increased number of days with high PM_{10} concentrations measured at 64 Glenbrook Beach Road over the last 10 years (see Figure 7.1).

Recent improvements to dust controls at the Site, such as new high-capacity water carts, a new dust sweeper and road surface improvements are expected to have reduced dust emissions. However, as many of these improvements were completed in early 2021 (after the summer period) it is not yet possible to demonstrate the effectiveness of these measures from the ambient air monitoring data.

8.4 Controls to manage dust emissions

8.4.1 Tipping of hot materials

8.4.1.1 Iron plating

NZ Steel aims to avoid tipping of molten iron in open tipping beds as a result of process disruption, to the extent practicable. In the absence of fume suppression equipment, the iron plating generates fume during pouring as the molten iron oxidises on contact with the air, as illustrated in Figure 8.3 below.

In order to minimise the visual impact of iron plating, NZ Steel has developed a plating fume suppression system. In this system, the molten iron is poured via a hopper in an inert atmosphere and through a 4-metre launder to the tipping bed (see Figure 8.1 and Figure 8.2).

There are three iron plating beds, two of which will be set up with the fume suppression system. One unit has been fully commissioned as of mid-2021 and the second unit will be available in 2022. The third plating bed will only be used should the other two not be available, therefore it is anticipated that greater than 90 percent of ladles tipped will be fume suppressed.

Fume generation is suppressed through two mechanisms:

- Modification to the ladle-carrier hydraulics in this system enables a much slower pouring rate, which reduces turbulence mixing with oxygen; and
- The fume suppression system uses fixed nitrogen nozzles to blanket the iron surface in an inert gas, further minimising oxidation of the metal.

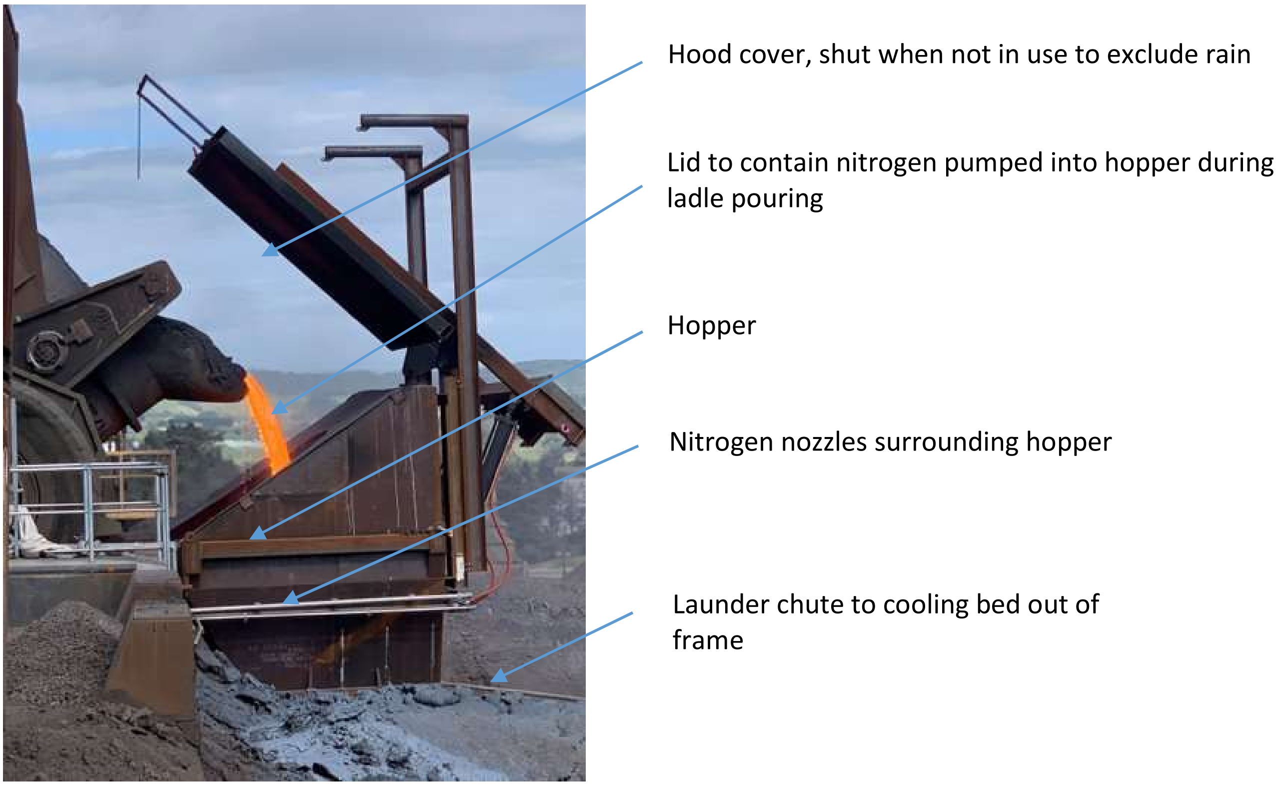

Figure 8.1: Molten iron poured to the fume suppression system *(Source: NZ Steel)*

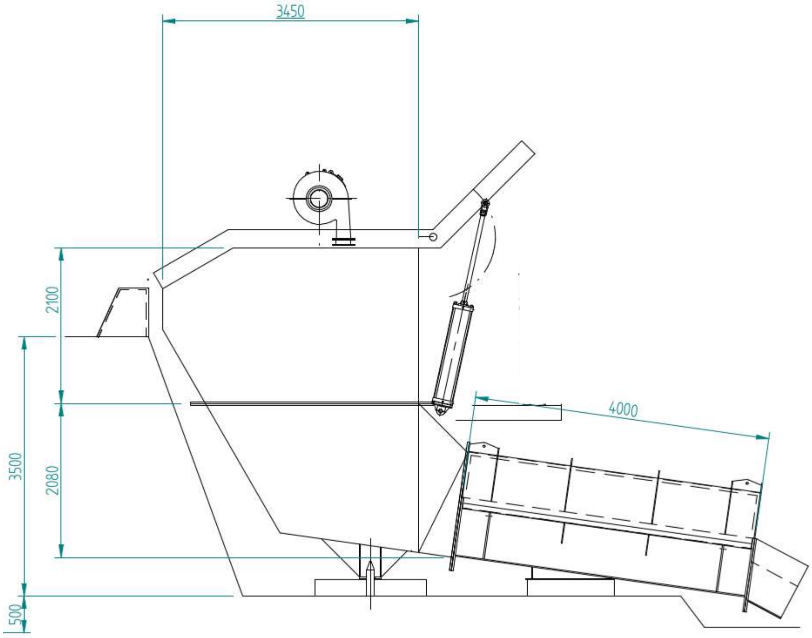

Figure 8.2: Schematic of fume suppression system showing 4 m launder *(Source: NZ Steel)*

The efficacy of the fume suppression system has been found to vary with iron temperature, pour speed, ladle chemistry and wind direction. However, the fume is substantially reduced.

There will be some circumstances when the fume suppression system will not be utilised for a plating event, such as if the carbon content of the metal is out of specification for pouring via the chute, or when the system is out for maintenance. However plating events without fume suppression will be minimised to the extent practicable. This will minimise the visual impact of hot metal tipping and any effects of iron plating on off-site PM_{10} concentrations (noting that any effect will be small as the contribution from iron planting is not discernible in the PM_{10} monitoring data).

Figure 8.3: Fume generated during an unsuppressed iron plating event *(Source: NZ Steel)*

8.4.1.2 Slag tipping

The fume emissions from slag tipping are significantly less than from iron plating. Slag is comprised of a variety of metal impurities and oxides formed during the iron and steelmaking processes and does not form oxides during tipping to the same extent as the pouring of iron metal. As a result, the fume cloud produced during slag tipping is much smaller than from iron plating and is typically visible for only around 15 seconds before dissipating.

In addition, slag cannot be poured through a chute because it would rapidly solidify within the unit and block the flow of material, making it impractical to operate and service. Given these differences, a fume suppression system like that developed for iron plating is not feasible.

While slag tipping does generate some PM_{10} in the form of metal fume, the measured impact of the PM_{10} from slag tipping at monitored locations has been demonstrated to be negligible.

8.4.1.3 RPCC losses

For the same reasons discussed above in relation to slag tipping, the fume suppression technology developed for iron plating would not be effective for RPCC tipping, as the emissions are not metal oxides but predominately particulate.

