Before the Independent Commissioner

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| Under | the Resource Management Act 1991 |
| In the matter of | an application by Tegel Foods Limited for resource consent for the discharge of contaminants to air at 112 Carmen Road, Hornby, Christchurch |

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**Statement of Evidence of Jason Savelio Karena Pene**

28 July 2020

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## 1.1 Qualifications and experience

1 My full name is Jason Savelio Karena Pene.

2 I am a Principal Environmental Engineer of Tonkin & Taylor Ltd (**T+T**) and in this role I provide air quality and environmental engineering consultancy services to a range of private and public sector clients.

3 I hold a Bachelor of Engineering degree with honours in Chemical and Process Engineering from the University of Canterbury and I am a Certified Air Quality Professional of the Clean Air Society of Australia and New Zealand (**CASANZ**).

4 I have been involved in the assessment and management of environmental impacts, with a particular focus on discharges of contaminants to air, in various roles in consultancy, for regulatory authorities and in industry for almost 20 years.

5 Of specific relevance to this statement of evidence, I have conducted and overseen odour and air quality impact assessments of a range of industrial and food processing operations in New Zealand and Australia, including:

a Air quality impact assessments for chicken processing facilities at Henderson (Tegel) and Karaka (Van den Brinks) in the Auckland region;

b Review of air quality impacts of Greenlea Meats and Tuakau Proteins rendering plants at Morrisville (proposed) and Tūākau (existing), respectively for the Waikato Regional Council; and

c Air quality impact assessments of boiler combustion discharges at a variety of industrial sites in New Zealand and Australia.

## 1.2 Involvement in the application

6 T+T was engaged by Tegel Foods Ltd (**Tegel**) in 2017 to prepare an application to replace the existing resource consents for discharges to air from its poultry processing facility at Carmen Road, Hei Hei (**the Site**). This engagement included assessment of the impacts of the discharges on local air quality.

7 As part of this engagement I have authored or managed the delivery of the following T+T assessment documents:

a "Tegel Christchurch Poultry Processing Plant Discharges to Air - Air Quality Impact Assessment", report dated April 2019 (**Air Quality Assessment**); and

b "Tegel Foods Ltd Resource Consent Application CRC185584 - Proposed Modifications to Biofilter Design", letter dated 21 February 2020.

8 In preparing this statement of evidence I have considered the following documents:

a The Assessment of Environmental Effects report prepared by T+T that accompanied the Application (**AEE**).

b The Odour Assessment and Air s92 Response described above.

c Submissions relevant to my area of expertise.

d The section 42A report prepared for the ECan (**s42A Report**) and preceding review documents prepared for ECan by Enviser Ltd and Pattle Delamore Partners Ltd (PDP) in relation to the application.

9 I have visited the Site and surrounds on a number of occasions and I am familiar with the locality.

### 1.3 Code of conduct

10 While this is not a hearing before the Environment Court, I confirm that I have read the Code of Conduct for expert witnesses contained in the Environment Court Practice Note 2014 and that I agree to comply with it. I confirm that I have considered all the material facts that I am aware of that might alter or detract from the opinions I express. In particular, unless I state otherwise, this evidence is within my sphere of expertise and I have not omitted to consider material facts known to me that might alter or detract from the opinions I express.

## 2 Scope of evidence

11 My statement of evidence addresses the following matters:

a The nature of discharges to air from the site, including odour, combustion contaminants and particulate matter.

b The receiving environment around the Site in terms of the sensitivity of local activities to the discharges, influences on the dispersion and transport of emissions to air and background air quality.

c A summary of the methodology and key findings of the assessments of air quality impacts of the discharges to air, including:

i The effects of the currently consented discharges to air;

ii The effects of the discharges following recent and proposed modifications to site activities and discharge management.

iii The mitigation and management of the discharges to air.

d Matters raised by submitters in relation to the effects of discharges to air.

e Matters raised in the Council s42A Report.

f Conditions of consent.

## 3 Executive summary

12 Resource consent is sought by Tegel to continue the discharge of contaminants to air from its poultry processing plant at Carmen Road, Hei Hei. The air contaminants emitted from the site include:

a Odour, particularly from meat by-product rendering carried out at the protein recovery plant (**PRP**), which has the potential to cause nuisance and amenity effects;

b By-products of combustion from the combustion of a range of fuel options in boilers including recycled lubrication oil (**RLO**) used currently and diesel likely be used predominantly in future, which have the potential to affect human health; and

c Particulate matter emissions from the smokehouse, which also have the potential to affect human health.

13 The site is located within an established industrial area and is surrounded by commercial and industrial activities of moderate to low sensitivity to the emissions from the site. Further afield in the residential areas beyond Buchanans Road to the north and Carmen Road to the west, sensitivity to the emissions will be high.

14 Particulate emissions from the smokehouse are intermittent and small in scale and are unlikely to result in adverse impacts on human health or other aspects of the local environment.

15 Combustion by-products emissions have been assessed through atmospheric dispersion modelling. This investigation has indicated that changes to boiler combustion at the site proposed by Tegel (including replacement and relocation of boilers and changes to fuel use) are likely to result in a substantial reduction in impacts on ambient air quality. With the implementation of those changes, I

consider the potential impacts of combustion emissions from the site on human health in the area to be minimal.

16 Community feedback relating to odour and a programme of odour observations have indicated a potential for odour nuisance in the area surrounding the site, particularly in the surrounding commercial/industrial area. The PRP was identified as the main source of the odour. In response Tegel has proposed and implemented upgrades to odour management at the PRP. I anticipate the changes will substantially improve the capture and control of odour at the site. This in turn should lead to an avoidance of the type of nuisance effects indicated in the community feedback and the more intense odour levels recorded in odour observations. With the upgrades now in place and the modified consent conditions I have described below in place, offensive and objectionable odour beyond the site boundary should be avoided and I consider the potential for odour nuisance effects to be minor.

17 I consider that the conditions of consent recommended in the Council s42A Report are broadly appropriate but that specific changes should be adopted to more accurately reflect the existing and proposed activities and to provide for more effective management of potential air quality impacts. Additionally, I believe duration of consent of longer than the 10 year duration recommended in the Council s42A Report can be contemplated in this instance.

# 4 Site activities and the nature of the discharges to air

## 4.1 Site activities

18 The existing site process activities are described in detail in the Application and summarised in the s42A report. Further detail on some specific parts of the process is provided in the evidence of Ms Marshall. The activities with a potential to discharges contaminants to air (to varying degrees) are as follows:

a Receipt of chickens and turkeys from local supplier farms for processing.

b Primary chicken processing, comprised of two parallel processing lines and incorporating stunning, scalding, evisceration and spin chilling of chickens.

c Turkey processing, incorporating a smaller scale of the chicken processing.

d Further processing of poultry meat products including a smokehouse.

e Protein recovery plant (**PRP**), involving rendering of by-products generated from the on-site poultry processing plants and Brinks local chicken processing plant into meal and tallow oil products.

f Collection, conveyance and storage of wastewater generated from the site activities.

g Combustion of recycled lubrication oil (**RLO**) in boilers to provide heat for the process activities on-site.

19 Tegel proposed in its consent application to modify activities at the site to improve the management of air quality impacts and has subsequently implemented a number of the modifications. The modifications (implemented and proposed) are as follows:

a An enclosed cover over the rear wastewater balance tank was installed in November 2019 and ventilation of headspace air to the biofilter for treatment was connected in January 2020;

b An upgrade of air extraction from the PRP was completed in January 2020;

c Replacement of the biofilter to treat the extracted air was completed in May 2020; and

d Replacement of front boilers with a new relocated boiler and change in fuel from RLO to diesel is proposed to occur later in 2020. Tegel also seeks to retain the ability to use light fuel oil (**LFO**), diesel, biodiesel and liquefied petroleum gas (**LPG**) in the boilers as currently consented[1].

20 The air contaminant emissions from the site include:

a Odour from a variety of sources;

b By-products of combustion in the boilers; and

c Particulate matter emissions from the smokehouse.

21 I will discuss each of these in turn.

## 4.2 Odour emissions

22 There are a number of potential odour sources including, in broad process order:

[1] Authorised by the previous resource consent CRC054334.2

a Bird receipt – bird, feather and potentially manure type odour may be generated from birds delivered to the site by truck, prior to processing.

b Scalding, which is the main odour source associated with chicken processing – air extracted from extraction hoods above the scaler baths is discharged via two stacks of 18 m in height located above the processing plant building.

c Other chicken processing plant sources – the other process sources include the use of chlorinated sanitary chemicals and air from the processing plant that is discharged via horizontal fans located on the north wall of the process plant building (directed into the Site).

d Smokehouse – the cooking of meat (including smoking phases) may generate odour, which is discharged via vertical stacks located on the smokehouse roof.

e PRP – rendering of meat by-products can generate odours of reasonably strong intensity and negative hedonic tone (without effective emissions control in place). Emissions of odour extracted directly from PRP process sources and from the PRP building and treated through biofiltration (resulting in a sharp reduction in the intensity of odour and modification of its character to a more neutral hedonic tone).

f Waste storage and conveyance – anaerobic degradation of wastewater generated at the site can result in odour if this occurs prior to discharge to the trade waste (sewer) system.

23 The intensity and character of odour generated from each odour source varies. As noted in paragraph 41 of the s42A report, the PRP is the main odour source on-site.

### 4.3 Combustion emissions

24 Two 1.1 MW boilers are currently operated at the front boiler house to provide heat for the chicken processing and smokehouse. An additional four 1.1 MW boilers are operated at the rear of the site to supply heat (steam) to the PRP and turkey processing operations.

25 The boilers are currently fuelled with RLO. A range of additional fuels are authorised for use under the current consent including light fuel oil (**LFO**), diesel, biodiesel, coal and liquefied petroleum gas (**LPG**), a number of which have been

used or trialled at the site in the past. The existing consent CRC054334.2 provides for up to 9.2 MW of combustion capacity (well in excess of the 6.6 MW rated capacity currently employed).

26 The existing boilers are relatively inefficient and Tegel proposes to replace the existing 2.2 MW of boiler capacity at the front boiler house with a new, more efficient boiler of 2 MW in capacity (**the new boiler**). The new boiler will be located at a new front boiler house location that is separated from tall buildings. This will improve the dispersion of combustion emissions and reduce their impact in the receiving environment.

27 Combustion processes can emit a range of contaminants with the potential to impact on human health if people are exposed to high concentrations. These include fine particulate matter ($PM_{10}$ and $PM_{2.5}$), sulphur dioxide ($SO_2$), nitrogen dioxide ($NO_2$) and carbon monoxide (CO).

28 The new boiler will be capable of both diesel and LPG combustion and will be fired with diesel in the first instance. Tegel also intends to modify the 4 x 1.1 MW rear boilers to combust diesel and potentially consolidate these boilers into either one or two boilers of the corresponding scale in future. Though Tegel wishes to retain the current liquid and gaseous fuel options (including RLO, LFO, biodiesel and LPG), the switch from RLO to diesel within the new boiler (and potentially the rear boiler house in the future) will generally result in lower emissions.

29 The emissions are described in further detail in **Appendix A**.

### 4.4 Smokehouse particulate emissions

30 The smokehouse features five ovens, four of which include a smoking function. During the smoking phase of cooking batches, fine particulate matter is generated either through friction or pyrolysis of wood shavings.

31 The smoking phase occurs intermittently during each smoked cooking batch (not all cooking batches are smoked. The smokehouse emissions represent a small fraction of overall particulate emissions from the site (on a daily average basis, smokehouse $PM_{10}$ emissions equate to 2% of corresponding emissions from the boilers).

# 5 Receiving environment

## 5.1 Sensitivity of the receiving environment

32 The Tegel site is located in a well-established industrial area and as identified by Ms Brabant is underlain by two industrial zones in the district plan:

a The east/rear of the site including the PRP, wastewater storage and turkey processing plant is located in the heavy industrial zone; and

b The west/front of the site including the bird receipt, chicken processing plant, smokehouse offices and cool stores is located in the general industrial zone.

33 Sensitivity of activities in the surrounding environment to the nuisance impacts of odour and health impacts of combustion contaminants and particulate matter vary and in my opinion:

a Properties in the surrounding industrial area feature a range of commercial and industrial activities ranging in sensitivity to the discharges to air from moderate (e.g. offices) to low (e.g. metal fabrication).

b Sensitivity will generally be high in the residential areas beyond Carmen Road to the west and beyond Buchanans Road to the north of the site. This is generally as a result prolonged occupation (potentially constant at dwellings), high expectations of amenity and the presence of sectors of the community that may be more vulnerable to respiratory health impacts (e.g. infants and the elderly). Sensitivity at schools within the residential area (such as Hornby High School and Hornby Primary School to the southwest) will also be generally high during school hours but generally low while unoccupied.

## 5.2 Existing air quality

34 Air quality in the Christchurch urban area is influenced by a range of sources, including:

a Domestic heating emissions within the adjacent residential areas during winter periods;

b Industrial and commercial combustion activities in the wider commercial/industrial area east of Carmen Road; and

c Motor vehicle exhaust emissions from local roads, including Carmen Road.

35 As a result of emissions from these sources and as noted at paragraph 98 of the s42A report, ambient concentrations of $PM_{10}$ and $PM_{2.5}$ particulate in urban areas of Christchurch are at times elevated, particularly over winter periods.

36 Under the National Environmental Standards for Air Quality[2] (**NESAQ**) the site is located within the Christchurch Airshed (which encompasses the Christchurch urban area). This airshed continues to be classified as polluted in terms of $PM_{10}$ concentrations under the NESAQ.

37 The site is also located within the Christchurch/Ōtautahi Clean Air Zone under the Canterbury Air Regional Plan (**CARP**), which applies a more stringent rule framework to allow ECan to manage air quality in the polluted airshed.

38 The dispersion modelling investigation of the potential impact of combustion emissions from the site (as I discuss later) included estimates of background contaminant levels (based on ECan monitoring results) for the purposes of assessing cumulative effects. These background estimates are described in section 5.3 and Appendix B of the Air Quality Assessment.

39 Background odour sources existing in the area including Couplands Bakery at the corner of Buchanans Road and Carmen Road. Bakery odour was noted in observations downwind of the bakery site in the odour observation programme I describe in paragraph 54 below.

## 5.3 Meteorological and topographical influences on dispersion of emissions

40 Weather conditions, in particular wind speed and direction and atmospheric stability, can influence the dispersion of contaminant emissions and their potential to impact on air quality.

41 A wind rose frequency analysis of wind speed and directions (wind blowing from) observed at the Riccarton meteorological station for the period 2008 to 2017 (inclusive) has been uplifted from the Air Quality Assessment and reproduced at Figure 2 of the s42A report. As illustrated in that figure, there is a strong prevalence of winds from the northeast (particularly in summer months), with a secondary prevalence from the opposite southwest quadrant.

[2] Resource Management (National Environmental Standards for Air Quality) Regulations 2004

# 6 Assessment of impacts on air quality

## 6.1 Odour effects

### 6.1.1 Odour assessment methods employed

42 In assessing the potential nuisance impacts of the proposed odour discharges, the effects of the odour discharges as at the time the application was made and the potential changes to those effects as a result of the proposed site modifications were investigated.

43 The effects of the operation as at the time the application was made were assessed using the following techniques:

a Review of complaints and community feedback regarding odour;

b A programme of odour observations conducted in and around the site;

c A review of the efficacy of odour management measures currently employed.

44 The effects of the proposed odour control upgrades were assessed using the following techniques:

a A review of the efficacy of proposed modifications to odour management.

b Characterisation of the potential comparative change in odour levels through dispersion modelling.

45 The potential for nuisance effects of odour emissions from the currently consented and proposed activities was then summarised through consideration of the "FIDOL" factors (frequency, intensity, duration, offensiveness/character and location) referred to in Schedule 1 of the CARP.

### 6.1.2 Effects of the currently consented odour discharges

#### 6.1.2.1 Complaints relating to odour

46 The nature and frequency of complaints was analysed in section 7.2 and Appendix E of the T+T Air Quality Assessment. I have updated Figure 7.1 of the Air Quality Assessment (illustrating the annual frequency of complaints) in **Appendix B** of this statement to include up to date complaints records. Complaints are not a conclusive indicator of the presence or absence of odour nuisance but can provide a broad indication of odour nuisance experienced in the vicinity of the existing operations.

47 I note that the ECan complaint record I have referred to denotes whether a complaint has been "substantiated" or not. While the meaning of "substantiated" is not clear, based on the investigation descriptions provided I have assumed this refers to confirmation by ECan officers that the odour referred to in the complaint has been observed and that the odour is derived from the source referred to in the complaint (e.g. Tegel).

48 The complaints were categorised by area but a substantial portion of complaints were not able to be identified in the record as being lodged from the local residential or commercial/industrial areas. However, the majority of complaints that are able to be attributed appeared to result from the commercial/industrial area surrounding the site with the balance coming from the residential to the north and west.

49 Complaint investigation details indicate that the odour incidents substantiated though ECan complaint investigations were associated with abnormal operational circumstances (e.g. plant breakdowns). In each instance Tegel implemented response measures to deal will abnormal operation and to prevent reoccurrence (such as implementing cooker process controls to stagger venting from batches).

#### 6.1.2.2 Submission feedback on odour

50 Submissions on the application have provided further feedback on odour experienced historically in the community.

51 Eleven submissions were received in opposition to the application, each of which noted odour (or at least foul/unpleasant pollution) as a concern. Five of these submissions were received from the residential area to the north (beyond Buchanans Road) and three were received from the residential area to the west (beyond Carmen Road, including the Ministry of Education submission). The remaining three submissions were received from or in relation to premises in the commercial or industrial area.

52 I participated in a consultation meeting with representatives of the Ministry of Education on 15 July 2020 to further understand the concerns expressed in the submission. Feedback from the principal of Hornby High School indicated that unpleasant odour has been observed at the school at times in northeast winds, including as recently as the past summer period.

53 As Tegel did not have the benefit of this feedback at the time the odour was identified by the submitters (allowing an in-time investigation), it is difficult to ascertain the exact source or cause (and whether it related to abnormal operational incidents or from on-going routine emissions). However, the "freezing works" nature of odour referred to in submissions would appear to be consistent with odour associated with untreated odour from the PRP.

#### 6.1.2.3 Observations of odour in the environment

54 A programme of regular field odour observations was carried out from December 2017 to February 2018, as summarised in Appendix C below. This involved a variety of T+T Group technical staff making regular observations at the site and in the surrounding area at different times of the day (to encompass a range of operating and environmental conditions).

55 This type of assessment technique is used to provide an understanding of ambient odour levels resulting from diffuse sources (where direct sampling of odour at the source is not available) in a range of operating and environmental conditions.

56 The odour observation programme followed a similar methodology employed by T+T for assessment of other odour discharges. As no New Zealand guidance is available for this type of assessment[3], the methodology was broadly based on standard methods assessment published by the Association of German Engineers (Verein Deutscher Ingenieure).

57 The frequency of detection of recognisable odour was compared with assessment criteria for residential and commercial areas set out in the German Guideline on Odour in Ambient Air (**GOAA**) to identify where nuisance was likely to result from the observed odour. The German legislative context of the GOAA nuisance criteria differs from the RMA and planning context in which this application is made. However, in the absence of relevant New Zealand guidance, the criteria were used in the assessment to indicate where further investigation or improvements to odour management may be required.

58 This analysis indicated that the observed odour exceeded the GOAA nuisance criterion for commercial areas at three downwind locations at or near the site

[3] Australasian guidance on odour observation methods is currently in the early stages of development by the Clean Air Society of Australia and New Zealand (CASANZ)

boundary). Odour was observed at lower frequencies and intensities at locations further downwind at the boundary between commercial and residential areas (along Carmen Road and Buchanans Road) and did not exceed either of the nuisance criteria specified for residential or commercial areas.

59 Odour from the PRP was generally predominant in the odour observations particularly at the observation locations at or near the site boundary. Furthermore, observations undertaken around the PRP at or near the site boundary in conditions that allowed odour from the biofilter and from the PRP building to be considered separately indicated that the PRP odour was likely to be predominantly sourced from the PRP building (e.g. as fugitive releases) rather than from the biofilter.

#### 6.1.2.4 Conclusion regarding effects of the currently consented odour discharges

60 Overall, the odour observations, along with the community feedback detailed in the complaint record, indicated that odour emissions from the site have historically had the potential to cause odour nuisance in the immediately adjacent commercial/industrial area during normal operation. The observations also indicated that the odour at these locations was likely to have been caused predominantly by the fugitive release of untreated odour from the PRP building.

61 Further afield in the residential areas observed odour levels were lower and complaints from these areas appear to have been associated with abnormal operational incidents.

### 6.1.3 Management of odour emissions and mitigation of impacts

62 The PRP presents the greatest risk of odour nuisance of the site activities and therefore requires the greatest attention to control and management of odour.

63 In addition to controlling the quality of raw material input to the PRP (the bulk of which is generated on-site and able to be directly controlled by Tegel, with all input material processed on the day it is generated or received), the control of PRP odour focusses on the capture and extraction of odorous air arising from the cookers and released into the PRP building. The extracted air is treated through biofiltration before being discharged to air.

64 This type of approach is commonly applied to control odour from animal by-products rendering activities. However, the assessment of existing odour impacts identified that fugitive escape of odour from the PRP containment and

treatment system as the likely cause odour levels observed in the industrial/commercial area surrounding the site. This in turn could potentially have resulted in odour nuisance referred to in community feedback in submissions.

65 In order to address this issue, Tegel proposed as part of the consent application to upgrade the PRP ventilation system to increase the extraction rate from the PRP building and to add direct extraction from the outdoor offal bin.

66 As well as providing for more direct extraction coverage for process sources, the 70% increase in extraction would also increase the potential building extraction rate to up to 25 air changes per hour, which is at the higher end of extraction rates for this type of rendering odour management system. The additional building extraction provides for a higher degree of negative pressure differential (between the inside of the building and ambient conditions) and containment and extraction of odorous air within the building for treatment, including during hot ambient conditions outside the building.

67 A potential alternative to increasing the rate of building ventilation would be further direct extraction from process odour sources. However, direct extraction is inhibited by the batch nature of the rendering process in this instance. As an example, cooker loadout is one of the main PRP odour sources downstream of the cooker. Loadout of material from cookers to the press conveyor occurs manually at the end of each cook/batch. The requirement for access during manual loadout limits the ability to enclose this odour source or apply extraction hoods and building extraction is therefore necessary to capture odour.