NZ Steel has a long-established objective to minimise loss of RPCC for a range of reasons, including material and production efficiencies (cost and yield), to avoid particulate deposition in the community (nuisance effect) and to avoid waste deposits into its landfill. As such, NZ Steel has set and tracked a target to minimise RPCC tipping, as a percent of kilns production. Although the annual average reported RPCC loss rates for 2017-2019 have been very low, at around 3% or less of the Kiln production rate, NZ Steel has been active in introducing initiatives to further reduce RPCC losses. These include the following:

- In March 2016, a project was started to accurately record a range of variables during start-ups. At the same time, a more aggressive approach was taken to add process air volumes to the kilns through the kiln shell air fans. In addition, the RPCC metallization acceptance level was reduced from 65% to 60%. The outcome of this project is estimated to have avoided RPCC losses of around 2800 tonnes per annum – in addition to reducing coal and primary concentrate losses of 5800 tonnes per annum.
- The Melter "feed acceptance criteria" for metallics was reduced, which further reduced the volume off-specification product and therefore loss to the iron making process.
- Investigation into commissioning in-line crushing of accretions for direct recovery of RPCC. This avoids tipping hot material into excavated pits and then screening in an open area which has potential to generate dust. This would reduce the frequency of RPCC tipping significantly and would eliminate up to half the annual RPCC losses.

8.4.2 Iron and steel process fugitive emissions

Fugitive emissions from the iron and steel plant areas are captured at source wherever possible. The control measures to minimise fugitive dust from processes is specific to the manufacturing plant, process or activity, but can broadly be described as follows:

- Use of enclosed or covered conveyors for materials where dust may be generated;
- Provision of local ventilation and extraction around activities that cannot be completely sealed, such as the ladles;
- Inspections and preventative maintenance scheduling for optimal performance of the material handling equipment.
- Housekeeping to minimise carryover of dusty materials from the plants onto adjacent roads, during transport of materials into and out of plant.

Flap lifts at the MHF or Kiln waste gas systems occur as a result of overpressure in the equipment from process disruptions. NZ Steel aims to minimise flap lifts for process safety reasons and to optimise production. Flap lifts are primarily minimised through regular maintenance and testing of the safety interlocking and pressure control systems.

8.4.3 Wind and mechanically generated dust

There are a number of environmental factors that influence the potential for dust to be generated within the Operational Area. These factors include:

- Surface wind speed – The generation of dust emissions through wind erosion of exposed surfaces generally increases with wind speed. Dust pick-up by wind typically becomes significant at hourly average wind speeds of greater than 7 m/s (13 knots)[23]. Propagation of dust suspended in air through mechanical disturbance towards downwind locations may also occur at lower wind speeds.
- Moisture content of the material – Moisture binds particles together and prevents dust from being generated through surface wind or disturbances such as vehicle movement. Application of water or chemical suppressants to unsealed roads and yards minimises dust generation from vehicle movements.
- The area of the exposed surface – The greater the area of exposed surface, the larger the potential for dust generation will be. Stabilisation of surfaces (e.g. through application of water or chemical suppressants to roadways as described above, or through coverage of coal

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[23] AWMA 2000. Air Pollution Engineering Manual – Second Edition. Air and Waste Management Association, John Wiley & Sons Incorporated, Canada.

stockpiles with limestone) significantly decreases the potential for generation of dust by binding surface particles and reducing surface wind speeds.

- Particle size distribution of the material – Fine particles are more easily entrained in wind or lifted via mechanical disturbance.

These sources are expected to be key contributors to elevated levels of dust off site, and the dust management and control measures are generally focussed on managing the contributing factors listed above. The methods for minimising fugitive emissions are set out in the Draft Air Quality Management Plan (**Appendix F**) and summarised in **Table 8.1**

Table 8.1: Mitigation summary for fugitive emissions

Fugitive source	Control measure
All sources	NZ Steel has established screening plantings around much of the site boundary, including taller trees around the northern edge of the stockpiling areas. These plantings are principally to provide a visual screen, however vegetative plantings can have positive impacts on mitigating dust effects in two different ways. First, tall screening planting can reduce wind speeds and therefore reduce dust pick-up. This is most effective when the plantings are upwind of the dust source and the plantings are relatively permeable, to minimise the creation of turbulence zones in the lee of the planting, which can have the opposite effect of increasing dust entrainment. Second, vegetation can have a filtering effect, by capturing a portion of the dust. The effectiveness of vegetative screenings at filtering dust is not well characterised and will be influenced by the density of planting and the type of trees (e.g. leaf shape, leaf density, etc).
Coal and primary concentrate stockpiles and handling - coarse dust	Enclosed conveyors for transfer of coal, primary concentrate and limestone reduces particulate emissions. The height of stockpiles is managed to maintain the minimum practicable height and located to minimise wind shear. Housekeeping in yards, such as containment of stockpile margins and when yards are empty, full maintenance program to remove fine materials back to stabilised yard surface. Maintenance of unsealed roads in stockpile areas and yards (such as removal of fine material from roads and regular resurfacing with appropriate roading material).
Co-product (including slags) and works debris processing and stockpiling	Height of stockpiles is managed to maintain the minimum practicable height, particularly where material placed on or recovered from a stockpile is undertaken at the top of the stockpile. Processing areas and stockpile location for the finer dry materials such as KOBM slag, works debris and other co-products, are situated to minimise wind shear and water sprays applied for dust suppression, where practicable. Minimising stockpiling of material to be processed in Metal Recovery Plant and co-product screening areas. Minimising stockpiling of processed materials, before reuse in Primary Plants or sale. Housekeeping (such as containment of stockpile margins) and unsealed road maintenance in stockpile areas and yards (such as removal of fine material from roads and regular resurfacing with appropriate roading material).

Fugitive source	**Control measure**
Sealed an unsealed roads and yards	Daily deployment of watercart for dust suppression in dry conditions. Sweeping of sealed roads when dust build up is observed. Stabilising of unsealed surfaces using chemical dust suppressant application or "metalmaxx" aggregate. Road repairs, upgrades and maintenance to minimise extent of unsealed roads, road deterioration and pothole formation. Where internal unsealed roads and yards exit onto sealed roads, the apron is stabilised to minimise carryover. This is to be progressively extended as existing sealed roads are resealed and current unsealed roads are sealed. Large vehicle speeds limited in unsealed areas. Recent capital investments targeted the reduction of emissions from these sources, include: • the commissioning of two new high capacity water carts; • the commissioning of a new road sweeper; • use of "metalmaxx" aggregate for a durable surface at new entry to coal stockpile area; • sealing the site exit to Brookside Road; and • Installation of a wheel bath in July 2020 at the North Gate (Weighbridge Road exit) for trucks leaving the site onto the sealed internal road and Brookside Road. This portion of sealed road has the highest volume of movements for vehicles exiting the site.
RPCC tipping	Tipping of prime RPCC only occurs as a contingency operation due to process disruptions. A 700 tonne RPCC hopper is used for storage of prime RPCC to avoid tipping during process disruptions. RPCC tipping targets set at an agreed percentage of kilns production. Reduction in prime and off-specification RPCC material tipped since 2016 due to changed operational control, particularly during Kiln start-up and lowered Melter feed iron content acceptance criteria. Operational focus on reducing RPCC accretions (boulder like material formed in kilns which cannot pass to storage hopper, or Melters) which account for up to 50% of the annual RPCC losses.
Iron plating	A fume suppression system, which operates by blanketing the metal being poured with an inert gas to reduce formation of iron oxide fume has been developed that was being commissioned at the time of preparing this report.
Co-product and ferrous scrap yard	Housekeeping (such as containment of stockpile margins) and unsealed road maintenance in stockpile areas and yards (such as removal of fine material from roads and regular resurfacing with appropriate roading material). Minimising stockpiling of material to be processed in MR Plant and processed materials. Consolidation of ferrous scrap and works debris stockpiling and processing areas, to minimise internal large vehicle traffic on unsealed roads.
Dust and fume capture systems	Many sources in the Iron and Steel Plant are controlled using conveyor covers, extraction systems and hoods and enclosures, which enable capture fugitive dust and fume. Scheduled equipment maintenance, daily inspection and visible monitoring, to ensure equipment is operating correctly and avoid/minimise fugitive fume and dust.

Fugitive source	Control measure
Waste handling and landfill	Waste handling methods to minimise/avoid dust generation, including wetting of dusty materials, water sprays, location of activities and associated stockpiles to minimise wind shear and material transfer.

8.4.4 Adaptive management of fugitive dust

In 2015, NZ Steel developed a qualitative fugitive dust source ranking tool to help to prioritise capital expenditure on fugitive dust sources, based on their relative potential for off-site impacts. The methodology for this prioritisation tool is provided in detail in **Appendix H**.

The tool specifies key criteria for three different source types – roads, stockpiles and processes. Each of these categories have different parameters for calculating a ranking score as follows:

- The parameters for ranking roads include whether the surface is sealed, the frequency of watering or sweeping, proximity to sensitive receivers, the road grade and vehicle speed, number and type.
- Stockpile parameters include stockpile height, frequency of loading, proximity to receivers, and the particle size, moisture and density.
- Parameters for comparison of processes include height of dust release, particle size, density and moisture content, frequency of activity and proximity to receivers.

Because the parameters of interest are different between the categories, the qualitative ranking scores cannot be compared between categories.

The tool identified a number of roads for priority sweeping and sealing, as well as priority stockpiles for additional capital investment. The planned and recent fugitive dust controls are set out in **Table 8.2** below.

Dust generated at the landfill is not a matter for the renewal of this consent, however it is also noted that NZ Steel propose to install fixed water sprays at the landfill.