68 In the process of upgrading the ventilation system and conducting maintenance on the biofilter, Tegel identified that design modifications to the biofilter bed and flow distribution plenum could improve biofilter operation to better handle the increased extraction flow. Tegel subsequently updated the application to propose a replacement of the biofilter[4].

69 The design and operation of the new biofilter is discussed in the evidence of Mr Cudmore, which indicates that it will provide improved control of odour in the increased extraction rate from the PRP.

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[4] T+T. "Tegel Foods Ltd Resource Consent Application CRC185584 - Proposed Modifications to Biofilter Design", letter dated 21 February 2020

70 To manage the potential impacts of the existing odour emissions, Tegel proceeded with implementing the odour control upgrade in advance of the conclusion of this application process. The upgraded ventilation fan was installed and commissioned in January 2020. Subsequently, the biofilter has been replaced, during which time the increased extraction flow was directed to a single biofilter bed (while the other bed was deconstructed and replaced). The new replacement biofilter was commissioned to receive the full upgraded extraction flow in May 2020.

71 Collectively these improvements allow for improved capture and treatment of previous fugitive releases of untreated emissions from the PRP.

72 Tegel has also implemented the proposed enclosure of the wastewater tank adjacent to the PRP and as part of the PRP ventilation upgrade air is now extracted from the tank to the biofilter. This provides complete containment and treatment of an odour source that Tegel had previously identified as an intermittent odour source in the investigation of historical complaints.

73 The extent of potential odour generation from other sources, including bird receipt, chicken processing and wastewater conveyance is less than from the PRP. Except for wastewater storage adjacent to the PRP, the control of odour from these source does not involve capture and treatment as employed at the PRP.

74 Instead the control of odour from these sources focusses on:

a Minimisation of odour at source (e.g. by avoiding build-up of organic material in process units or conveyance networks and anaerobic degradation that can result in odour); and

b Containment and dispersion (e.g. air captured from the processing plant scalders is discharged via tall stacks to aid dispersion).

75 Tegel has formally collated and documented its odour management procedures for the PRP and other sources in an Odour Management Plan. This includes previous modifications to operations and site activities implemented by Tegel in response to complaints. Implementation of these procedures should reduce the risk of abnormal PRP odour emissions in future.

76 Overall, I consider that with the recent implementation of the upgrades to odour management, the management measures employed at the site should provide effective control of the odour generated at the site.

#### 6.1.4 Anticipated effects of odour discharges following upgrades

77 Dispersion modelling was used to illustrate the potential change in odour levels that could be achieved with improved capture of PRP odour. An excerpt from the Air Quality Assessment describing this investigation is provided in Appendix D below.

78 Without being able to quantify the exact extent of reductions in fugitive releases achieved by the upgraded ventilation system, the exercise included a number of assumptions about the extent of fugitive release prior to the upgrade and the improvements in odour capture that may be achieved. As a result, this was a hypothetical exercise. Notwithstanding this, the exercise broadly illustrates the improvements in odour levels that can be achieved through improved capture and treatment of odour.

79 The predictions also do not account for the likely changes in hedonic tone of odour captured and treated through the biofilter. Not only will the changes result in a reduction in intensity of existing untreated PRP odour but the odour released in treated form from the biofilter generally has an earthy character that is less likely to be considered offensive.

#### 6.1.5 Summary of odour impacts

80 The FIDOL factors (frequency, intensity, duration, offensiveness/character and location) are commonly used in New Zealand to describe or assess the potential for odour nuisance, and the potential for objectionable or offensive effects in particular at locations where odour from a particular source may be observed.

81 A summary consideration of odour from the Site, as at the time the application was lodged and following the recent odour management upgrades, against the FIDOL factors was provided in Table 7-6 (Section 7.8) of the Air Quality Assessment. For ease of reference, this assessment is reproduced in Appendix E of this statement.

82 On the basis of that consideration, the Air Quality Assessment (section 7.8) drew the following conclusions:

*In summary, odour levels observed in the immediate vicinity of the PRP have been observed to exceed the relevant intensity/frequency threshold for commercial areas, which would indicate a potential for nuisance effects in this area. The intensity and frequency of odour has been observed to reduce with distance and at the residential areas the observed odour levels met the corresponding threshold for residential areas. The observations therefore indicated that with appropriate management of odorous activities to minimise the risk of abnormal emissions, odour nuisance in the residential areas should be avoided.*

*Tegel proposes to implement measures to improve the management of odour at the PRP and adjacent wastewater storage tank. These measures will reduce the frequency and intensity and modify the character/hedonic tone of the odour in the adjacent commercial area where odour levels are currently highest (as well as in the more sensitive residential areas beyond).*

83 With the implementation of the odour management upgrades I consider that offensive and objectionable odour should be avoided beyond the site boundary in future, including in the adjacent commercial/industrial area and in the residential areas further afield, and that the potential odour nuisance effects are minor.

## 6.2 Effects of combustion emissions

84 Atmospheric dispersion modelling was used to assess the potential effects of combustion contaminants emissions on local air quality and human health within the receiving environment.

85 This investigation assessed the impacts of combustion emissions in the following scenarios:

a The existing combustion plant configuration; and

b The configuration following proposed modifications to the front boilers at the site

86 The dispersion model has taken account of the scale and physical characteristics of the emissions, local meteorological conditions, terrain and adjacent buildings to predict the impact of the emissions on ambient contaminant concentrations

in the surrounding area. In each scenario, worst case emissions, based on the fuel options sought in the consent (based primarily on RLO combustion and the proposed conditions of consent) were assessed.

87 Predicted peak contributions of the site emissions to ambient contaminant concentrations and cumulative concentrations (including estimated background source contributions) were compared with national air quality standards and guidelines referred to in the CARP. These include the ambient air quality standards specified in the NESAQ and the Ambient Air Quality Guidelines (**AAQG**) published by the Ministry for the Environment (**MfE**)[5].

88 Where national air quality standards or guidelines have not been specified, the predictions were compared with air quality guidelines (**AQG**) published by the World Health Organisation (**WHO**). This is the case currently for $PM_{2.5}$, and the WHO AQG values used in the assessment for this contaminant are likely to be incorporated into amendments to the NESAQ.

89 The dispersion model predictions are summarised in Appendix F to this statement. The model predictions indicate that emissions of the majority of contaminants from the boilers were predicted to make only small contributions to ambient contaminant concentrations (relative to the standards and guidelines used as assessment criteria) at off-site locations where people are likely to be exposed.

90 However, as a result of downwash turbulence impacts of the tall buildings adjacent to the current front boiler stack, the use of fuel oil and the general inefficiency of the existing boilers, the existing boiler emissions were predicted to contribute up to 30% of the NESAQ threshold for $PM_{10}$ concentrations. Coincidence of peak contributions from the existing boilers with high background $PM_{10}$ concentrations in winter could therefore potentially exacerbate exceedances of the NESAQ in the area.

91 Tegel proposes to reconfigure the site combustion appliances, replacing the current 2 x 1.1 MW front boilers with a new, more efficient 2 MW boiler. This boiler will be located at a new front boiler house distant from the tall buildings

[5] MfE. 2002. “Ambient air quality guidelines: 2002 update”.

neighbouring the current front boiler house. This will reduce downwash impacts on dispersion of the front boiler emissions caused by adjacent buildings.

92 With the proposed boiler replacement in place, impacts on local concentrations of combustion contaminants are predicted to be substantially reduced (to 16% of the NESAQ threshold for $PM_{10}$ concentrations at the peak sensitive receptor).

93 Although Tegel wishes to retain the flexibility to use the liquid and gaseous fuels currently available under the existing consents, the new front boiler is likely to be fired with diesel for the foreseeable future. The predictions of the dispersion modelling based on higher emission RLO and the proposed consent conditions fuels are therefore likely to overstate the impact of the boiler emissions (and the reductions in impacts will be greater than predicted).

94 Overall, with the proposed combustion modifications in place, I consider the potential impact of the combustion emissions on human health in the local environment to be minimal.

# 7 Submissions

## 7.1 General submitter concerns

95 As I noted in paragraph 51 above, each of the submitters in opposition raised (or appeared to have raised) concerns in relation to historical odour levels in the community. The proposed upgrade will improve the control and management of odour to reduce odour levels in the community and avoid reoccurrence of the effects described in submissions.

## 7.2 Ministry of Education submission

96 The Ministry of Education submission refers to odour effects experienced at both Hornby High School and Hornby Primary School to the southwest of the site. During consultation with the Ministry it was identified that odour had continued to be experienced at Hornby High School over the recent summer period (including after the installation of the new fan in January 2020) and concerns were raised in relation to the efficacy of this upgrade in controlling odour.

97 As noted in paragraph 70 above, the biofilter was in the process of being replaced during this period and the increased extraction flow from the new fan was directed to a reduced biofilter volume (half of the existing volume). Although it is difficult to identify the potential cause of ambient odour

retrospectively, the direction of the full increased flow to the reduced biofilter volume could have reduced the degree of treatment of odour or increased the potential for bypass.

98 The proposed biofilter has been designed with the proposed increased extraction flow in mind and improved plenum design should provide for better distribution of that flow across the bed. The full impact of proposed modifications on odour control is best understood with both the extraction and treatment upgrades in place, which has been the case since May 2020. With the full odour control upgrade in place I expect that a reoccurrence of the odour nuisance impacts noted at the Hornby High School over the preceding summer should be avoided in future.

### 7.3 Van Koten submission

99 Chikako Van Koten noted specific concerns in relation to the odour observation programme not being conducted in calm conditions when odour impacts are greatest and that a community response survey by phone.

100 The programme was conducted at various times of the day in order to encompass a variety of environmental (and operational) conditions. This included observations in calm conditions.

## 8 Council s42A Report

### 8.1 Fuel options

101 In its conclusions, the s42A report indicates "*that a wholesale change to cleaner fuels such as diesel or liquefied petroleum gas (LPG) would be ideal*". While I agree that this would improve impacts on air quality (and diesel is likely to be the main fuel used at the site in future) a wider range of fuel options is currently required at the site (including RLO at least) and is appropriate in future.

102 Process heat (steam) is currently raised at the site in boilers through combustion of RLO, and diesel is scheduled to be used in future. Provided resulting emissions can be managed appropriately, I consider there to be no detriment to air quality and there are potential environmental benefits in providing for the proposed range of fuels.

103 The new front boiler will be able to combust LPG and the use of this comparatively clean-burning fuel could potentially become more viable in

future. Use of RLO and biodiesel involve sustainability benefits of utilising fuel from repurposed or renewable sources.

104 The Air Quality Assessment has considered an envelope of effects on air quality (arising primarily from the current use of RLO controlled by the proposed consent conditions). I believe the use of the proposed range of fuels will not increase that envelope of effects and should be provided for in the consent.

## 8.2 Estimation of particulate emissions

105 Concerns were raised in paragraph 53 of the s42A report regarding the fraction of $PM_{2.5}$ in particulate emissions from the boilers estimated in the Air Quality Assessment.

106 The estimation of boiler particulate emissions (reproduced in **Appendix A**) was based on an assumed maximum particulate emission concentration of 250 mg/$Nm^3$ (i.e. corrected to 0°C, 1 atmosphere and dry conditions) and estimated combustion exhaust flow at the full rated load. This maximum concentration has been adopted as an emission limit for $PM_{10}$ in draft consent condition 9(a) of the s42A report (with a further requirement to correct the concentration to 12% $CO_2$).

107 $PM_{10}$ emissions were conservatively assumed to comprise 100% of particulate emissions. In reality, particulate emissions are likely to include particles of greater than 10 µm in diameter and this assumption will overstate $PM_{10}$ emissions. For example, $PM_{10}$ emissions measured in rear boiler emission tests conducted in 2009 and 2010 comprised, on average, 72% of particulate emissions from RLO combustion and 55% of corresponding emissions from LFO combustion.

108 $PM_{2.5}$ emissions from the boilers have not been measured but are likely to comprise only a portion of the $PM_{10}$ emissions. Emission factors for fuel oil combustion published by the US EPA[6] assume that 37% of $PM_{10}$ from LFO combustion[7] is comprised of $PM_{2.5}$ and this was applied to the assumed $PM_{10}$ emissions from the boilers.

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[6] US EPA. 2010. "AP-42, Fifth Edition Compilation of Air Pollutant Emissions Factors, Volume 1: Stationary Point and Area Sources. Chapter 1.3- External Combustion Sources – Fuel oil Combustion." Table 1.3-7.

[7] No corresponding AP-42 estimates were available for the $PM_{2.5}$ fraction of $PM_{10}$ emissions from RLO combustion

109 Without the benefit of $PM_{2.5}$ emission test results for boilers, it is possible that the assumed $PM_{2.5}$ fraction of $PM_{10}$ emissions is understated. However, the $PM_{10}$ testing that has been conducted illustrates that the assumed 100% $PM_{10}$ composition of particulate emissions is likely to overstate $PM_{10}$ emissions.

110 It is also possible that diesel combustion could result in a higher fraction of $PM_{2.5}$ in particulate emissions from the boilers. However, I would expect overall particulate emissions during diesel combustion to be much lower than estimated in the Air Quality Assessment.

111 Overall, I do not believe that $PM_{2.5}$ emissions have been underestimated in the Air Quality Assessment. In the event that the $PM_{2.5}$ emissions are higher than estimated, the extent of the underestimation is unlikely to be significant given the results of $PM_{10}$ testing and this would not change the conclusions of the assessment of these emissions. The contributions of boiler emissions to ambient $PM_{2.5}$ concentrations where the public is likely to be exposed would still be relatively low and reduced further by the replacement and relocation of the front boiler house.

### 8.3 Odour assessment methods

112 The s42A report refers at paragraph 131 to odour assessment methodology discussions between Tegel and ECan early in the consent process and the potential to use an odour annoyance survey method. I initially discussed the methodology with ECan in pre-application consultation in September 2017.

113 Community feedback can provide important information on historical nuisance effects of existing discharges. In developing the odour assessment methodology, I considered an odour annoyance phone survey in the area as means of obtaining quantitative feedback. I have used this method in the past but discounted it in this instance due to issues with gaining a representative population sample associated with decreasing landline usage (refer Appendix L of the Air Quality Assessment).

114 As an alternative, I proposed a questionnaire survey to solicit qualitative feedback from the community. I have used this method for assessment of other odour discharges but was advised against using it in pre-application consultation with ECan.

115 The Air Quality Assessment therefore relied on community feedback provided via the complaint record and the odour observation programme was conducted to provide a quantitative assessment of odour in the local area.

116 Further community feedback has since been provided in qualitative terms via the notification process and submissions received from the surrounding area.

117 Overall, I consider the methodology used to assess the effects of the existing discharge to be robust and consistent with requirements set out for an application of this type in Schedule 1 of the CARP.

### 8.4 Change in relative importance of odour sources

118 The s42A report notes at paragraph 130 that "*removing the PRP from the site's odour profile is likely to reveal the extent of other contributions to off-site effects*".

119 I agree that in relative terms, the reduction in the odour emissions from the PRP brought about through improvements to odour control could potentially increase the importance of other odour sources on site, such as wastewater storage/conveyance, bird receipt, scalding and the smokehouse.

120 The odour observation programme indicated that stronger intensity odours were associated with the PRP and, to a lesser extent, wastewater storage/conveyance. This is consistent with feedback I have had from Tegel staff in relation to odour generation. Both the PRP and wastewater storage are subject to the odour management improvements that have now been implemented at the site to reduce the intensity and frequency of odour emissions.

121 Odour types associated with other sources at the site that are not proposed to be modified such as bird receipt and the smokehouse were also observed in the odour observation programme, albeit at lower frequencies and intensities. While the relative levels of odour from the various site sources may change, in absolute terms odour levels will be reduced by the proposed modifications. I would not expect the residual odour from the unmodified sources identified in the surrounding area in the odour observation programme to cause offensive or objectionable effects.

### 8.5 Uncertainty in the effects in the residential area

122 The s42A report notes at paragraph 131 concerns relating to the potential effects of routine odour emissions from the site (without the odour control upgrades in place) within the adjacent residential areas.

123 The complaint record indicated that substantiated complaints were associated with abnormal operational incidents and the odour observation programme highlighted that odour in the residential area during typical operation is of a much lower intensity than in the commercial/industrial area surrounding the site.

124 Notwithstanding this, the odour control upgrades will reduce the intensity and frequency of odour within the residential areas as well as the adjacent commercial/industrial area and reduce any previous potential for nuisance effects as a result of routine emissions in those areas.

## 9 Recommended conditions of consent

125 I consider the draft conditions recommended in the s42A report to be broadly appropriate but that modifications are required to reflect the proposed activity and provide for effective control of the discharges to air and associated environmental effects.

### 9.1 Condition 4 – Boiler specifications

126 Condition 4 sets out maximum combustion.

127 While I consider this condition to be generally appropriate, I recommend that modifications be made to provide for the following:

a For clarity I believe it would be useful if the condition refers to maximum heat output “rating” (or capacity);

b The condition should refer to discharge points (boiler stacks) rather than boiler houses, the location of which is not relevant to the discharge or effects;

c The new front boiler will be 2 MW (previously proposed to be up to 2.3 MW) and the maximum front boiler house capacity prior to this upgrade will be the current 2.2 MW.

d The condition and associated plan need to provide for operation of the existing front boilers until they are replaced; and

e As noted in the evidence of Mr Atkinson, simultaneous operation of both the existing and proposed front boilers may be required during commissioning. Operation will be at partial load and the overall front boiler load will be less than provided for in clause b of proposed condition 4.

### 9.2 Condition 5 - Fuel quality

128 Condition 5 specifies an absolute limit on sulphur content of fuel of 0.5 percent by weight. I consider a sulphur content limit to be appropriate to manage $SO_2$ emissions and the assessment of $SO_2$ impacts was based on a fuel sulphur content.

129 However, condition 5 differs from the corresponding existing consent condition (Condition 1(c) of CRC054334.2), which specifies two limits (by weight):

a a monthly weighted average of 0.5%

b with an absolute maximum of 0.8%.

130 RLO and LFO are the only proposed fuel options with a realistic potential to approach or exceed this limit. The sulphur content of RLO is likely to remain within the specified maximum limit of 0.5% (w/w) - the sulphur content in 2017 RLO quality reports that were reviewed during preparation of the Air Quality Assessment varied from 0.45% to 0.48%.

131 However, it is possible that sulphur content of individual deliveries of RLO (or LFO if it were to be used in future) could potentially exceed 0.5%. Provided exceedance of the 0.5% limit were not prolonged, I believe occasional exceedance of the 0.5% limit (up to an absolute maximum of 0.8%) is unlikely to result in materially different or more adverse impacts on air quality. The contributions of boiler emissions would still remain comfortably within the NESAQ and MfE AAQG assessment criteria referred to in the CARP at locations where members of the public may be exposed.

132 Adoption of the sulphur limit regime from the previous consent would provide flexibility for Tegel while not materially increasing the potential adverse environment effects of the boiler emissions.

### 9.3 Condition 12 - Fuel reporting

133 Condition 12 requires recording of "*the amount, type and sulphur content of fuel used each month*".

134 I consider it is reasonable to record the amount and type of fuel used but consider the recording of sulphur content to be unnecessary for fuels where the sulphur content may be readily inferred or is likely to be negligible.

135 Diesel is set to become the main boiler fuel for the foreseeable future. The quality of diesel is already closely regulated under the Engine Fuel Specifications Regulations 2011 by the Ministry of Business and Innovation. The regulations limit the content of contaminants to well below the levels set out in the s42A draft conditions 5 and 6. In relation to sulphur, the maximum content in diesel (10 mg/kg) is 50,000 times lower than the 0.5% sulphur content limit in draft condition 5.

136 LPG is also likely to contain only trace amounts of sulphur-based odorant additives (e.g. mercaptans) for safety purposes and sulphur content could be reliably considered to be minimal.

137 It is therefore my opinion that recording of sulphur content under condition 12 should only be required where RLO or LFO are used.

### 9.4 Condition 18 – Management of odour from the wastewater balance tank

138 Condition 18 requires that "*wastewater does not become anaerobic at any stage of its storage, conveyance or discharge off site*".

139 While avoidance of anaerobic degradation where practicable is desirable, I believe the specified threshold of "not becoming anaerobic" is unclear and is not readily measurable. A minimal degree of anaerobic degradation of organic matter in stored wastewater is unavoidable and could result generation of residual low intensity odour that may be detectable in immediate proximity.

140 Additionally, the rear wastewater balance tank (where anaerobic degradation has generated odour in the past) is now enclosed and ventilated to the biofilter to control odour. Ventilation of the tank to the biofilter is included as a requirement of draft Condition 15 but this condition refers specifically to PRP operation.

141 To provide measurable criteria for wastewater odour management and to more clearly set out odour ventilation and treatment requirements I consider that Condition 18 should instead specify a requirement to enclose and ventilate the wastewater (and the reference to this tank in condition 15 should be removed).

142 Further requirements in Condition 27 to document procedures in the ADMP to ensure that solids build-up within the wastewater system is regularly checked and removed would provide more clearly for avoidance of anaerobic conditions.

### 9.5 Condition 23 - Site boundary odour assessments

143 Condition 23 sets out a requirement for Tegel to undertake odour observations at the downwind site boundary on a daily basis.

144 I agree that regular odour observations at the downwind site boundary would be useful provided the observations are undertaken by staff members not regularly exposed to the odour (e.g. office staff or other staff members not regularly in close proximity to site odour sources). This would provide ongoing monitoring of odour control performance and identify changes in the odour discharge that may require investigation and response. However, I disagree with the proposed requirement for the assessments to be conducted "*in general accordance with the Verein Deutscher Ingenieure [VDI] method 3940*".

145 The odour assessment method used in the Air Quality Assessment was developed drawing on relevant aspects of VDI 3940 (Parts 1 and 2) guidance for plume and grid odour assessments (to understand odour levels within the wider receiving environment).

146 However, the VDI 3940 standard (which has largely been superseded by the European standard EN-16481) contains a substantial amount of detail that is not relevant to the proposed surveillance of odour downwind of individual odour sources. I therefore believe the procedure would be more effectively set out in the Air Discharge Management Plan (**ADMP**) required under Condition 27 and I provide a suggested draft of that procedure in Appendix G below.