Table 8.2: Recent and planned fugitive dust source mitigation measures

Priority source	Proposed mitigation
Heavy traffic on unsealed roads	Two priority high-traffic raw material delivery access routes were sealed in early 2021. Purchase of two high-capacity water carts for scheduled dust suppression. (1 x Feb 2020 and 1 x Jan 2021). Quick-fill water tanks to be installed mid-2021 to provide for quicker turnaround of the high-capacity water carts. The installation of two new 30,000 litre, drive through, high volume flow, gravity drop-tanks, to minimise water cart refill time. (Apr 2021).

Priority source	Proposed mitigation
Tracking of deposited material from unsealed areas or raw materials yards to sealed areas	Installation of a wheel bath at the internal road exit from the coal yard to the main internal access route to the exit at Brookside Rd. New high-performance road sweeper for scheduled clearing of deposited dust. Diversion of internal site traffic to reduce the volume of trucks moving from unsealed areas to use the weighbridge on the recently sealed main internal access route. The intersections from unsealed areas to the planned sealed roads will be stabilised with chemical suppressants to minimise tracking.
Co-product and works debris processing and stockpiling	Improvement to recycled water pumping pressure to provide for more effective dust suppression sprays on tipping banks and around co-product processing areas (potentially from late 2021).
Coal stockpiles	Fixed waters sprays for dry domestic coal are currently being trialled.
Dust and fume capture systems	Steel Plant baghouse filter design modification and fume capture system modification to improve capture, underway with implementation potentially from late 2021.
Iron plating	New fume suppression system developed for commission in mid 2021. Slower tipping of molten iron via a chute and in an inert atmosphere significantly reduces turbulence of the metal and oxidation, resulting in a much smaller fume.
Metal cutting yard	While activities in this yard are considered to have a minor contribution to fugitive dusts, the remediation of 2 hectares of this area and relocation of the activities will reduce heavy vehicle traffic over unsealed roads and tracking.

8.5 Assessment of dust effects

8.5.1 Monitoring data and trigger levels

TSP monitoring data collected at the Training Centre (Site 3) monitoring site is relevant for evaluating the impact of NZ Steel' activities on ambient dust levels. The Training Centre is located relatively close to the northern yard area and will experience much higher dust levels than off-site receptors. PM_{10} monitoring data at the 64 Glenbrook Beach Rd (Site 20) monitoring site is also relevant and this data has been evaluated in Section 7.2 to show that fugitive dust sources are a significant contributor to measured PM_{10} concentrations. Time-varying trends in the TSP monitoring data show a similar positive correlation with higher wind speeds and time varying trends as the PM_{10} data at 64 Glenbrook Beach Rd (Site 20) (see **Appendix E** Section 6.6.2).

Good practice guidance includes recommended trigger levels for TSP to be used for proactive management of dust on site, as reproduced in **Table 8.3**.[24] A 1-hour PM_{10} trigger level of 150 µg/m^3 has also been recommended for high sensitivity receiving environments. In this context, PM_{10} is used as a proxy for the nuisance effects from coarser dust.

The Site is located in a rural area, which would generally be described as having a low sensitivity to dust, although dwellings will have a moderate to high sensitivity to dust. Overall, the recommended

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[24] Ministry for the Environment. 2016. Good Practice Guide for Assessing and Managing Dust. Wellington: Ministry for the Environment.

trigger level for a moderate sensitivity receiving environment, i.e. 250 µg/m^3 as a 1-hour average, is considered to be the most appropriate in the context of the environs around the Site.

Table 8.3: Short term trigger levels for management of dust (MfE, 2016)

Trigger	Averaging period	Sensitivity of receiving environment		
		High	**Moderate**	**Low**
Short term	5-minute	250	n/a	n/a
	1-hour	200	250	n/a
Daily**	24-hour (rolling average)	60	80	100

** For managing chronic (i.e. long term) dust only

Figure 8.4 presents the number of exceedances in each year at the Training Centre (Site 3) and 64 Glenbrook Beach Rd (Site 20) monitoring sites of the recommended trigger levels for TSP (moderate sensitivity receiving environment) and PM_{10} (high sensitivity receiving environment), respectively.

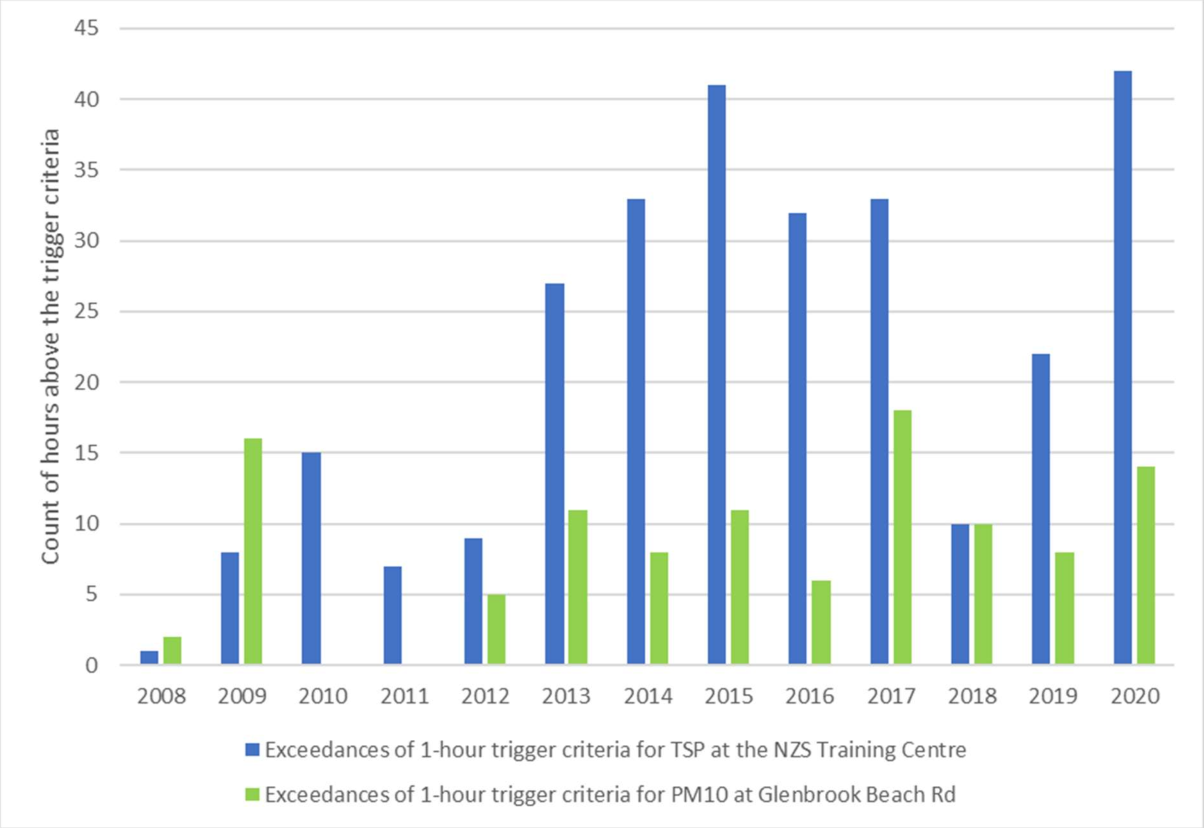

Figure 8.4: Count of hours above the 1-hour trigger criteria for PM_{10} at Glenbrook Beach Rd (Site 20) and TSP at the NZS Training Centre (Site 3) by year

As noted above, the Training Centre (Site 3) will experience much higher dust levels than off-site receptors. In this respect, 64 Glenbrook Beach Rd (Site 20) is considered to be more representative of sensitive receptors. There are typically between 5 and 17 hours each year where measured PM_{10} concentrations at 64 Glenbrook Beach Rd would exceed trigger levels recommended for high sensitivity receiving environments. In some cases, these hours occur on the same day (for instance, the 18 hours in 2017 that were above the trigger level occurred over ten days) and therefore the frequency of occurrence of dust at levels that might cause an odour nuisance is relatively infrequent. NZ Steel propose to adopt the 1-hour trigger level as the investigative trigger level for TSP at the Training Centre to be set in the new Air Permit to enable proactive management of acute short term dust events.

8.5.2 Separation distance

Raw materials and co-products storage and handling activities are predominantly undertaken on the northern part of the site (see **Figure 2.2** and **Figure 4.7**). Separation distances between sensitive receptors and the 'Operational Area' of the Site are identified in **Table 2.1**. This separation distance does not necessarily correspond with the nearest source of fugitive dust. For instance, the nearest Operational Area boundary to 190 Mission Bush Rd is the easternmost Site boundary, within which the closest activities are the rail lines and the Site administration carpark, neither of which are expected to materially contribute to off-site fugitive dusts at the residential location.