147 I therefore recommend that the reference to the VDI 3940 standard in Condition 23 be replaced with a reference to a procedure for boundary odour assessments set out in the ADMP.

148 I further consider that Condition 23 should provide a mechanism for allowing the frequency of odour observations to be reduced in the case of low observed odour levels and a good record of compliance.

### 9.6 Condition 24 and 25 – Recording and reporting of monitoring results

149 Condition 24 and 25 require the recording and reporting to ECan of the results of site boundary odour assessments, odour incidents and potential non-compliance with conditions on a six-monthly basis.

150 I consider it is reasonable for Tegel to analyse and report on these matters on a regular basis and that this could also include a consideration of complaints regarding the discharges.

151 However, I consider that an annual reporting frequency would be more reasonable. I also believe it would be clearer if Condition 24 related to record keeping (and that the keeping of records should be time limited and not infinite) and Condition 25 set out the combined reporting requirements.

### 9.7 Duration of consent

152 The s42A report recommends a duration of 10 years for the following reasons, which I discuss in turn below:

a the uncertainty around ongoing odour effects and the effectiveness of the PRP upgrades;

b that Tegel wishes to continuing use of boiler fuels that are not the cleanest of those currently widely-available; and

c that the site is located in a highly sensitive location.

153 In relation to the uncertainty of on-going odour effects, as I have noted in paragraph 124 above, the odour control upgrades should reduce on-going, routine emissions and any previous associated potential for nuisance effects in both the adjoining industrial/commercial and residential areas further afield. The impact of the recently implemented improvements should be most apparent over summer periods when the frequency of complaints has historically been highest.

154 Condition 28 provides for a regular review of odour management, taking account *of odour effects being created by the site at that time*. This would allow odour nuisance effects and the measures used to manage and mitigate those effects to be reviewed and considered on a regular basis (in a manner similar to an assessment of environmental effects) without the need for a short consent duration. The requirement in clause e) of condition 28 of the s42A report to submission of the review report "*no later than five, ten and fifteen years*

*following the commencement of this resource consent*" would appear to indicate a duration of 20 years has at least been contemplated in the preparation of the s42A report.

155 In relation to the availability of fuel options, the consent at the very least needs to provide for the current use of RLO, which effectively sets the envelope of air quality effects of combustion emissions.

156 Comparatively clean-burning diesel will be used in the new front boiler when it is commissioned later this year and Tegel's intent is convert or replace the rear boilers to provide for the same dual fuel (diesel-LPG) combustion capability.

157 As I have noted in paragraph 103, for potential sustainability benefits to the environment it is important that the option to use of RLO and biodiesel is retained. The Air Quality Assessment indicates that with improved dispersion of front boiler emissions, in the instance that RLO is used, the impacts of emissions would still be reduced compared to the current impacts and predicted impacts on ambient contaminant levels are low compared with relevant health assessment criteria (including current and potential future NESAQ ambient standards).

158 In relation to sensitivity, despite being situated within an appropriate district plan zone, residential areas lie beyond Carmen Road and Buchanans Road. I agree that sensitivity to air pollution is generally high in these areas. However, the assessment of effects of the discharge has considered the presence of highly sensitive activities in these areas.

159 For the above reasons, I consider a longer duration than the 10 years recommended in the s42A report would be appropriate in this instance.

## 10 Conclusions

160 In summary, it is my opinion that:

a Odour is emitted from a number of sources at the site, and from the PRP in particular. Combustion by-products are emitted from the boilers supplying heat to the site and additional particulate matter is emitted from the smokehouse. Each of these contaminants has the potential to affect local air quality.

b The site is located within an established industrial area and is surrounded by commercial and industrial activities of moderate to low sensitivity to

the emissions from the site. Further afield in the residential areas beyond Buchanans Road to the north and Carmen Road to the west, sensitivity to the emissions will be high.

c Smokehouse particulate emissions are intermittent and small in scale and are unlikely to result in adverse impacts on human health or other aspects of the local environment.

d A number of changes to boiler combustion are proposed at the site (including replacement and relocation of boilers and changes to fuel use) and these are predicted to lead to a substantial reduction in impacts on ambient air quality. With the implementation of those changes, I consider the potential impacts of combustion emissions from the site on human health in the area to be minimal.

e In relation to odour impacts, community feedback and observations conducted by T+T staff have indicated a potential for odour nuisance in the area, and in the surrounding commercial/industrial area in particular, as a result of odour emissions from the PRP. Tegel therefore proposed a number of changes to odour management at the PRP and has recently implemented those changes. With those changes in place I anticipate a substantial improvement in the capture and control of odour and avoidance of nuisance effects of the type indicated in the assessment of the previous PRP configuration. With the upgrades now in place and the modified consent conditions described above imposed, offensive and objectionable odour beyond the site boundary should be avoided and I consider the potential for odour nuisance effects to be minor.

**Jason Pene**

28 July 2020

# Appendix A: Estimation of combustion contaminant emission rates

## Existing Rear Boilerhouse Combustion Emissions

### Assumed/specified values

| Parameter | Value | Unit | Derivation |
|---|---|---|---|
| Rated boiler output | 4.4 | MW | 4 x 1.1 MW Boilers |
| Oil calorific value | 43 | MJ/kg | Fulton Hogan used oil |
| Assumed design efficiency | 85% | | |
| Excess air | 35% | | |
| Inlet air temperature | 20 | °C | |
| Exhaust temperature | 250 | °C | |

### Calculated values

| | | | | |
|---|---|---|---|---|
| Gross energy input | 5.18 | MW | | |
| Fuel oil combustion rate | 0.120 | kg/s | = | 433 kg/h |

### Fuel properties

| Component | Fuel mass composition | Combustion rate (kg/s) | Combustion rate (kmol/s) | Combustion O2 molar ratio | Combustion O2 rate (kmol/s) |
|---|---|---|---|---|---|
| C | 85.1% | 0.102 | 0.0085 | 1 | 0.0085 |
| H2 | 10.6% | 0.013 | 0.0064 | 0.5 | 0.0032 |
| O2 | 0.0% | 0 | 0 | -1 | 0 |
| N2 | 0.0% | 0 | 0 | 0 | 0 |
| S | 0.5% | 0.001 | 1.9E-05 | 1 | 1.9E-05 |
| Water | 2.0% | 0.002 | 0.0001 | 0 | 0 |
| Ash | 1.8% | 0.002 | | | |
| Total | 100.0% | 0.120 | 0.0151 | | 0.0118 |

### Dry inlet air properties (ambient)

| Component | Inlet air volume composition | Relative molar mass | Inlet air mass composition |
|---|---|---|---|
| N2 | 78.03% | 21.8 | 75.5% |
| O2 | 20.99% | 6.72 | 23.2% |
| Argon | 0.94% | 0.38 | 1.3% |
| CO2 | 0.03% | 0.0132 | 0.0% |
| Total | 100.0% | 29.0 | |

| | | | | |
|---|---|---|---|---|
| Combustion O2 rate | 0.0118 | kmol/s | = | 0.376 kg/s |
| Minimum combustion air rate | 1.62 | kg/s | | |
| Combustion air rate (with excess | 2.19 | kg/s | | |

### Exhaust gas output

| Component | Exhaust rate (kmol/s) | Exhaust rate (kg/s) | Volume composition wet | Volume composition dry |
|---|---|---|---|---|
| CO2 | 0.0086 | 0.3765 | 10.94% | 11.94% |
| N2 | 0.0590 | 1.6515 | 75.42% | 82.30% |
| SO2 | 0.000019 | 0.0012 | 0.02% | 0.03% |
| O2 | 0.0041 | 0.1316 | 5.26% | 5.74% |
| Water | 0.0065 | 0.1176 | 8.36% | 9.12% |
| Total (wet) | 0.0782 | 2.2785 | | |
| Total (dry) | 0.0717 | 2.1608 | | |

| | | |
|---|---|---|
| Exhaust flow rate (STP dry) | 1.6 | Nm3/s |

### Emission assumptions

| | | |
|---|---|---|
| PM emission concentration | 250 | mg/Nm3 (assumed to be 12% O2) |
| PM10 fraction of PM | 100% | |
| PM2.5 fraction of PM | 37% | |
| Sulphur mass content of fuel oil | 0.5% | |

### Emission rate calculations

| | | |
|---|---|---|
| PM emission rate | 0.40 | g/s |
| PM10 emission rate | 0.40 | g/s |
| PM2.5 emission rate | 0.15 | g/s |
| SO2 emission rate | 1.20 | g/s |

## Existing Front Boilerhouse Combustion Emissions

### Assumed/specified values

| Parameter | Value | Unit | Derivation |
|---|---|---|---|
| Rated boiler output | 2.2 | MW | 2 x 1.1 MW Boilers |
| Oil calorific value | 43 | MJ/kg | Fulton Hogan used oil |
| Assumed design efficiency | 85% | | |
| Excess air | 35% | | |
| Inlet air temperature | 20 | °C | |
| Exhaust temperature | 250 | °C | |

### Calculated values

| | | | | |
|---|---|---|---|---|
| Gross energy input | 2.59 | MW | | |
| Fuel oil combustion rate | 0.060 | kg/s | = | 217 kg/h |

### Fuel properties

| Component | Fuel mass composition | Combustion rate (kg/s) | Combustion rate (kmol/s) | Combustion O2 molar ratio | Combustion O2 rate (kmol/s) |
|---|---|---|---|---|---|
| C | 85.1% | 0.051 | 0.0043 | 1 | 0.0043 |
| H2 | 10.6% | 0.006 | 0.0032 | 0.5 | 0.0016 |
| O2 | 0.0% | 0 | 0 | -1 | 0 |
| N2 | 0.0% | 0 | 0 | 0 | 0 |
| S | 0.5% | 0.000 | 9.4E-06 | 1 | 9.4E-06 |
| Water | 2.0% | 0.001 | 0.0001 | 0 | 0 |
| Ash | 1.8% | 0.001 | | | |
| Total | 100.0% | 0.060 | 0.0075 | | 0.0059 |

### Dry inlet air properties (ambient)

| Component | Inlet air volume composition | Relative molar mass | Inlet air mass composition |
|---|---|---|---|
| N2 | 78.03% | 21.8 | 75.5% |
| O2 | 20.99% | 6.72 | 23.2% |
| Argon | 0.94% | 0.38 | 1.3% |
| CO2 | 0.03% | 0.0132 | 0.0% |
| Total | 100.0% | 29.0 | |

| | | | | |
|---|---|---|---|---|
| Combustion O2 rate | 0.0059 | kmol/s | = | 0.188 kg/s |
| Minimum combustion air rate | 0.81 | kg/s | | |
| Combustion air rate (with excess | 1.09 | kg/s | | |

### Exhaust gas output

| Component | Exhaust rate (kmol/s) | Exhaust rate (kg/s) | Volume composition wet | Volume composition dry |
|---|---|---|---|---|
| CO2 | 0.0043 | 0.1882 | 10.94% | 11.94% |
| N2 | 0.0295 | 0.8258 | 75.42% | 82.30% |
| SO2 | 0.000009 | 0.0006 | 0.02% | 0.03% |
| O2 | 0.0021 | 0.0658 | 5.26% | 5.74% |
| Water | 0.0033 | 0.0588 | 8.36% | 9.12% |
| Total (wet) | 0.0391 | 1.1392 | | |
| Total (dry) | 0.0358 | 1.0804 | | |

| | | |
|---|---|---|
| Exhaust flow rate (STP dry) | 0.8 | Nm3/s |

### Emission assumptions

| | | |
|---|---|---|
| PM emission concentration | 250 | mg/Nm3 (assumed to be 12% O2) |
| PM10 fraction of PM | 100% | |
| PM2.5 fraction of PM | 37% | |
| Sulphur mass content of fuel oil | 0.5% | |

### Emission rate calculations

| | | |
|---|---|---|
| PM emission rate | 0.20 | g/s |
| PM10 emission rate | 0.20 | g/s |
| PM2.5 emission rate | 0.07 | g/s |
| SO2 emission rate | 0.60 | g/s |

## Proposed Front Boilerhouse Combustion Emissions

**Assumed/specified values**

| Parameter | Value | Unit | Derivation |
|---|---|---|---|
| Rated boiler output | 2.3 | MW | |
| Max fuel rate | 216 | kg/h | |
| Excess air | 35% | | |
| Inlet air temperature | 20 | °C | |
| Exhaust temperature | 250 | °C | |

**Calculated values**

| | | |
|---|---|---|
| Fuel oil combustion rate | 0.060 | kg/s |

**Fuel properties**

| Component | Fuel mass composition | Combustion rate (kg/s) | Combustion rate (kmol/s) | Combustion O2 molar ratio | Combustion O2 rate (kmol/s) |
|---|---|---|---|---|---|
| C | 85.1% | 0.051 | 0.0043 | 1 | 0.0043 |
| H2 | 10.6% | 0.006 | 0.0032 | 0.5 | 0.0016 |
| O2 | 0.0% | 0 | 0 | -1 | 0 |
| N2 | 0.0% | 0 | 0 | 0 | 0 |
| S | 0.5% | 0.000 | 9.4E-06 | 1 | 9.4E-06 |
| Water | 2.0% | 0.001 | 0.0001 | 0 | 0 |
| Ash | 1.8% | 0.001 | | | |
| Total | 100.0% | 0.060 | 0.0075 | | 0.0059 |

**Dry inlet air properties (ambient)**

| Component | Inlet air volume composition | Relative molar mass | Inlet air mass composition |
|---|---|---|---|
| N2 | 78.03% | 21.8 | 75.5% |
| O2 | 20.99% | 6.72 | 23.2% |
| Argon | 0.94% | 0.38 | 1.3% |
| CO2 | 0.03% | 0.0132 | 0.0% |
| Total | 100.0% | 29.0 | |

| | | | | |
|---|---|---|---|---|
| Combustion O2 rate | 0.0059 | kmol/s | = | 0.187 kg/s |
| Minimum combustion air rate | 0.81 | kg/s | | |
| Combustion air rate (with excess | 1.09 | kg/s | | |

**Exhaust gas output**

| Component | Exhaust rate (kmol/s) | Exhaust rate (kg/s) | Volume composition wet | Volume composition dry |
|---|---|---|---|---|
| CO2 | 0.0043 | 0.1876 | 10.94% | 11.94% |
| N2 | 0.0294 | 0.8231 | 75.42% | 82.30% |
| SO2 | 0.000009 | 0.0006 | 0.02% | 0.03% |
| O2 | 0.0021 | 0.0656 | 5.26% | 5.74% |
| Water | 0.0033 | 0.0586 | 8.36% | 9.12% |
| Total (wet) | 0.0390 | 1.1356 | | |
| Total (dry) | 0.0357 | 1.0770 | | |

| | | |
|---|---|---|
| Exhaust flow rate (STP dry) | 0.8005 | Nm3/s |

**Emission assumptions**

| | | |
|---|---|---|
| PM emission concentration | 250 | mg/Nm3 (assumed to be 12% O2) |
| PM10 fraction of PM | 100% | |
| PM2.5 fraction of PM | 37% | |
| Sulphur mass content of fuel oil | 0.5% | |

**Emission rate calculations**

| | | |
|---|---|---|
| PM emission rate | 0.20 | g/s |
| PM10 emission rate | 0.20 | g/s |
| PM2.5 emission rate | 0.07 | g/s |
| SO2 emission rate | 0.60 | g/s |

## Boiler Emission Factor Calculations (based on Recycled Lubrication Oil combustion)

**Assumed/specified values**

| | | | |
|---|---|---|---|
| Calorific value | 43 | MJ/kg | Fulton Hogan recycled oil |
| Assumed boiler design efficiency | 85% | | |
| New front boiler max fuel rate | 216 | kg/h | Provided by boiler suppliers |

**Emission factors (RFO combustion)**

| | | | |
|---|---|---|---|
| NOx | 2.39 | g/kg | Aus NPI (Combustion in Boilers Manual v3.6 2011, Table 30) |
| Cr III | 2.52E-03 | g/kg | Aus NPI (Combustion in Boilers Manual v3.6 2011, Table 30) |
| Pb | 6.92E-02 | g/kg | Aus NPI (Combustion in Boilers Manual v3.6 2011, Table 30) |
| PaHs | 3.70E-05 | g/kg (B[a]Peq) | Aus NPI (Combustion in Boilers Manual v3.6 2011, Table 30) |

| Current stack emissions | Rear stack | Front stack | Units | Basis |
|---|---|---|---|---|
| Number of boilers | 4 | 2 | | |
| Indvidual boiler output rating | 1.1 | 1.1 | MW | |
| Overall rated ouput | 4.4 | 2.2 | MW | |
| Fuel usage | 433 | 217 | kg/h | Estimated based on fuel calorific value and estiamted efficiency |
| Fuel usage | 0.120 | 0.060 | kg/s | |
| NOx | 0.288 | 0.144 | g/s | |
| Cr III | 3.03E-04 | 1.52E-04 | g/s | |
| Pb | 8.33E-03 | 4.17E-03 | g/s | |
| PaHs | 4.5E-06 | 2.23E-06 | g/s | |

| Proposed stack emissions | Rear stack | New front stack | Units | Basis |
|---|---|---|---|---|
| Overall rated ouput | As above | 2 - 2.3 | MW | |
| Fuel usage | | 216 | kg/h | Provided by boiler suppliers |
| Fuel usage | | 0.060 | kg/s | |
| NOx | | 0.143 | g/s | |
| Cr III | | 1.51E-04 | g/s | |
| Pb | | 4.15E-03 | g/s | |
| PaHs | | 2.22E-06 | g/s | |

# Appendix B: : Updated odour complaint frequency

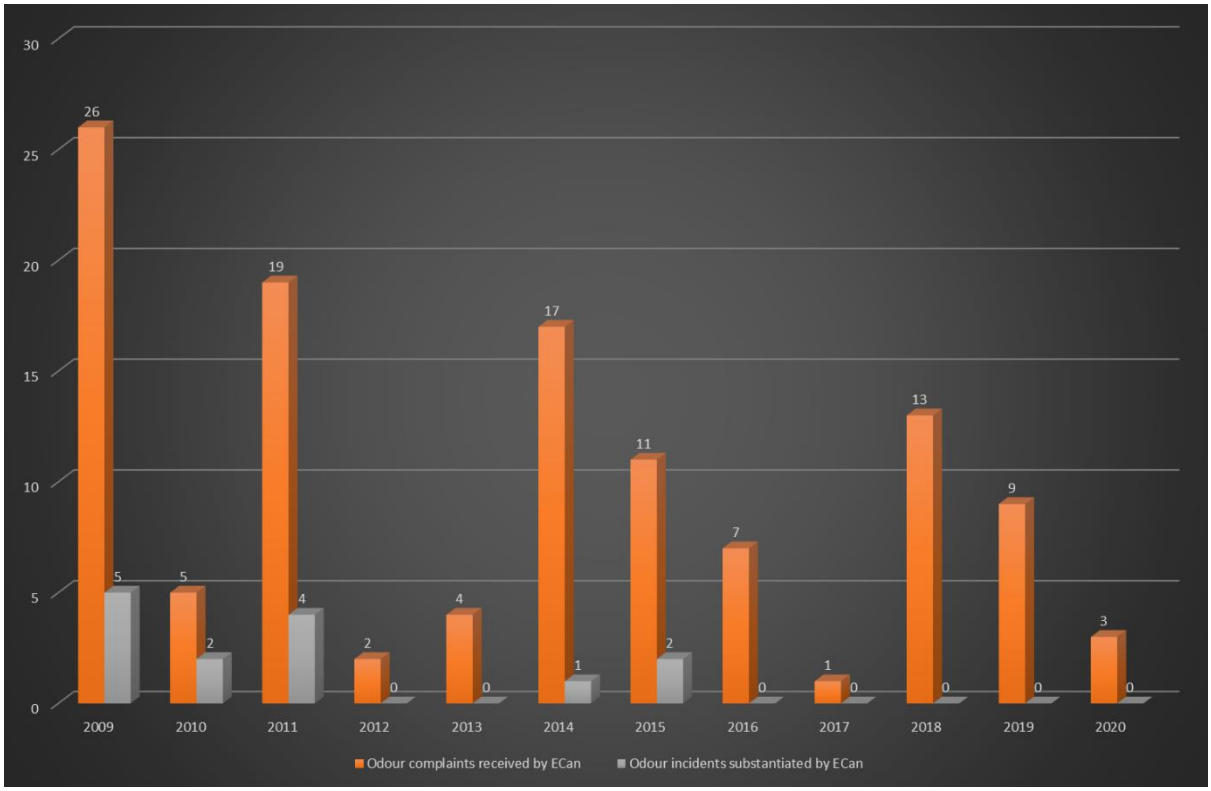



*Figure C1: Annual frequency of odour complaints and odour incidents substantiated by ECan 2009-2020*

# Appendix C: Odour observation survey excerpt

## A1 Survey method

A field-based odour observation survey was conducted at locations on-site and in surrounding areas to assess existing odour levels and their potential to cause nuisance. The field odour observation survey utilising methods based on standards developed by the Association of German Engineers (Verein Deutscher Ingenieure [VDI])[8].

The survey method is summarised as follows (refer Appendix F of the Air Quality Assessment for further details):

- Observations were conducted by individuals from a group of seven observers on 27 days between 13 December 2017 and 28 February 2018. The observation survey period has encompassed the January-February period when the bulk of odour complaints have been historically been received (refer Appendix E).
- In order to encompass times when site emission sources were in operation, observation periods were scheduled at varying times from Monday to Friday and from 6am to 7pm.
- During each observation period odour observations were conducted at up to eight sample locations including the following general locations (dictated by wind conditions):
  - Downwind of the PRP at either Carmen Road or Buchanans Road (the residential zone border).
  - Transect locations 100 m in either direction along the residential zone border.
  - Downwind of PRP in commercial area.
  - Site boundary downwind of the bird receipt area.
  - Site boundary downwind of the PRP.
- At each sample location the intensity of odour observed at ten second intervals was recorded over a period of ten minutes. Odour character was recorded along with observed weather conditions.
- An odour intensity scale detailed in German Standard VDI 3882 (I) was used to quantify observed odour intensity. This odour intensity scale, is *widely used throughout New Zealand*[9], and is summarised in Table D1.
- Corresponding threshold criteria for observed odour intensities are specified in the German Guideline on Odour in Ambient Air (GOAA, 2003) for the purpose of identifying where odour is likely to result in nuisance. For residential and mixed use areas the threshold is 10% (i.e. greater than 10% of odour observations at the location are recognisable, of an intensity of 3 or more using the VDI scale); for commercial land uses, the threshold criterion is 15%.