In practice, the northern yard contains the majority of fugitive dust sources such as material handling, stockpiles and unsealed roads. The separation distances between northern yard and the closest off-site receptors are of the order of 500 to 600 m (the closest sensitive receptor is R6 with a separation distance of 510 m to the northern yard area).

8.5.3 Meteorology

The generation of dust emissions through wind erosion of exposed surfaces and the propagation of suspended dust increases with wind speed. Dust pick-up by wind typically becomes significant at hourly average wind speeds of greater than 7 m/s (13 knots)[25], and surface pick up increases markedly at wind speeds greater than 10 m/s[26].

Propagation of dust suspended in air through mechanical disturbance towards downwind locations may occur at lower wind speeds.

The wind rose in **Figure 8.5** shows the prevalence of winds >7 m/s in the vicinity of the Site. This is based on hourly average wind speeds (not gust speed) measured at the 10 m mast at the Training Centre (Site 3). Winds greater than 7 m/s occur for less than 15% of the time. Most of the strong winds (greater than 7 m/s) experienced at the Site blow from the southwest (toward the 64 Glenbrook Beach Rd (Site 20) monitoring site. There is a much lower proportion of strong winds from the west compared to the frequency of all wind speeds (see **Figure 2.4**). This means that sensitive receptors to the east will be downwind of strong winds much less frequently than receptors to the northeast.

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[25] AWMA 2000. Air Pollution Engineering Manual – Second Edition. Air and Waste Management Association, John Wiley & Sons Incorporated, Canada.

[26] Watson J, Chow J, Pace T 2000. Fugitive Dust Emissions. The Air Pollution Manual – Second Edition. Air & Waste Management Association.

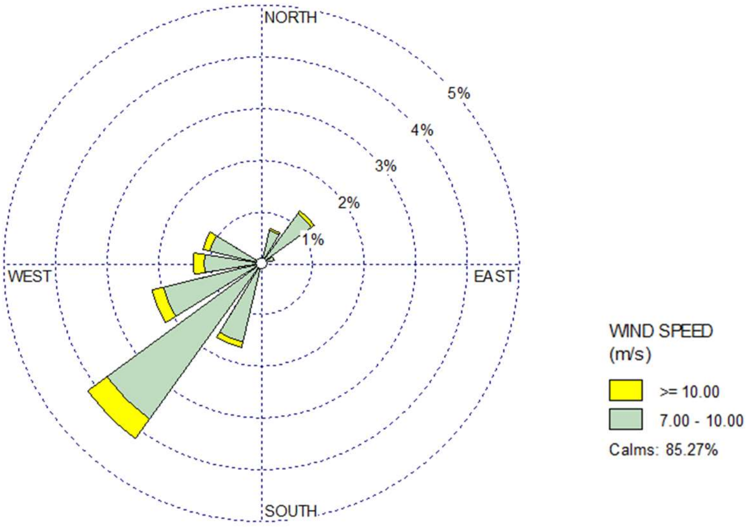

Figure 8.5: High speed wind rose for data collected at the 10m mast installed at the NZS Training Centre June 2019 – January 2021

8.5.4 Complaints records

NZ Steel keeps a detailed database of complaints from the community regarding environmental matters. The complaints record documents the date, time, weather conditions during the event, and also the result of any NZ Steel investigation and actions taken to mitigate the source of the complaint. **Figure 8.6** shows the number of complaints received annually by NZ Steel regarding fugitive dusts. While the absence of complaints does not necessarily indicate absence of nuisance effects, the trend in the number of complaints would indicate that the nuisance effects of dust to people off-site is becoming less frequent.

The root cause of dust complaints is predominantly determined to be RPCC fallout, which has a distinct localised deposition pattern. RPCC fallout is recorded as the cause of 43 out of the 57 complaints on record.

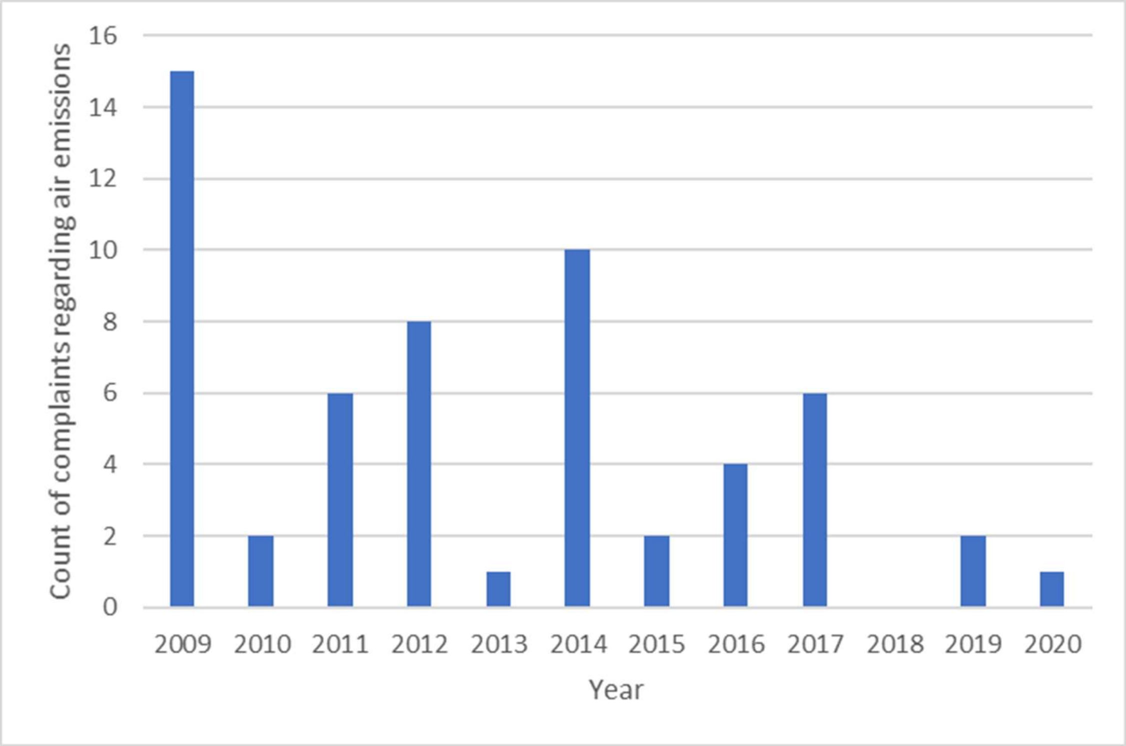

Figure 8.6: Annual number of complaints on record regarding fugitive dusts from the Steel Mill (current to end of 2020)

8.6 FIDOL assessment

Whether dust has an offensive or objectionable effect requires an overall judgement that considers the "FIDOL" factors. These FIDOL factors are described in the MFE "Good Practice Guide for Assessing and Managing Odour"[27] (MfE, 2016a) and are as follows:

Frequency	How often an individual is exposed to the dust.
Intensity	The concentration of the dust.
Duration	The length of exposure.
Offensiveness/character	The type of dust.
Location	The type of land use and the nature of human activities in the vicinity of the dust source

The following FIDOL assessment also highlights the measures that NZ Steel takes in order to avoid, remedy or mitigate any potential adverse effects on the environment.

Table 8.4: FIDOL dust assessment

Frequency	Frequency is determined by both the frequency of dust generating activities and the frequency that a sensitive location is downwind in strong wind conditions. The prevailing winds, particularly those that are strong with the potential to transport dust (≥ 7 m/s, see **Figure 8.5**) are from the south west. Winds from these directions would transport any dust inland towards houses along Glenbrook Beach Road. Strong

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[27] Ministry for the Environment. 2016. Good Practice Guide for Assessing and Managing Odour. Wellington: Ministry for the Environment (MfE 2016a)

	winds towards receptors on Reg Bennett Road and the northern end of Mission Bush Road are less frequent. In terms of the frequency of activities potentially giving rise to dust: • Stockpiles of raw material (coal, primary concentrate and slags) are present continuously, while deliveries and handling are most frequent during dayshift hours Monday-Friday; • Co-product handling, crushing and grading occurs typically during the day Monday-Friday; • Vehicle movements on the sealed and unsealed areas of the Site may occur 24/7, with greater traffic during dayshifts Monday-Friday; • Slag tipping may occur at any time from production at the Melters, VRU or KOBM; • RPCC tipping is minimised to the extent practicable and only occurs as a contingency when process disruptions occur and the RPCC storage hopper is at capacity; • Pressure relief flap lifts at the Kilns and MHFs may also occur as a contingency measure during abnormal processing conditions, which could occur at any time but are avoided to the extent practicable by process control measures to maintain a stable system; and • Process iron plating is also a contingency measure and may occur at any time, while iron plating for commercial purposes occurs primarily during dayshift operations.
Intensity	The intensity of dust impacts will reduce significantly with distance from the source. The majority of coarse dust particles will deposit within the approximately 100 to 200 m from the source depending on wind speed. Generally, separation distances of the order of 500 m to sensitive receptors, as exists at the Site, would be expected to be sufficient to mitigate dust effects from materials handling and processing activities. The thermal buoyancy of some of the dust and fume generated form tipping hot material means that these plumes can travel farther. Historically, RPCC losses have been identified as an infrequent source of localised off-site impacts of highly visible particulate matter deposition. The intensity of off-site dust impacts is also a function of the scale of the activity being undertaken. Dust emissions will increase with the height of raw material and by-product stockpiles, with the frequency of product tipping activities and with the frequency of vehicle movements on dry roads. The commercial iron plating is limited in frequency and volume across a day. The application of dust management measures set out in the Air Quality Management Plan (AQMP), including wet suppression methods, vehicle speed limits and road maintenance aim to reduce the intensity of dust generation in the northern yard, where the majority of fugitive dust sources are located. The intensity of dust generation from fugitive sources is lower in damp periods (winter) but exacerbated in hotter drier periods (notwithstanding the use of water carts to maintain moisture levels). NZ Steel continuously measures TSP at the Training Centre (Site 3) monitoring site for comparison with investigative trigger levels. If the trigger level is exceeded, NZ Steel staff are automatically notified and an investigation into the conditions and likely causes of the exceedance is initiated and, where practicable, additional controls are implemented to reduce dust levels.
Duration	In terms of the generation of dust emissions, the duration of each activity undertaken in the northern yard is slightly different. Emissions may be essentially continuous for stockpiling, though principally the duration of emissions are limited by the duration of periods with strong winds. Emissions from vehicle movements and slag processing may also occur at any time but will occur most often during the day-shift periods. Slag tipping, iron plating and RPCC tipping events occur for short periods, albeit at a regular frequency.

Offensiveness	The fugitive dusts generated from site activities can contain coal particulate and metals, particularly iron oxide from plating, and other metals (vanadium) from slag stockpiling. Given this, some of the fugitive dust emissions will have a different character to that of inert aggregate or soil derived dust (e.g. a dark or orange coloured) and potentially be more visible on surfaces.
Location	The immediate receiving environment within 1 km of the site is largely insensitive to dust impacts, being largely industrial land or rural land owned by NZ Steel. However, the environment to the northeast beyond 500 m is comprised of rural land with a low density of dwellings. Glenbrook School is also considered highly sensitive to dust emissions and is located 1.8 km east of the northern yard at the nearest point. Additionally, the adjoining estuarine environment is likely to be sensitive to dust deposition impacts with the potential for contaminating marine sediments.

8.7 Conclusions

The main sources of fugitive dusts at the Steel Mill, such as raw material stockpiling and handling, material recovery processes and the majority of heavy vehicle movements on unsealed areas, are situated in the northern yard. While the configuration of stockpiles and traffic routes are often subject to change to enable operational flexibility, the extent of the Operational Area forms the bounds of these activities on the wider NZ Steel landholding. The separation distances from this area to dwellings are at least 500 m, with dwellings located to the northeast of the yard (downwind of the predominant wind direction under strong winds) being at least 600 m away. This significant separation distance is a key mitigating factor in the likely intensity of any off-site dust impacts.

The frequency and duration of dust events are a product of the duration/frequency of the activity itself but also the incidence of strong winds which transport dusts to off-site locations. Activities may be continuous (example: raw material stockpiles) or intermittent (example: iron plating or raw material unloading). The frequency and duration of off-site impacts are also related to the frequency and duration of strong winds. Sensitive receptors not located to the northeast of the Site will have a relatively low frequency and duration of exposure to fugitive dust.

The intensity of dust northeast of the northern yard is measured using TSP at the Training Centre (Site 3) and PM_{10} at the more distant 64 Glenbrook Beach Rd (Site 20) monitoring site. The 64 Glenbrook Beach Rd (Site 20) monitoring site, which is broadly representative of downwind receptors, typically has between 5 and 18 hours per year during which dust levels exceed recommended trigger level of high sensitivity receiving environments. This trigger level is not necessarily indicative of an adverse effect but is useful as prompt for proactive management of dust sources on site. Overall, this is considered to be a relatively low frequency of dust events and it is considered unlikely that the effects of dust emissions from the Site would constitute an offensive or objectionable effect.

Notwithstanding this, the PM_{10} component of fugitive dust has been shown to make a significant contribution to off-site PM_{10} concentrations with respect to air quality standards and guidelines to protect against health effects. Therefore, there is a need for improved mitigation and ongoing adaptive management of dust sources in the Operational Area, as set out in Section 8.4.

9 Assessment of potential ecological effects

9.1 Effects on plant health

9.1.1 Ecological assessment criteria

The AAQG include criteria for ecological effects, divided into critical levels for ambient concentrations of acid gases on plants, and critical loads for assessment of deposition of air pollutants into ecosystems. These criteria are based on the UNECE/WHO (1996)[28] and Australia and New Zealand Environment and Conservation Council (ANZECC) guideline values.

There are no critical loads for sulphur or nitrogen deposition specified in the AAQG. A guideline critical load for nitrogen deposition of 5 kg/hectare was developed for use in the European Union. Although this critical load may or may not be appropriate for New Zealand ecosystems due to New Zealand's very low background nitrogen supply, and it was not adopted in the AAQG, a total atmosphere load below 5 kg N/ha/year is likely to be protective of any local ecosystem [29].

The impacts of sulphate deposition pertain to acidification of the soil; the AAQG notes that problems of soil/ecosystem acidification are unlikely to occur in New Zealand and therefore a critical load for sulphate deposition has not been recommended.

9.1.2 Sensitive ecological areas

The site is located in a largely modified rural environment. The AUP has a Significant Ecological Area -Terrestrial (SEA-T) overlay which identifies areas of significant ecological value in the region. These areas are comprised of indigenous vegetation that may be home to native fauna. Most of the identified areas of significant ecological value are situated to the southeast of the Operational Area.

The levels of NO_2, SO_2, nitrogen and sulphate deposition have been evaluated in Appendix D using monitoring data at 64 Glenbrook Beach Rd (Site 20). While some of these areas are closer to the NZ Steel operational area than the 64 Glenbrook Beach Rd (Site 20) monitoring site, they are likely to experience a lower annual average concentration because they are less frequently downwind of the site (see wind rose in **Figure 2.4**). Therefore, on balance, the use of monitoring data from 64 Glenbrook Beach Rd (Site 20) will provide a conservative assessment against the critical levels and critical loads.

9.1.3 Assessment against critical levels and critical loads

The critical level for protection of lichen is 10 $\mu g/m^3$ (annual average). The most protective winter-time average critical level in the AAQG is 20 $\mu g/m^3$ for protection of forest and natural vegetation.

The critical level for sulphate particulate in the AAQG is not relevant to the Site as it only applies where there is ground level cloud present for more than 10% of the time.

Measured concentrations of SO_2 and NO_2 are below the relevant critical levels (see **Table 9.1**).

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[28] United Nation Economic Commission for Europe. *Convention on the Long Range Transboundary Air Pollution*. 1996
World Heath Organisation. *Proposed Air Quality Guidelines for Europe.* 1996

[29] Stevenson et al. *Effects of Air Contaminants on Ecosystems and Recommended Critical Levels and Critical Loads*. Ministry for the Environment. October 2000.

Table 9.1: Measured concentrations of SO_2 and NO_2 compared with critical levels for ecosystem protection

Contaminant	Assessment criteria (µg/m³)	Averaging period	Ecosystem type	Measured concentration (µg/m³)	% of criterion
SO_2	20	Winter average	Forest and natural vegetation	3.6	18%
	10	Annual average	Lichen	3.0	30%
NO_2	30	Annual average		6.2	21%

Based on the annual ambient concentration of NO_X measured at 64 Glenbrook Beach Rd (Site 20), the deposited nitrogen load in the vicinity of the Site (is estimated at 2.9 kg N/ha/year (see **Appendix E Section 8.4**). This value is below the suggested critical load of 5 kg/ha/year for nitrogen.

As the concentrations and loads, based on measured air quality at 64 Glenbrook Beach Rd (Site 20), are below the relevant assessment criteria, there are not expected to be any adverse effects on plants or lichens from the discharges of SO_2 and NO_2 from the Steel Mill.

9.2 Effects on freshwater and marine environment

The important metals identified in Marine Ecology Assessment prepared as part of NZ Steel's application to replace existing water discharge permits[30] are copper, lead and zinc in sediments. The deposition monitoring carried out in the vicinity of the Site (described in Section 7.4.3.1) provides useful information on the likely contribution of aerial deposition to the concentrations of these contaminants in the marine environment, compared to water-related discharges.

Average copper and lead deposition rates at the downwind NZS Northern Boundary (Site 4B) and 64 Glenbrook Beach Rd (Site 20) monitoring sites were marginally lower than the copper and lead deposition rate at the background Boundary Road site (Site 18), indicating that aerial deposition of copper and lead are not influenced by the Steel Mill activities.

Deposition rates for zinc were comparable between 64 Glenbrook Beach Rd (Site 20) and Boundary Rd (Site 18). However zinc deposition at NZS Northern Boundary (Site 4B) was at a higher average rate than observed at the other two sites. This pattern suggests that zinc levels at the NZS Northern Boundary (Site 4B) may be impacted by activities north of the 64 Glenbrook Beach Rd (Site 20) monitor, such as from placement of material at the NZ Steel landfill. The deposition rate of zinc at the NZS Northern Boundary (Site 4B) was approximately 70 mg/m²/year, which is unlikely to be material.

9.3 Effects on commercial kiwifruit crops

The surrounding area at Glenbrook is largely rural and a number of kiwifruit orchards have been established in the area, some of which are subject to a *Profit A Prendre* agreement with NZ Steel. This agreement pertains to the quantity of the kiwifruit harvest that are not able to go to market due to staining on the skin of the fruit that occurs as a result of RPCC tipping fallout on the crops.

NZ Steel receive an annual report on the impact of RPCC losses on the kiwifruit crop. Fruit samples are collected from packhouses, noting the weather conditions of the season and the application of any preventative sprays such as Lactic Acid. Fruit from crops that are not subject to an agreement with NZ Steel are also inspected and reported to NZ Steel.

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[30] Marine Ecology Assessment for Water Discharge Consent Replacement, Tonkin and Taylor 2021. To be lodged June 2021.

The percentage of fruit trays lost to staining has been relatively low and stable since 2012, at 0.008% of all trays.

Factors that influence the impact of RPCC tipping on kiwifruit crops have been identified as:

- Application of preventative sprays to the fruit, such as lactic acid, has been observed to have a significant effect on the degree of staining.
- Weather conditions in the season – light showery periods are suspected of washing RPCC fallout from the canopy onto the fruit resulting in greater staining, while periods of heavier rainfall seem to have a lesser impact, as the RPCC residue tends to be washed away entirely.

The impact of the Steel Mill activities on horticulture in the area will continue to be managed through agreements of the kind already in place, where appropriate.

10 Proposed monitoring

10.1 Proposed changes to ambient monitoring

The Main Air Permit (and Commercial Iron Plating Air Permit) currently require NZ Steel to undertake ambient monitoring of TSP and PM_{10} at agreed locations. The current monitoring programme is described in Section 2.4. Based on the findings of the assessment, we consider the following changes to the ambient air quality monitoring programme would be appropriate:

- Decommission the PM_{10} monitoring site at Sandspit Reserve (Site 19), as this site has not shown any material influence of emissions from the Steel Mill and does not provide useful information;
- Decommission the monitoring site at Glenbrook School (Site 17), as all monitoring to date has shown excellent to good performance with all assessment criteria for the protection of human health;
- Change the monitoring at Boundary Road (Site 18) from TSP to PM_{10}, to provide a background site for comparison with the results from 64 Glenbrook Beach Rd (Site 20); and
- Include a requirement for $PM_{2.5}$ (as well as PM_{10}) and SO_2 monitoring at 64 Glenbrook Beach Rd (Site 20).

10.2 Stack testing programme and proposed changes

10.2.1 Proposed changes to existing TSP consent limits

The potential for the existing consent limits to be reduced in light of the stack emission monitoring record has been reviewed. The emission concentration limits on the Metals side and Slagside baghouses are proposed to be changed to $PM_{2.5}$ limits because size-fractionated testing is possible on the baghouse emissions and for consistency with anticipated changes to the National Environmental Standards for Air Quality to focus on $PM_{2.5}$ rather than PM_{10}. The proposed $PM_{2.5}$ limits are shown in Table 10.2.

The consent limit and associated testing requirement on the KOBM flarestack is proposed to be removed for health and safety reasons, as discussed in Section 10.2.2. The consent limit and associated testing requirement on the Primary Concentrate Drier baghouse is proposed to be removed because this is a minor source in the context of the Site and does not warrant periodic testing. Other process control methods, such as pressure drop measurement, are more appropriate to monitor the ongoing good performance of the baghouse.

No change is proposed to the consent limits on the MHF stacks and Kiln stacks, as there is only a small margin to the maximum measured concentrations. It is not possible to change the consent limit to a $PM_{2.5}$ limit as the emissions are controlled by wet scrubbers and it is not practical to undertake size-fractionated testing.

Table 10.1: Summary of proposed changes to TSP limits

Stack	Stack ID	TSP limit in current consent	Maximum measured TSP concentration	Proposed consent limit
		mg/m³	mg/m³	
MHF stacks	IP1-IP4	75	62	No change
Kiln stacks	IP23-IP26	75	69	No change

Stack	Stack ID	TSP limit in current consent	Maximum measured TSP concentration	Proposed consent limit
		mg/m³	mg/m³	
Metalside Baghouses	IP33-IP34	50	30	Change to $PM_{2.5}$ limit
Slagside Baghouse	IP32	50	23	Change to $PM_{2.5}$ limit
KOBM Flarestack	SP1	200	169	Remove limit and testing requirement
Pipe Mill Blowdown Scrubber	PM3	125	53	Decommissioned
Pipe Mill Galvanising Baghouse	PM2	10	4	Decommissioned
Primary Concentrate Drier baghouse*	SR1	125	8	Remove limit and testing requirement

1 Referred to as the Millscale & ironsand drier (Steelserv) in the previous Air Permit

Table 10.2: Proposed $PM_{2.5}$ stack concentration limits

Stack	Stack ID	$PM_{2.5}$ max measured (mg/m³)	Proposed limit
Metalside Baghouses	IP33-IP34	12	15
Slagside Baghouse	IP32	14	15

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10.2.2 Proposed changes to stack testing programme

The Main Air Permit requires regular stack emission monitoring for TSP, NO_X, HCl and CO. Based on the findings of the assessment, we consider the following changes to the stack testing programme would be appropriate:

- Analysis of the relative contribution of each modelled stack source in Section 8 of the Dispersion Modelling Study in **Appendix C** shows that emissions from the Kiln stacks, MHF stacks, Steel Plant Baghouse, and Melter Baghouses (Metalside and Slagside) contribute 98% of the PM_{10} on the highest ground level concentration off-site. Based on this, regular monitoring of stack emissions from the KOBM Flare (currently quarterly) and Primary Concentrate Drier Baghouse (6 monthly), could be discontinued.
- Remove requirement to monitor for HCl at the Pickle Line fume scrubber and the ARP scrubber stack. Emissions at the current rates are demonstrated to be well below the assessment criteria when using the highly conservative dispersion model. Critical process parameters at the ARP include scrubber flow rates and caustic dosing levels which are continuously monitored.
- Testing of the KOBM Flarestack should be discontinued, or continued at a reduced frequency (currently quarterly). Testing of this stack is dangerous to worker health due to elevation of the sampling port and the high concentrations of CO within the stack prior to the flare. A

significant record of process monitoring data (flowrates, pressure drops, temperatures) is available over the stack testing history for this point source. These parameters could be analysed to identify correlated process conditions for monitoring of the performance of this stack.

- NO_X monitoring is currently an annual requirement for the following point sources: The Slab Reheat Furnace, KOBM Flarestack, Kilns stacks, and MHF stacks. Monitoring of NOx and NO_2 at the Glenbrook Beach Rd monitoring site (Site 20) shows that all health and ecological assessment criteria are complied with (EPI category good and excellent). It is proposed to cease NOx testing at the KOBM Flarestack due to the hazard to staff conducting the testing, as well as difficulty to obtain reliable combustion gas analysis in this stack. It is proposed that the testing frequency for NO_x on the other sources (Slab Reheat Furnace, MHF and Kilns stacks) remain the same.
- Testing of the Steel Plant Baghouse is not a requirement of the Main Air Permit and NZ Steel do not propose to add it to the monitoring conditions. As the baghouse does not have a stack, it is monitored using a non-standard test method. The modelling has shown that the Steel Plant Baghouse is only a relatively small contributor to off-site PM_{10} concentrations and NZ Steel will continue to visually inspect the emissions from this baghouse and carry out regular dye tests to identify any bags that need replacement as set out in the AQMP.

The proposed changes to the stack testing programme are summarised in **Table 10.3** below.

Table 10.3: Proposed changes to stack testing programme

Stack name	Contaminant	Current minimum test frequency	Proposed minimum test frequency
MHFs stacks	Particulate matter	6 monthly	6 monthly
	Oxides of nitrogen	1 yearly	1 yearly
Kilns stacks	Particulate matter	6 monthly	6 monthly
	Carbon monoxide	6 monthly	6 monthly
	Oxides of nitrogen	1 yearly	1 yearly
Melter Metalside Baghouse	Particulate matter	3 monthly	3 monthly (change to $PM_{2.5}$)
Melter Slagside Baghouse	Particulate matter	3 monthly	3 monthly (change to $PM_{2.5}$)
KOBM Flarestack	Particulate matter	3 monthly	Remove limit and testing requirement
	Oxides of nitrogen	1 yearly	Remove limit and testing requirement
Slab Reheat Furnace	Oxides of nitrogen	1 yearly	1 yearly
Acid Regeneration Plant	Hydrogen chloride	3 monthly	3 monthly
Pickle Line	Hydrogen chloride	1 yearly	Remove limit and testing requirement
Primary Concentrate Drier Baghouse	Particulate matter	1 yearly	Remove limit and testing requirement

10.3 Process monitoring

NZ Steel do not rely on the scheduled stack tests to indicate that air emission control equipment is functioning as it should. Continuous process monitoring provides live data on critical process parameters such as scrubber flow rates, differential pressure, temperatures, fan speeds and is used to indicate how well the equipment is functioning.

The process monitoring programme also enables NZ Steel to specify set-points for critical parameters to effective function of the equipment. Critical parameters will trigger an alarm to alert the operators when the identified parameters are outside of the range that enable effective gas cleaning, to trigger a corrective action or to stop the process.

NZ Steel also undertaken annual (at minimum) baghouse dye tests to identify damaged bags for replacement in the Steel Plant Baghouse, Melter Metalside and Melter Slagside Baghouses. A record of baghouse maintenance is kept.

Critical parameters for monitoring the effective operation of the KOBM primary waste gas cleaning system (which discharges to the KOBM Flarestack) have been identified as:

- The secondary scrubber differential pressure;
- The scrubber water flowrate; and
- Flare flame outs during the high CO portion of the steelmaking heat.

The first two parameters pertain to the particulate scrubbing system and the final bullet relates to the combustion of CO at the flare.

For the ARP scrubbing system, the critical parameters are:

- The flow rate of acid to the acid regeneration roaster;
- The flowrate of scrubbing liquid to the ARP scrubbing tower; and
- The caustic dosing rate.

NZ Steel propose to identify a set point range for process condition monitoring under the AQMP.

11 Mitigation

11.1 Point source emission controls

Section 3 provides detailed descriptions of the emission control systems that operate on each plant. **Table 11.1** below summarises this information for the major point sources (large pieces of equipment that operate continuously or have a large output flowrate) and the current controls on emissions to air from stacks on site. Small or discontinuous point sources and controls are summarised in **Appendix J**.

Table 11.1: Point source emission controls - Main

Stack ID	Detail	Description	Control method	Detail
IP1-4	Multi-hearth furnace stacks	Afterburner waste gas	Cyclones, incineration, venturi scrubber	Waste gases leaving the MHFs are passed through cyclones to remove coarse particulate matter, and gases pass through an afterburner before a waste heat boiler for energy capture. After the boiler the hot gas is quenched by water sprays before passing through a venturi scrubber to remove particulate and two cyclone droplet separators.
IP17-18	Melter flare stacks	Melter off gas	Cyclones, venturi scrubber, flare	Combustible waste gas is collected and passed through a two-stage venturi scrubber and two cyclones. If this gas cannot be utilised at the MHF or Kilns systems then it is discharged to the Melter flare. This is minimised to the extent possible and has improved with upgrade of adding flue gas recirculation to the MHFs in 2018.
IP23-26	Kiln stacks	Kiln off gas	Incineration, venturi scrubber	Large entrained particulate matter from the kiln feed is removed from the Kiln's waste gases at a drop-out chamber. The waste gases are then directed to the Kilns Cogeneration Plant for energy capture via combustion of the flammable components of the gas. If this system is offline the gases are instead combusted in the Kiln's afterburners. Post-combustion (either at the Cogeneration plant or the afterburners) the hot gases are quenched to saturation temperature and precleaned in the upper section by the water sprays before entering the high energy scrubbing stage where fine particles are removed by water droplets. The cleaned gas is discharged via the Kiln's stacks.
IP32	Melter Slagside tapping fume	Metal fume	Baghouse	The slag side system collects fume from the two slag tapholes and four collection ducts serving the two slag bowl areas. The collected gases are extracted and cleaned in a pulse jet baghouse before discharge to atmosphere (the Melter Slagside baghouse). The collected dust discharges to a closed bin that is emptied daily by a mobile dust collection unit.

Stack ID	Detail	Description	Control method	Detail
IP33-34	Melter Metalside tapping fume	Metal fume	Baghouse	The metal tapping fume is extracted from three ladle hoods, two iron tap holes, four ducts serving the upper launder area and four ducts serving the lower launder area on each Melter (the launder being the refractory lined channel through which the metal flows from the Melter). The collected gases are cleaned in a pulse jet baghouse (the Melter Metalside baghouse) before discharge to atmosphere.
SP1	KOBM Flarestack	KOBM waste gas	Venturi scrubber, flare	The primary gas cleaning system receives the hot primary off-gas at approximately 1400°C. The gas is drawn off through a water-cooled hood before a two stage wet scrubbing to reduce the gas temperature and reduce the particulate load. The cleaned gases exhaust to atmosphere through a tall stack with a flare tip. During approximately 30 percent of the oxygen blowing period the gases will be flammable (>12% CO composition) and are ignited at the flare tip by the pilot light.
SP4	Steel Plant baghouse	Slab making plant fume	Baghouse	Local extraction at various steelmaking operations (VRU1, LTS, LMF, the KOBM charging, tapping and slagging fume) are extracted to a system of interconnected ducts. Extraction volume is controlled by the fan inlet vanes and an inlet pressure sensor upstream of the fan set, which adjusts to optimise capture at the relevant process. The extracted gases are filtered through a pulse jet type baghouse with six compartments, which can operate with one compartment offline. Dust collected in the six hoppers is discharged via screw feeders into a covered bin.
HSM1	Slab Reheat Furnace	Furnace waste gas	-	Hot combustion gas (mainly carbon dioxide, steam, nitrogen oxides, air) from the Slab Reheat Furnace goes through a recuperator to preheat the combustion air for the gas burners. The combustion air is then passed through a waste heat boiler to generate steam for the Site.
CSM1	Acid Regeneration Plant	HCl vapour from adsorption column gas	Mist eliminator, wet scrubber	Emissions from the ARP pass through a chevron mist eliminator and scrubber system with packed tower mist eliminator prior to discharge via a stack with a pseudo-droplet separator section at the exit.
CSM2	Acid regeneration plant baghouse	Iron oxide	Baghouse	Iron oxide collection at the ARP occurs via bag filters to retain this valuable co-product.

Stack ID	Detail	Description	Control method	Detail
CCL3	Paint line incinerator – prime oven	Solvent fume	Incineration	Emission from the Paint Line ovens are combusted in an incinerator to destroy VOCs prior to emission via the stacks.
CCL4	Paint line incinerator – finish oven	Solvent fume	Incineration	Emission from the Paint Line ovens are combusted in an incinerator to destroy VOCs prior to emission via the stacks.
SR1	Primary concentrate drier baghouse	Drier	Baghouse	Emissions from this source are vented through bag filters for removal of particulate.

11.2 Management of fugitive dust

The existing and proposed adaptive controls for managing sources of fugitive dust at the Steel Mill have been set out in **Table 8.1** and **Table 8.2** in the assessment of nuisance dust effects (**Section 8** of this AQA).

11.3 Management of unplanned emission controls

The Steel Mill has a number of safety mechanisms to prevent adverse scenarios such as overpressure of equipment. Generally, these are used only when needed as NZ Steel aims to keep conditions as stable and controlled as possible. Process safety reviews are regularly undertaken to assess risks from the operations, and the specific controls to minimise unplanned emissions are described in **Table 11.2** below.

Table 11.2: Unplanned emission risk control measures

Process	Description
Hazard and operability studies / detailed risk assessments	NZ Steel conducts annual risk assessments for activities identified in the risk register (MARS) as high risk. The environmental risks and impacts are managed through a framework called LAWWNE, which seeks to: • Reduce the environmental impact on **Land, Air, and Water** • Reduce generation of **Waste and Noise** • Minimise use of **Energy** and the generation of greenhouse gas emissions. The high level register of LAWWNE risks is reviewed and reported to Bluescope annually by the Environment Manager at NZ Steel. This provides an opportunity to review LAWWNE risks and define activities for proposed controls. A review of the items listed in the Risk Register are to be taken into account: • During annual business planning. • When processing management of change submissions for significant process changes, ie capital works or process modifications. • In preparing/applying for and then following the issue of new resource consents for the business. • Following a significant incident relevant LAWWNE risks are to be reviewed to take into account the findings of the incident investigation.
Interlocked process safety control systems	Critical emission control operating parameters such as pressure drops, temperatures and water flow rates are monitored and alarmed. Interlocks prevent unsafe or unacceptable operational conditions from continuing.
Standard operating procedures	Operators of the processes are trained in the standard operating procedures for their specific tasks to enable efficient and consistent operation of the processes.
Change management procedures	NZ Steel have a documented process for implementing changes at the site, aimed to ensure that all implications of a change to the processes or management methods are understood and to avoid adverse unintended consequences.
Emergency response procedures	NZ Steel have identified the potential Major Incident Events for operations at the Steel Mill and have an emergency response plan which sets of the key roles, actions and safety measures to follow to minimise the impacts to employees, surrounding residences and the environment.

12 Best practicable option

12.1 Introduction

There are a range of engineering operational and management controls used to manage discharges to air from the Site. The appropriateness of this suite of measures can be evaluated by considering the extent to which it constitutes the 'best practicable option' (BPO). BPO is defined in Section 2 of the Resource Management Act 1991 (RMA) as follows:

> *best practicable option, in relation to a discharge of a contaminant or an emission of noise, means the best method for preventing or minimising the adverse effects on the environment having regard, among other things, to—*
>
> *(a) the nature of the discharge or emission and the sensitivity of the receiving environment to adverse effects; and*
>
> *(b) the financial implications, and the effects on the environment, of that option when compared with other options; and*
>
> *(c) the current state of technical knowledge and the likelihood that the option can be successfully applied*

The concept of BPO is consistent with the RMA framework, which is focussed on avoiding, remedying or mitigating adverse effects. This is a different approach to concepts used overseas such as "Best Available Technique" (BAT), which are focussed on identifying the best technically and financially viable technologies as the basis for setting emission limits (regardless of the nature and scale of effects). BPO is determined on a site-specific basis, taking into account the nature and scale of emissions and the environmental context.

The Steel Mill was constructed in the late 1960's and reflects the technology of the time. If a new Steel Mill were built today, it would use fundamentally similar emissions abatements techniques, such as wet scrubbers, baghouses, etc. However, with advancements in technology there may be differences in equipment selection for some processes or in the details of engineering design or process control. The Mill is one of the largest industrial facilities in New Zealand and the scale of processes and equipment at the Site means that the retrofitting of new technology is very expensive and is only considered where warranted to manage an identified adverse effect on the environment.

The effects of PM_{10} and SO_2 emissions have been identified as the most significant effects of discharges to air from the site. The effects of discharges of other contaminants meet relevant air quality standards and guidelines, and therefore significant investment in further reducing emissions would not be warranted. For this reason, the evaluation of current control measure against BPO has focussed on PM_{10} and SO_2.

12.2 BPO for management of PM_{10}

Fugitive dust emissions from activities such as stockpiling, handling and processing of raw materials and co-products and heavy vehicle movements have been identified as the most significant sources contributing to elevated levels of PM_{10}. As such, management of fugitive dust emission is a key aspect of managing off-site effects of PM_{10}.

As the availability of suitable locally-sourced coal declines, NZ Steel will need to continue importing coal from overseas suppliers. Currently, coal is imported via Ports of Auckland, however there is also the potential to use alternative ports, such as Tauranga, in the future. There are limited train lines from Auckland City, no coal terminal at the Port to Rail connection and the constrained network cannot accommodate the required delivery schedule or clear a shipment in the timeframe required by the Port. Therefore, the only practical option is to deliver coal to Site by truck.

Coal shipments are larger and less frequent than domestic deliveries, requiring storage of greater volumes of coal by NZ Steel and proportionally more truck movements to unsealed areas than required for coal sourced domestically. The increased dependence on imported coal has required an overall increase in the quantity of coal stockpiled within the Operational Area of compared to when most coal was sourced locally. NZS requires a high degree of flexibility around the amount of coal it can stockpile, as it is dependent on international supply chains and the frequency and volume of coal shipments is variable.

If on-site coal storage were limited, this would necessitate the establishment and consenting of an off-site stockpile facility. Overall, provided the storage and handling of coal at the Steel Mill is appropriately managed, the construction and operation of a separate off-site facility and associated additional handling of coal would have greater environmental effects. It is also important to note that the effects of fugitive dust emissions are not directly correlated with the quantity of coal on Site. Stockpile height, moisture content, handling frequency, exposure to high winds and proximity to off-site receptors all contribute to the impact beyond the Site boundary.

The historical PM_{10} monitoring data shows that there are higher average PM_{10} concentrations on weekdays compared to weekends. This suggests that activities that occur to a greater extent on weekdays, such as processing and distribution of co-products or movement of materials to the landfill, make a significant contribution to offsite PM_{10} concentration. The recent improvements identified in Table 8.2, which include paving of roadways, a wheel bath and improved infrastructure for watering unpaved roads, will have reduced PM_{10} emissions from heavy vehicle movements. However, as these improvements occurred in early 2021, after the dry summer period, it has not yet been possible to demonstrate the effectiveness of these measures through ambient monitoring records.

Adverse effects of PM_{10} can be minimised by reducing fugitive dust emissions to a minimum practicable level. Given the nature of fugitive dust emissions, this requires a range of techniques including engineering, operational and management controls. NZ Steel has established a management process to identify, evaluate and prioritise the sources of fugitive dust, based on their potential for off-site effects, and progressively implement additional dust control measures. The management controls include continuous monitoring of TSP against trigger levels that escalate dust control measures. This overall management approach is considered to represent the best practicable option to minimise adverse effects of PM_{10} emissions.

12.3 BPO for management of sulphur dioxide

The primary method to minimise SO_2 emissions at the Site is to continue to source coal with a relatively low sulphur content. The current limit of 0.5% sulphur content of coal used in the process remains appropriate, as lower sulphur coal is not always commercially available and, at times, NZ Steel needs to blend the coal grades to meet the consent limit.

NZ Steel has considered the feasibility of emission abatement techniques to further reduce emissions of SO_2. The Bluescope Port Kembla facility, which is located close to an urban area, has installed a dry flue gas desulphurisation system. The process is based on adsorption of SO_x (and other contaminants) onto activated coke. The activated coke is regenerated by driving the SO_X off the adsorbent to produce a SO_2-rich gas stream. The recovered gas is then further processed into gypsum to make a saleable product. The regeneration of the coke (for re-use) is necessary to minimise ongoing costs of purchasing adsorbent materials and to avoid creating a large volume of solid waste that needs to be disposed.

A high-level cost estimate of NZ$48M has been made by pro-rating the cost of the Port Kembla dry gas desulphurisation plant based on the difference in total volume of gas that would need to be treated at Glenbrook. The actual costs are likely to be higher as the Glenbrook site would require four smaller plants, rather than a single large plant like at Port Kembla.

The discharges of SO_2 from the site do not cause any exceedance of the New Zealand ambient air quality guidelines and standards. The conclusions of the review by a public health expert are that the effects of exposure to levels of SO_2 measured at 64 Glenbrook Beach Rd (Site 20) are less than minor. On this basis, it is concluded that the current technology is consistent with BPO, particularly in that the significant financial costs of installing additional SO_2 abatement are not warranted, nor is a reduction of the current consent limit of 0.5% sulphur content of coal used in the Iron Plant.

13 Conclusions

This Air Quality Assessment has evaluated the likely impacts of air emissions from the Steel Mill in terms of effects on human health, ecology and nuisance/amenity.

The assessment has relied on the following information:

- Ambient monitoring data collected downwind of the predominant wind direction at the Site boundary to measure the cumulative impact of point sources, fugitive sources and background sources; and
- An air dispersion model of major point sources of key contaminants to identify the stacks with the greatest off site impact, verify that monitoring sites are appropriately located to evaluate the impacts at the most affected off site locations and to predict off site concentrations of contaminants that are not monitored (specifically CO, HCl, Cl_2, VOCs, mercury).
- An air dispersion model of emissions from the operation of proposed diesel generators to understand the potential additional impact on off-site concentrations of CO, PM_{10}, $PM_{2.5}$, NO_2, SO_2 and PAHs.

This assessment has found that all contaminants comply with the relevant assessment criteria for the protection of human health and ecology, with the exception of PM_{10}.

Ambient monitoring at 64 Glenbrook Beach Rd (Site 20) has recorded a number of measurements above the NESAQ value of 50 $\mu g/m^3$ as a 24-hour average PM_{10} concentration. Analysis of trends in the monitoring data have indicated that fugitive sources form the most significant component of the elevated levels of PM_{10}, as opposed to continuous point source emissions or background sources.

The public health assessment conducted by Dr Francesca Kelly (**Appendix F**) concludes that the effects of infrequent and sporadic exposure to PM_{10} concentrations exceeding the NES value of 50 $\mu g/m^3$ as a 24-hour average are minor.

Notwithstanding this, NZ Steel has been undertaking a programme of improvements to fugitive dust management including progressive sealing of unsealed roads and site access points, provision of high performance road watering and sweeping equipment, installation of a wheel bath for raw material delivery vehicles and fume suppression facilities for iron planting. The ongoing monitoring of PM_{10} at 64 Glenbrook Beach Rd (Site 20) will be used to evaluate the impact of these improvements on peak PM_{10} levels at downwind locations.

In relation to potential amenity effects of nuisance dust, the assessment concludes that it is unlikely that the effects of dust emissions from the Site would constitute an offensive or objectionable effect.

14 Applicability

This report has been prepared for the exclusive use of our client New Zealand Steel, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

We understand and agree that our client will submit this report as part of an application for resource consent and that Auckland Council as the consenting authority will use this report for the purpose of assessing that application.

We understand and agree that this report will be used by Auckland Council in undertaking its regulatory functions in connection with the applications for replacement resource consents.

Tonkin & Taylor Ltd

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