[8] VDI 3940 Parts 1 and 2

[9] MfE 2016. “Good Practice Guide for Assessing and Managing Odour”.

**Table D1: Odour intensity scale**

| Odour intensity | Intensity level |
|---|---|
| None | 0 |
| Very weak | 1 |
| Weak | 2 |
| Distinct | 3 |
| Strong | 4 |
| Very Strong | 5 |
| Extremely Strong | 6 |

## A2 Observation analysis

The frequency of odour recognisable odour at each sample location type in different wind directions conditions are detailed in Table D2 and compared with the German GOAA threshold.

**Table D2: Odour recognition frequency by sample location and observed wind directions**

| Sample location type | Odour recognition frequency by wind direction | | | GOAA Nuisance Threshold |
|---|---|---|---|---|
| | Northeast | Southwest | Other/variable | |
| Number of observation periods | 18 | 6 | 3 | - |
| Peak downwind residential border | 6.1% | 2.2% | - | 10% |
| Residential border transect (north/west) | 6.8% | 1.4% | - | 10% |
| Residential border transect (south/east) | 3.7% | 0.6% | - | 10% |
| Peak downwind commercial area | - | **16.0%** | 7.8% | 15% |
| Peak downwind of PRP | **35.9%** | **38.9%** | **38.0%** | 15% |
| Peak downwind of bird receipt area | **17.8%** | 5.0% | **17.8%** | 15% |
| Upwind | 0.5% | 0.8% | 0.0% | 10% |

The approximate locations where odour recognition frequencies were recorded are illustrated for observations in northwest winds in Figure D1 and southwest winds in Figure D2 (the observed odour frequencies are denoted by colour at each location).


*Figure D1: Odour recognition frequency by observation location (approximate) in northeast wind conditions – observed odour frequencies denoted by colour*


*Figure D2: Odour recognition frequency by observation location (approximate) in southwest wind conditions – observed odour frequencies denoted by colour*

As noted in D2, the frequency of recognisable odour from the site exceeded the German GOAA threshold for industrial and commercial areas at the following locations:

- Peak locations downwind of the PRP (on-site adjacent to the site boundary);
- Peak locations downwind of the bird receipt area (adjacent to the site boundary) – the guideline was only in northeast and variable wind conditions and not in southwest winds, which possibly indicates an influence of odour from the PRP further upwind in northeast; and
- Peak locations downwind in the adjacent commercial/industrial area on Halwyn Drive in southwest.

Further afield the frequency of recognisable odour from the site at and beyond the residential zone boundaries remained within the German GOAA threshold for residential areas.

Additionally, the recorded observations indicated the following:

- Strong odour was also observed reasonably frequently at peak locations downwind of the PRP (on-site adjacent to the site boundary). On average 23% of observations were of at least strong odour intensity at this type of location (in all wind conditions).
- Rendering type odours (noted as render, meat, burnt etc.) were noted in most of the observations at the three exceedance locations listed above along with infrequent references to cadaverous or sewer type odour.
- In addition to rendering type odour, bird/feather, sewer and chlorine/cleaning chemical type odours were also noted downwind of the bird receipt area along with what was recorded as “plant odour”.
- Background odour types recorded included bakery, fuel and solvent odours.
- In the infrequent conditions where the impact of emissions from the PRP building and biofilter is able to be discerned (e.g. in northwest or varying wind conditions), observations indicate that odour from the direction of the biofilter resulted in low intensities compared to odour downwind of the PRP building.

Overall, the observed odour recognition frequency exceeded the relevant German nuisance guideline for this type of observation survey at locations in close proximity to and downwind of certain site odour sources: the PRP in particular and the bird receipt area to a lesser degree. The locations where the guideline was exceeded were generally within the site but near the site boundary and the guideline was also exceeded slightly at Halwyn Drive, adjacent to the rear site entrance.

# Appendix D: Estimated impact of proposed PRP modifications

## Assessment of impact of PRP odour capture improvement

### Background

Dispersion modelling has been used to indicatively quantify the change in odour levels likely to be occur as a result of the proposed improvements to odour management at the PRP.

### Assumptions

- Biofilter emissions (modelled as an area source) and fugitive emissions from the PRP building (modelled as a volume source) are the only modelled odour sources.
- 10% of odour generated within the PRP is released as fugitive emissions.
- 80% of current fugitive emissions will be captured via improvements (directed to biofilter).
- The biofilter has a 95% odour treatment efficiency.

### Emission calculations

Using the above assumptions, odour emissions have been calculated based on an assumed current inlet odour concentration to the biofilter of 10,000 OU/$m^3$. Note that this concentration has not been measured and has only been used as a starting point to compare existing and potential future emissions.

| | | |
|---|---|---|
| Biofilter design parameters | | |
| Biofilter area | 2,000 | m2 |
| Current extraction to biofilter | 7.4 | m3/s |
| | | |
| Assumptions | | |
| Biofilter inlet odour concentration | 10,000 | OU/m3 |
| Treatment efficiency | 95% | |
| Current fugitive loss rate | 10% | |
| | | |
| Calculations | | |
| Current untreated inlet odour | 74,000 | OU/s |
| Future untreated inlet odour | 104,919 | OU/s |
| Reduction in fugitive loss | 90% | |
| Future fugitive loss rate | 1.0% | |

| | | | | | |
|---|---|---|---|---|---|
| Current emission scenario | | | Future emission scenario | | |
| Fugitive odour emission rate | 7,400 | OU/s | Fugitive odour emission rate | 740 | OU/s |
| Biofilter odour emission rate | 3,700 | OU/s | Biofilter odour emission rate | 4,033 | OU/s |
| Total odour emission rate | 11,100 | OU/s | Total odour emission rate | 4,773 | OU/s |
| Biofilter area odour emission rate | 1.85 | OU/m2/s | Biofilter area odour emission rate | 2.02 | OU/m2/s |

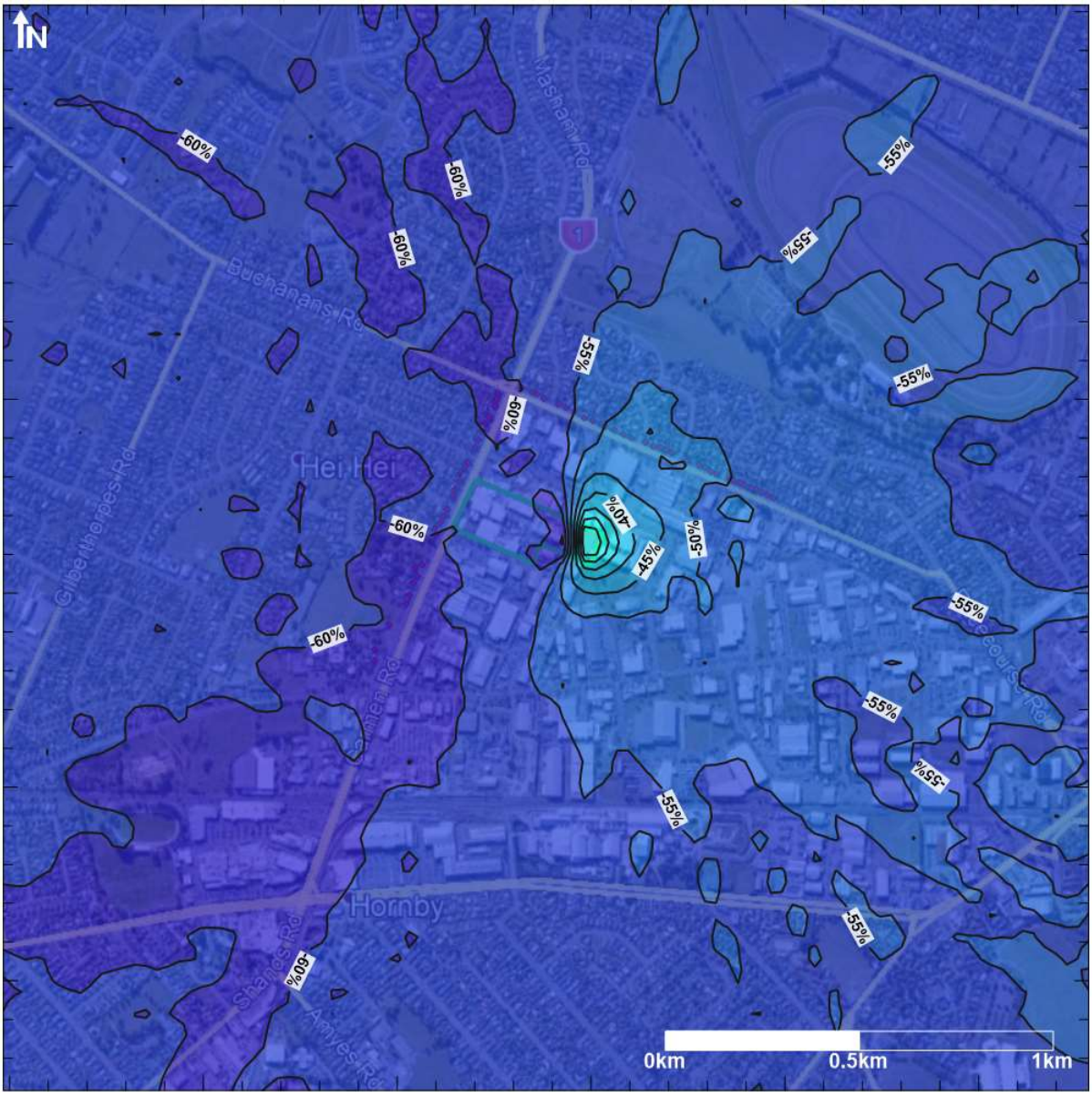
### Modelled discharge parameters

| Parameter | Fugitive emissions | Biofilter emissions |
|---|---|---|
| Source type | Volume | Area |
| Height | 4 m | 1 m |

| Parameter | Fugitive emissions | Biofilter emissions |
|---|---|---|
| Length | | 50 m |
| Width | | 40 m |
| Sigma y | 4.19 m | |
| Sigma z | 2.09 m | 0.47 m |
| Odour emission rates - current | 7400 OU/s | 1.85 OU/m2/s |
| Odour emission rates - future | 740 OU/s | 2.02 OU/m2/s |

## Predictions

As noted above actual odour emissions have not been quantified and relative changes in odour levels have been analysed, the spatial distribution of which are illustrated in the following figure.




**Spatial distribution of predicted percentage change in peak (99.9th percentile) odour concentrations with improved odour capture relative to current PRP configuration**

# Appendix E: Odour FIDOL Consideration

**Table D1: Consideration of odour from currently consented and future site configurations against the FIDOL factors**

| Factor | Current configuration | Future configuration |
|---|---|---|
| Frequency/ duration | The frequency and duration of odour observations at off-site receptor locations will be dictated by the frequency of emissions and by wind conditions.<br>Observations indicate that the PRP is the main source of odour beyond the site boundary. This source operates constantly from Monday morning to Saturday afternoon, though activities within that period such as cooker unloading may briefly increase emissions.<br>Odour propagation towards off-site receptors is likely to be greatest in light wind conditions. As illustrated in section 5.2 (of the Air Quality Assessment) both light winds of less than 3 m/s and winds in general predominantly come from the northeast, which would push odour towards the southwest. The frequency of winds from the southwest will be higher in winter months.<br>In both instances, the prevailing winds would tend to push PRP odour towards adjacent commercial areas in the first instance and then towards residential areas beyond (300m – 400m from the PRP).<br>As noted in section7.3.2 (of the Air Quality Assessment), observations have indicated that at locations in close proximity to the PRP the frequency of recognisable odour exceeds levels recommended for commercial areas. Conversely the frequencies observed at and beyond the transition to residential zoning meet the corresponding recommendations for residential areas. | The improvements to odour capture at the PRP decrease the likelihood of fugitive release and therefore the potential frequency of exposure to odour. |
| Intensity | Intensity of odour observations at receptor locations will be a function of intensity of odour emissions and the degree of dispersion of emissions, which in turn will be a function of geographical separation and meteorological conditions.<br>The intensity of odour has been observed to be highest downwind of and in close proximity to the PRP. | As noted in section 7.6 (of the Air Quality Assessment), provided the biofilter is well managed to effectively treat captured odour, the improvements to PRP ventilation and odour capture should result in substantial reduction in the intensity of fugitive odour emissions. As a result, the intensity of odour observed off-site should be substantially improved with the implementation of the proposed modifications. |

| Factor | Current configuration | Future configuration |
|---|---|---|
| Offensiveness/ character/ hedonic tone | As noted in section 4.2 (of the Air Quality Assessment), the predominant PRP odour has a variable hedonic tone that may trigger a moderately negative hedonic response. Treat air from the biofilter generally has an earthy character also with a relatively moderate hedonic tone. If material is degraded, anaerobic type (e.g. rancid, cadaverous) odour of a strongly negative hedonic tone is likely to be generated. | Improved odour capture at the PRP is likely to result in replacement of much of the residential PRP odour with odour of a more earthy character (of much lesser intensity).<br>Improvements to wastewater storage (including the containment and ventilation of the wastewater buffer tank) should reduce the potential for anaerobic odour. |
| Locational sensitivity | As noted in section 5.1 (of the Air Quality Assessment), sensitivity to odour varies in the surrounding area.<br>Sensitivity is high in residential areas to the west of Carmen Road and north of Buchanans Road, whereas sensitivity ranges from low to moderate in the industrial commercial area surrounding the site on the east side of Carmen Road.<br>The analysis of odour observation data has taken the varying general sensitivity of the two types of activities in the receiving environment. | The PRP is located within the Industry – Heavy zone, which provides for the type of activity located on-site, and adjacent activities within this zone are unlikely to be replaced with more sensitive activities. Further afield, the Industry – General and residential zones reflect the type of activities existing within those zones at present. As a result there is unlikely to be any widespread change in the sensitivity of these areas. |

# Appendix F: Summary of combustion emission dispersion model predictions

## Summary of combustion emission dispersion model predictions

Excerpt from section 6.3 of the Air Quality Assessment

Table 6-4: Predicted peak site contributions to local 24-hour and annual average $PM_{10}$ concentrations

| Prediction location | Peak 24-hour average $PM_{10}$ concentration ($\mu g/m^3$) | | Annual average $PM_{10}$ concentration ($\mu g/m^3$) | |
|---|---|---|---|---|
| | Current scenario* | Proposed scenario* | Current scenario* | Proposed scenario* |
| Highest at a sensitive receptor | 14.9 | 7.9 | 2.0 | 1.0 |
| Highest in residential area to west | 14.9 | 7.9 | 2.0 | 1.0 |
| Highest in residential area to north | 5.9 | 4.6 | 1.0 | 0.6 |
| Estimated background concentration | Range of 4 to 134, average of 20* | | Average of 20* | |
| Assessment criteria | 50 | | 20 | |
| | NESAQ (1 annual exceedance) | | MfE AAQG | |

*Current scenario = existing front boilers plus existing rear boiler; Proposed scenario = proposed front boiler plus existing rear boiler

Table 6-5: Predicted peak site contributions to local 24-hour and annual average $PM_{2.5}$ concentrations

| Prediction location | Peak 24-hour average $PM_{2.5}$ concentration ($\mu g/m^3$) | | Annual average $PM_{2.5}$ concentration ($\mu g/m^3$) | |
|---|---|---|---|---|
| | Current scenario* | Proposed scenario* | Current scenario* | Proposed scenario* |
| Highest at a sensitive receptor | 5.5 | 2.9 | 0.7 | 0.4 |
| Highest in residential area to west | 5.5 | 2.9 | 0.7 | 0.4 |
| Highest in residential area to north | 2.2 | 1.7 | 0.4 | 0.2 |
| Estimated background concentration | Range of 2 to 60, average of 10* | | Average of 10* | |
| Assessment criteria | 25 | | 10 | |
| | WHO AQG | | WHO AQG | |

*Current scenario = existing front boilers plus existing rear boiler; Proposed scenario = proposed front boiler plus existing rear boiler

Table 6-6: Predicted peak site contributions to local 1-hour and 24-hour average $SO_2$ concentrations ($\mu g/m^3$)*

| Prediction location | Peak 1-hour average $SO_2$ concentration ($\mu g/m^3$) | | Peak 24-hour average $SO_2$ concentration ($\mu g/m^3$) | |
|---|---|---|---|---|
| | Current scenario* | Proposed scenario* | Current scenario* | Proposed scenario* |
| Highest beyond site boundary | 78.9 | 79.6 | - | - |
| Highest at a sensitive receptor | 77.0 | 68.5 | 44.6 | 23.7 |
| Highest in residential area to west | 77.0 | 68.5 | 44.6 | 23.7 |
| Highest in residential area to north | 46.0 | 55.0 | 17.6 | 13.7 |
| Estimated background concentration | Peak of 123 $\mu g/m^3$, average of12 $\mu g/m^3$ | | Peak of 54 $\mu g/m^3$, average of 12 $\mu g/m^3$ | |
| Assessment criteria | 350 | | 120 | |
| | NESAQ (9 annual exceedances) | | MfE AAQG | |

*Current scenario = existing front boilers plus existing rear boiler; Proposed scenario = proposed front boiler plus existing rear boiler

Table 6-7: Predicted peak site contributions to local 1-hour and 24-hour average $NO_2$ concentrations ($\mu g/m^3$)

| Prediction location | Peak 1-hour average $NO_2$ concentration ($\mu g/m^3$) | | Peak 24-hour average $NO_2$ concentration ($\mu g/m^3$) | |
|---|---|---|---|---|
| | Current scenario* | Proposed scenario* | Current scenario* | Proposed scenario* |
| Highest beyond site boundary | 18.9 | 19.1 | - | - |
| Highest at a sensitive receptor | 18.5 | 16.4 | 10.7 | 5.7 |
| Highest in residential area to west | 18.5 | 16.4 | 10.7 | 5.7 |
| Highest in residential area to north | 11.0 | 13.2 | 4.2 | 3.3 |
| Estimated background concentration | Range of 1.5 $\mu g/m^3$ to 40 $\mu g/m^3$, average of 20 $\mu g/m^3$, | | Range of 0 to 57 $\mu g/m^3$, average of 20 $\mu g/m^3$ | |
| Assessment criteria | 200 $\mu g/m^3$ | | 100 | |
| | NESAQ (9 annual exceedances) | | MfE AAQG | |

*Current scenario = existing front boilers plus existing rear boiler; Proposed scenario = proposed front boiler plus existing rear boiler

Table 6-8: Predicted peak site contributions to local annual average trivalent chromium and benzo-a-pyrene concentrations (µg/m$^3$)

| Prediction location | Annual average Cr-III concentration (µg/m$^3$) | | Annual average BaP concentration (µg/m$^3$) | |
|---|---|---|---|---|
| | Current scenario* | Proposed scenario* | Current scenario* | Proposed scenario* |
| Highest at a sensitive receptor | 0.0015 | 0.00077 | 0.000022 | 0.000011 |
| Highest in residential area to west | 0.0015 | 0.00077 | 0.000022 | 0.000011 |
| Highest in residential area to north | 0.0008 | 0.00048 | 0.000011 | 0.000007 |
| Estimated background concentration | Assumed to be nil | | Assumed to be nil | |
| Assessment criteria | 0.11 | | 0.0003 | |
| | MfE AAQG | | MfE AAQG | |

*Current scenario = existing front boilers plus existing rear boiler; Proposed scenario = proposed front boiler plus existing rear boiler

# Appendix G: Indicative Downwind Boundary Odour Observation Procedure

## Indicative Tegel Carmen Road Plant Downwind Boundary Odour Observation Procedure

1 Identify current wind direction and most appropriate site boundary location downwind of the site odour sources.

2 Print and take at least 1 copy of the odour observation sheet template overleaf

3 Travel to downwind site boundary location:

- a Note date, time, location and site activities undertaken at time on observation sheet.
- b Undertake a 10-minute observation:
  - i Note initial weather conditions and where they change during the course of the observation.
  - ii Breathing normally, note the intensity of odour (or lack thereof) on a scale of 0 to 6 every 10 seconds (disregarding any odour observed in the intervening period since the previous observation).
  - iii Describe the character/type of odour initially observed and whenever the character of odour changes (refer example odour descriptors below).

4 Upon return to office, scan and save copies of the observation sheets.

| Example odour descriptors | |
|---|---|
| Cadaverous (dead animal) | Bakery (fresh bread) |
| Sewer | Floral |
| Vomit | Fried chicken |
| Ammonia | Coffee |
| Sulphurous | Nutty |
| Fishy | Cut grass |
| Burnt meat | Malty |
| Blood, raw meat | Gasoline, solvent |
| Wood smoke | Chlorine, pool chemicals |
| Bird, feathers | |

**Data record sheet for grid measurements**

Assessor Name: _____ Date: _____

Measurement Point: _____ Location (coordinates or address): _____

Start of measurement: _____ End of measurement: _____

Odour intensity record (0 to 6):

| | 10s | 20s | 30s | 40s | 50s | 60s |
|---|---|---|---|---|---|---|
| 1st minute | | | | | | |
| 2nd minute | | | | | | |
| 3rd minute | | | | | | |
| 4th minute | | | | | | |
| 5th minute | | | | | | |
| 6th minute | | | | | | |
| 7th minute | | | | | | |
| 8th minute | | | | | | |
| 9th minute | | | | | | |
| 10th minute | | | | | | |

Intensity scale:

0 No odour
1 very weak
2 weak
3 distinct
4 strong
5 very strong
6 extremely strong

Odour character:

Odour offensiveness: Unpleasant/ Neutral/ Pleasant

Weather:

| | | | | | |
|---|---|---|---|---|---|
| Wind | No wind | light | breezy | strong | stormy |

Gusty: yes/ no Wind direction: _____

| | | | | |
|---|---|---|---|---|
| Cloud: | none | mixed | overcast | dark overcast |

| | | | | | |
|---|---|---|---|---|---|
| Rain: | none | drizzle | light rain | rain | heavy rain |

General comments: