REPORT

Tonkin+Taylor

Karaka North Village WWTP

Odour Assessment

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Karaka North Village Limited
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Tonkin & Taylor Ltd
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1 Introduction

1.1 Background

This proposal is for a fast-track consenting referred project for subdivision of an 81 hectare (ha) block in Karaka North to create an integrated rural village settlement, comprising residential development and a local centre at the intersection of Dyke, Blackbridge and Linwood Roads.

The application is for a subdivision of the land to create up to 850 residential sites, comprising medium density and more traditional residential development, the creation of residential superlots, a two hectare local centre, a community commercial venue building, and an integrated network of large private open spaces. The proposed project work will occur at Karaka North Village, 69a Dyke Road and 348 Linwood Road, Papakura, Auckland.

The applicant, Karaka North Village Limited (KNVL), has applied for resource consents for land-use and subdivision, bulk earthworks and enabling works to provide the associated infrastructure; including vested roads, and the provision of an on-site water treatment and wastewater treatment and disposal system.

KNVL has engaged Tonkin & Taylor Limited (T+T) to prepare this assessment of potential air quality impacts of odour emissions from the proposed wastewater treatment plant (WWTP) to inform the application.

1.2 Purpose and scope

The purpose of this report is to detail the methods, results and findings of the assessment of potential effects of odour emissions from the WWTP to inform the Assessment of Environmental Effects (AEE) for the application. In particular this report includes:

- A summary of the WWTP processes and activities as they relate to discharges of odour to air;
- A description of the nature of the odour emissions and sources;
- A description of the environmental setting of the discharges in terms of sensitivity to the discharged contaminants, background levels of the contaminants and potential influences on odour emissions from the WWTP;
- An assessment of the actual and potential effects of the odour emissions on local air quality; and
- A summary of conclusions and findings of the assessment.

2 Understanding of activities

2.1 Existing site

The site is located at 69a Dyke Road and 348 Linwood Road, Papakura, Auckland and comprises an area of approximately 81 ha. It is currently rural in nature, featuring pasture and a small number of rural dwellings.

The site is located within the Karaka North Precinct under the Auckland Unitary Plan, the purpose of which is "*to provide for an integrated development of a rural village settlement centred at the intersection of Dyke, Blackbridge and Linwood Roads"* (which the site adjoins to the northeast). This indicates an intention for urban development at the site.

2.2 Proposed development

The proposal will involve the subdivision of the existing properties comprising the site and the creation of:

- 850 residential properties of varying size and density;
- commercial properties adjacent to the existing village centre;
- a community building and open spaces;
- shared path and pedestrian routes; and
- the WWTP and adjacent water treatment plant.

The general layout of the development is illustrated in Figure 4.1.

2.3 Proposed wastewater treatment plant

Wastewater generated from properties within the development and potentially a further 400 properties at adjoining developments will be treated using a purpose built WWTP. The WWTP will be designed for a final peak wastewater flow of 845 m^3/d.

Treated wastewater will be discharged to land at the site via a subsurface irrigation system. In instances where wastewater demand exceeds the available subsurface irrigation rate, wastewater will be discharged to land via a rapid infiltration trench at the site.

The proposed treatment process, as illustrated in Figure 2.1, consists of the following process units/activities:

- Headworks screening
- Anoxic balance tank (Anoxic Tank 1)
- Aeration tanks (x2)
- 2nd Anoxic tanks (x2)
- Membrane bioreactor (MBR) tanks (x5)
- UV disinfection
- Chlorine dosing
- Treated wastewater storage tank
- Waste activated sludge (WAS) storage tanks (x2)
- WAS dewatering centrifuge

- WAS and screened solids collection skips
- Wastewater collection sump.

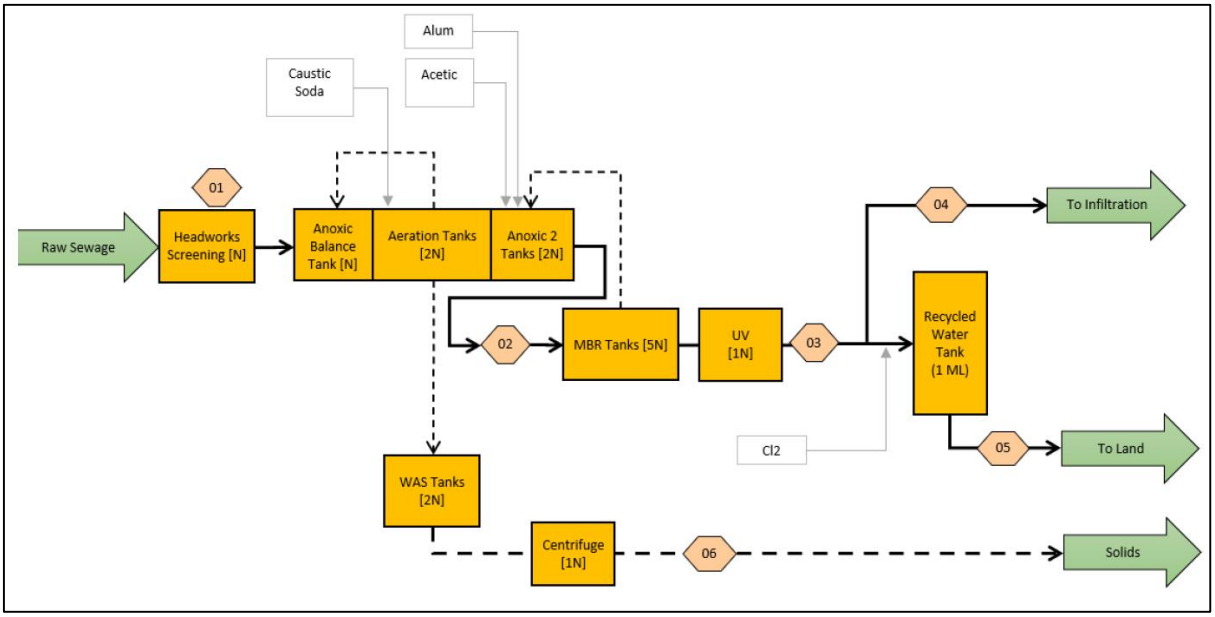

Figure 2.1: Proposed wastewater treatment plant process flow diagram (source: Apex Environmental)

3 Odour emissions and sources

Odour is the main air contaminant associated wastewater treatment processes and is primarily generated from anaerobic decomposition of the wastewater.

Anaerobic decomposition comprises a series of biochemical processes and may generate a range of potentially odorants, many of which have an unpleasant character and strongly negative hedonic tone. Anaerobic decomposition of the wastewater can occur where biochemical oxygen demand of the wastewater exceeds the availability of dissolved oxygen (or other oxidants such as nitrates) within the wastewater. The design of the proposed treatment process generally seeks to avoid these conditions from occurring.

Anoxic decomposition is to be used in the proposed treatment train to reduce the nitrate levels in the wastewater discharge. As with anaerobic decomposition, this type of process occurs in the absence of oxygen but where the reduction of available nitrate occurs in preference to anaerobic processes. Anoxic decomposition does not generate the unpleasant odorous by-products associated with anaerobic decomposition, but anaerobic conditions can develop if nitrate content is depleted.

Similarly, the gaseous by-products of aerobic decomposition are not odorous, but odour could be generated in the aerobic tanks if anaerobic zones are allowed to form (e.g. through ineffective mixing/aeration or accumulation of solids), or through the disturbance of sludge build-up.

The following sources have been identified as having the highest potential to generate odour. Odour from these sources is to be controlled by extracting odorous air from the headspace (or building in which the unit is enclosed in the case of the WAS dewatering screen) for treatment using caustic soda impregnated carbon absorption beds:

- Headworks screens;
- WAS dewatering centrifuge;
- WAS and screenings skips; and
- Wastewater collection sump.

Control of odour from the following sources with a lesser potential to generate odour is to be based on maintaining conditions that do not promote anaerobic degradation:

- Anoxic Balance Tank (Anoxic Tank 1).
- Aeration Tanks (x2);
- 2nd Anoxic tanks (x2); and
- Membrane bioreactor (MBR) tanks (x5).

The potential for odour generation from the following sources in the later stages of the process is generally low due to low organic content:

- UV disinfection;
- Chlorine dosing; and
- Treated wastewater storage tank.

4 Environmental setting

4.1 Locality and existing adjoining activities

An existing small village centre is located at the corner of Dyke, Blackbridge and Linwood Roads adjoining the site to the southeast, which includes the following activities:

- Grocery store
- War Memorial Community Hall
- Church
- Early childhood education centre
- Bowling club
- Sports park and events centre
- Recreational reserve
- A single row of four dwellings along Linwood Road to the south of the site.

The site is bordered to the west by an Auckland Council esplanade reserve and the Whangamaire Stream beyond.

The remainder of the local area is largely used for pastoral activities with rural dwellings interspersed across the area, along Linwood Road to the south, Urquhart Road to the west and in particular Karaka North Road to the east and northeast.

The development site is 81 ha in area, within which the WWTP will be well set back from road frontage boundaries. As a result, while there are a number of existing rural dwellings within 1 km, as illustrated in Figure 4.1 below, the nearest existing dwelling is located approximately 500 m from the WWTP (to the east at 58 Dyke Road).

Due to both low population density and the background of rural odours that may be expected from the agricultural activities in the area (such as dairy shed effluent storage/irrigation and intensive poultry farming operations), the rural pastoral area is generally of low sensitivity to odours.

Sensitivity to odour will be relatively high at the dwellings adjoining the existing village centre and at the isolated rural residences surrounding the rural area. Occupation of rural dwellings is likely to be consistent and potentially constant, and expectations of amenity will be higher. Expectations of amenity may also be high in garden and yard areas within the immediate curtilage of the dwelling.

Commercial, educational and recreational activities in and around the existing village centre to the southeast will also have a relatively high sensitivity to odour while in operation.

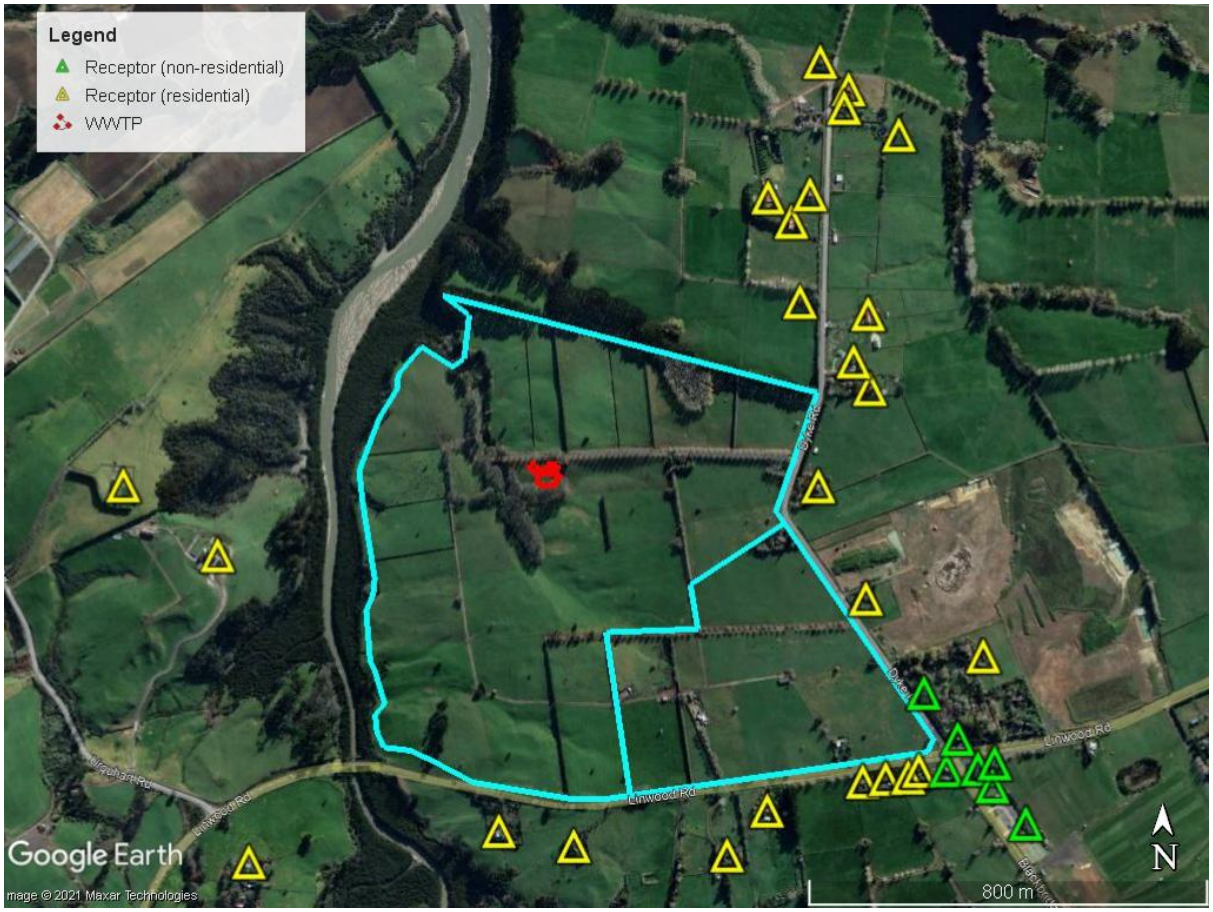

Figure 4.1: Site, WWTP location and adjacent receptor locations within 1 km of the WWTP or located within the existing Karaka village centre

4.2 Changes to the environmental setting resulting from the development

The development will introduce 850 residential properties to the site as illustrated in Figure 4.1. The majority of these properties will be located in closer proximity to the WWTP than the nearest existing off-site dwellings. Additional commercial activities will be introduced to the expanded village centre at the southeast corner of the site.

The nearest residential properties will be located approximately 40 m to the north of the WWTP (across a road). A reasonably high density of residential properties will also be located in the vicinity, as part of the development. For instance approximately 27 residential properties will be located within 100 m and 134 residential properties within 200 m of the WWTP.

The introduction of a reasonably high density of odour sensitive activities closer to the WWTP than existing sensitive activities will substantially increase the sensitivity of the receiving environment to odour. Consequently, a high degree of management of odour emissions will be required to avoid and mitigate potential nuisance impacts.

Figure 4.2: Location of the WWTP within subdivided site

4.3 Local topography

The topography of an area may influence winds and therefore the dispersion of odours.

The site is located on the true right bank of the Whangamaire Stream (to the east) and to the south of the Pahurehure Inlet.

The eastern portion of the site adjoining Dyke Road is relatively flat, gently sloping down to the west, towards the Whangamaire Stream. The western portion of the site is bisected by a tributary of the stream, which discharges to the Whangamaire Stream at the northwest corner of the site. This portion of the site features steeper terrain sloping down towards the tributary and main body of the stream.

The WWTP is to be located adjacent to the tributary stream to the east. We understand that it will be located on a benched platform at a lower elevation than adjoining areas to the north and east (where the nearest residential properties will be located).

4.4 Meteorological conditions

Meteorological conditions provide a significant external influence on the potential for odour nuisance effects. Dispersion of odour is reduced in low wind speed (e.g. of less than 3 m/s) and calm conditions and atmospheric inversions may result in higher odour levels in areas near the emission source.

Wind measurements are made at the Pukekohe Electronic Weather Station, located 15 km to the south-southwest. A wind rose analysis of winds measured at this monitoring station is presented in in Figure 4.3.

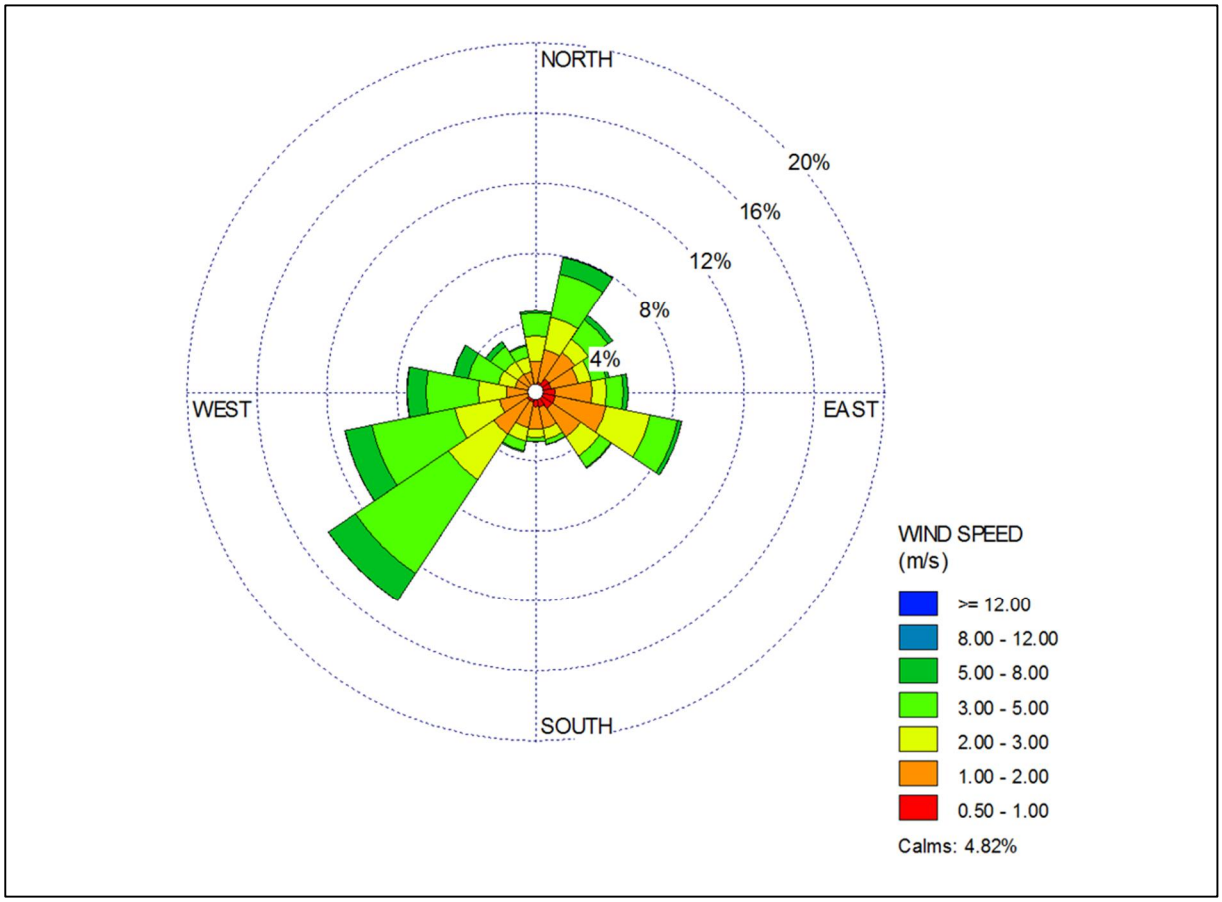

Figure 4.3: Frequency of wind speeds and directions measured at the Pukekohe Electronic Weather Station 2010-2019 (1-hour average data)

The Pukekohe EWS measurements are likely to provide a reasonable indication of overlying wind flows and Figure 4.3 illustrates a strong prevalence of winds from the southwest quadrant, as is typical for locations in the northern North Island. The frequency of light winds (of below 3 m/s) is highest from the east to southeast range of directions.

Wind roses analyses of diurnal and seasonal wind speed and direction frequencies are provided in Appendix A. These analyses indicate that:

- The overall prevalence of southwest winds is more pronounced over spring and summer months with a higher frequency of winds from the southeast in autumn and winter. The prevalence of light winds (<3 m/s) from the southeast is more pronounced over autumn and winter months.
- The frequency of winds of low wind speeds and calm conditions is highest at night with winds most frequently from the southeast (though this could be reflective of local drainage flows in the area of the weather station).
- Wind speeds are typically much higher and the frequency of light and calm wind conditions much lower in the afternoon.

The overlying wind flows are likely to be modified in the area of the Site by local topography. Influences on the dispersion of contaminants emitted from the site resulting from local topography are likely to include:

- Calm stable atmospheric conditions associated with overnight temperature inversions may promote the accumulation of any odour emitted at the site. Katabatic drainage air flows will tend to propagate accumulated odour down-gradient towards lower elevations. In this case this type of flow from the WWTP is likely to follow the adjacent tributary stream and subsequently the main body of the Whangamaire Stream towards the Pahurehure Inlet to the north.
- The presence of coastal marine area at the Pahurehure Inlet and Manukau Harbour to the north may result in a higher frequency of north-south land sea breezes.

5 Assessment of odour effects

5.1 Assessment methodology

Appendix 2 of the Ministry for the Environment (MfE) Good Practice Guide for Odour Assessment and Management (MfE 2016, 'Odour Guide'), sets out a range of odour assessment tools that can be used to assess the potential odour effects of proposed modifications to odour discharge activities. The relevance of each of the described odour assessment tools to the assessment of odour impacts of the proposed Site changes is considered in Table 5.1.

Table 5.1: Discussion of MfE Odour Guide odour assessment tools in relation to this assessment

Assessment tool	Relevance in relation to this assessment
Community Consultation	As both the WWTP and the proposed development (which will modify the sensitivity of the environment to odour) do not yet exist no community information can be gained on current or historical odour levels.
Experience with similar sites	Experience at similar sites has been taken into account in the review of odour management provided in Section 5.2.
Establish the prevalent seasonal wind patterns, topographical features and likely cold air drainage patterns at the site.	Discussed in Section 4.
Olfactometric quantification of source odour emissions and modelling	Estimation of odour emissions and prediction of dispersion and propagation of the emissions in the environment could be used to understand the potential chronic or ongoing exposure at local receptor locations to odour emissions associated with normal operation of the WWTP. However, the WWTP does not yet exist, and site-specific odour emission measurements are not possible. An extensive array of management measures is to be employed to control odour emissions, as discussed in section 5.2. Dispersion modelling using odour measurements from other existing WWTPs is unlikely to account for the impact of the proposed odour management regime and would likely misrepresent the effects of the proposed WWTP. As a result, dispersion modelling has not been utilised in this instance.
Review of proposed process emission control system(s) hardware, design standards, odour management plan and contingency procedures	Discussed in section 5.2.

The assessment of potential odour nuisance effects has therefore been based on the following assessment methods:

- A consideration of the receiving environment in terms of sensitivity (as well as influences on odour dispersion) (Section 4).
- A review of the measures proposed to control and manage emissions from each WWTP odour source and mitigate the potential for odour nuisance effects (Section 5.2).
- A summary of the potential for nuisance effects of odour emissions from the WWTP considering the FIDOL factors (Section 5.3).

5.2 Review of proposed odour management, monitoring and contingency measures

As noted in Section 4.2, the development and introduction of odour sensitive activities will result in a relatively high sensitivity of the receiving environment to odour. The regime management and monitoring of odour from the WWTP will need to cater for this sensitivity to avoid and mitigate potential nuisance impacts.

Table 5.2 presents a review of the new plant proposed to be installed as part of the WWTP and the potential for odour to occur.

Table 5.2: Assessment of odour potential from proposed process units

Process odour source	Control and monitoring measures	Consideration of odour generation potential and proposed management measures
Intake screens	· Enclosure and extraction of air for treatment · Back-up unit	The intake screens receive raw wastewater and have the potential to release odour. However, the intake screens are to be extracted to the odour control unit. Provided enclosure is complete and extraction is sufficient to prevent fugitive release except in strong wind conditions, uncontrolled odour emissions should be negligible during normal operation. Odour emissions could be increased if abnormal or unplanned operation occurs: · We understand from discussions with Apex Environmental that the potential impacts of overloading or outage of the intake screen is to be mitigated through having a redundant second screening unit in reserve. · Preventative maintenance procedures to minimise the potential for equipment or process failure and contingency procedures in the event this type of scenario occurs should be documented and rigorously implemented. These procedures are to be covered in the Operations and Maintenance (O&M) Manual to be prepared for the WWTP.
Anoxic balance tank	· Recycle of wastewater from aerobic tanks · Submerged inlet for influent from intake screens · Mixing · Continuous oxidation-reduction potential (ORP) and tank level monitoring · Automated process control	The 800 m^3 anoxic balance tank is intended to provide flow balancing for downstream processes and to treat nitrates in the screened wastewater. As noted in Section 3, the anoxic process is not inherently odorous and provided anoxic conditions are maintained odour emissions are likely to be minimal. The anoxic tanks are not proposed to be enclosed and extracted and the management of odour is based on maintenance of anoxic conditions across the tank and avoidance of anaerobic conditions. Prolonged retention times within the tank and low recycle rates of wastewater from the aerobic tanks could result in low nitrate concentrations and development of odorous anaerobic conditions in the anoxic tank. The development of these conditions can be avoided through effective mixing of the tank and automated control of influent streams based on ORP monitoring. Influent from the intake screens could be odorous on entry. However, we understand from discussions with Apex Environmental that the intake to the balance tank is proposed to be submerged, which in combination with the mixing within the tank is expected minimise the potential for release of odour from the influent.

Process odour source	Control and monitoring measures	Consideration of odour generation potential and proposed management measures
Aerated/aerobic tanks	· Aeration · Continuous dissolved oxygen (DO) monitoring · Automated process control · Back-up electrical supply · Critical aeration spare storage	The two 200 m^3 aerated tanks are to be operated in parallel to provide oxidative treatment of nitrogen and organic components of the wastewater. As noted in Section 3, the aerobic process is also not inherently odorous and odour generation from the tanks are likely to be minimal provided that anaerobic conditions are avoided. However, odour could be generated from the aerated tanks if anaerobic conditions are allowed to develop. Given their aerobic nature, the aerated tanks are not proposed to be enclosed and extracted and the focus on odour management is through maintenance of aerobic conditions. Mixing and aeration will be automatically controlled based on DO concentration in the tank to avoid anaerobic conditions. Provided aeration and mixing is sufficient to maintain oxygenated conditions across the tank, odour emissions from the aerobic pond are expected to be minimal. Minimisation of abnormal or unplanned operation that would lead to anaerobic or other odorous conditions will also be important and can be managed through the following: · Storage of a spare aeration blower is noted in the WWTP Design Report enabling rapid replacement of this key infrastructure if required. · The WWTP Design Report also notes the use of a back-up electricity generator to provide supply for aeration in the event of a network outage. · Preventative maintenance procedures to minimise the potential for equipment or process failure and contingency procedures in the event this type of scenario occurs should be documented and rigorously implemented
Secondary anoxic tanks	· Recycle of wastewater from MBR tanks · Mixing · Continuous oxidation-reduction potential (ORP), tank level monitoring · Automated process control	The two 100 m^3 secondary anoxic tanks provide for additional removal of nitrates. As with the anoxic balance tank, these two secondary anoxic tanks are not proposed to be enclosed and extracted and the potential mechanisms for odour generation are similar (though the secondary anoxic tanks will receive effluent from the aerobic tank rather potentially odorous screened raw influent).
MBR tanks	· Aeration scouring	The five MBR tanks remove residual solids (waste activated sludge – WAS) from the influent stream from the secondary anoxic tanks. Operation of the MBR tanks requires regular air scouring of membranes, which also introduces oxygen to the tanks and maintains aerobic conditions on an ongoing basis.

Process odour source	Control and monitoring measures	Consideration of odour generation potential and proposed management measures
Sludge dewatering	· Enclosure and extraction of air for treatment	Waste activated sludge (WAS) removed from effluent from the WWTP processes has the potential to generate offensive odour if stored or handled under anaerobic conditions. WAS from the process will be stored in enclosed tanks prior to dewatering. The sludge dewatering centrifuge will be located in an enclosed building with air extracted directly to the odour control unit.
De-watered sludge storage	· Storage in enclosed bins with extraction of air for treatment	De-watered sludge has the potential to develop anaerobic odour while de-watered sludge is to be stored in an enclosed skip with air extracted to the odour control unit. Odour may be released during removal of the skip when the extraction system is de-coupled, and the skip is removed from site (though the skips will remain covered through this relatively short-term activity).
Wastewater sump	· Enclosure and extraction of air for treatment	The enclosed underground wastewater sump will collect wastewater spillages from the process and wastewater generated from the WWTP amenities. Air from this enclosed sump air will be extracted to the odour control unit.
Odour extraction	· Fan operation monitoring	The active air extraction system is a critical component of the odour management regime, drawing odorous air from the process sources with the highest odour generation potential for treatment. Extraction rates and pressure differential to be maintained on each of the extracted sources have not been specified. However, provided the extraction rates is sufficient to maintain vacuum in calm, low and moderate wind conditions (e.g. winds of speeds of up to 7 m/s), odour from the extracted sources should not be apparent at off-site locations in conditions with which odour nuisance is typically associated. Monitoring of the extraction system to confirm the system is operating and effective will be important. We understand that monitoring of the extraction system is to be conducted via continuous monitoring of fan operation. This should be supplemented with periodic pressure monitoring at key points across the extraction system (including ducts, vessels or buildings, depending on the nature of the extracted sources) to confirm that sufficient draw on each source is maintained. Given the critical nature of the extraction system, the back-up electricity generator discussed in the WWTP Design Report should also be specified to be capable of supplying the odour extraction fans and blowers in the event of a network outage to maintain containment of the extracted sources. Critical spares extraction system should be maintained on-site (or at least at a nearby location from which the spares are readily retrievable) to minimise down time during equipment outages.

Process odour source	Control and monitoring measures	Consideration of odour generation potential and proposed management measures
Carbon adsorption beds	· Carbon adsorption · Caustic impregnation · Inlet preheating · Manual media saturation testing	Treatment/removal of odorants in the extracted air flow is to be provided through use of activated carbon beds. To aid the removal of acidic odorants such as hydrogen sulphide, carbon beds impregnated with caustic soda are proposed. Odorants are adsorbed in the bed media and provided the carbon beds are appropriately sized for the flow rate and odour loading of the influent stream, carbon adsorption can provide effective odour treatment. We understand from discussions with Apex Environmental, that the carbon beds will be specified to achieve a face or superficial velocity of 0.2 m/s (equating to 0.2 m^3/s of air flow per m^2 of media bed face area). Appropriate face velocities will depend on bed design and composition but in general terms the design criterion is reasonably low (meaning there is good level of bed area coverage for the flow rate)[1], which is appropriate given the potential intensity of extracted odour and sensitivity of the post-development receiving environment. The carbon media will become saturated over time, the rate of which will depend on the odorant loading of the influent stream. Consequently, the bed media will require replacement prior to reaching saturation. We understand that Apex Environmental proposes regular manual testing of bed saturation. The frequency and method of testing to ensure replacement prior to saturation should be set out in the O&M Manual. Moisture can interfere with adsorption, and we understand that preheating of the extracted air flow prior to adsorption is proposed to reduce humidity.

As noted in above, a high standard of odour management will be required to avoid or mitigate odour nuisance impacts on sensitive activities that will be located within reasonably close proximity to the WWTP once the site has been developed. To achieve this, the proposed odour management regime for the WWTP incorporates the following approaches:

- Enclosure and extraction of air from the process sources with the highest odour generation potential (including headworks screens, sludge storage tanks and skips, sludge dewatering equipment and wastewater sump) for treatment via carbon absorption; and
- Monitoring and automated control of other potentially odorous process units (including the anoxic, aerobic and MBR tanks) to avoid anaerobic conditions that could result in increased odour generation.

Provided that the extraction system is designed and maintained to contain odour in calm to moderate wind speed conditions, the carbon adsorption beds are sized appropriately for the extraction flow and the performance of both systems is monitored and maintained on an ongoing basis, odour emissions beyond the WWTP area from the extracted sources are likely to be minimal during normal operation.

[1] For instance the face velocity value is approximately 40% to 60% of superficial bed velocities discussed in United States Environmental Protection Agency "Air Pollution Control Cost Manual", EPA/452/B-02-001, Section 3.1, Chapter 1 - Carbon Adsorbers, 2018.

Avoidance of anaerobic conditions in the other potentially odorous process units largely relies on continuous instrumental monitoring and process automation augmented with manual operator oversight. Provided anaerobic conditions can be avoided, odour emissions beyond the WWTP area from the other (non-extraction) sources are likely to be minimal during normal operation.

Draft consent conditions are proposed in Appendix B (including draft conditions 6 to 8) to set out minimum requirements for the enclosure, extraction and treatment systems. Draft consent conditions 9 to 14 set out minimum requirements for measures to avoid anaerobic conditions.

Abnormal or unplanned operation may result in increased odour emissions. Given the proximity of sensitive activities within the development, avoidance of potential incidences of abnormal or unplanned operation that could result in increased odour emissions will be particularly important in this instance.

The O&M Manual to be developed for the WWTP in accordance with draft condition 20 (refer Appendix B) will detail operational management procedures for the management of the WWTP and the mitigation of odour from the treatment processes, including procedures for the following:

- Identification of odour sources and operation of the sources to minimise odour emissions;
- Continuous process monitoring and responses to monitoring results outside of specified normal operating ranges or indicating exceedances of specified alarm or trigger levels;
- Monitoring of the extraction system to confirm effective containment of odour (including periodic pressure monitoring at key points across the extraction system);
- Regular monitoring of carbon adsorption media condition;
- Regular observational monitoring of downwind odour levels at the WWTP area boundary;
- Regular inspection and maintenance of emissions control equipment and process plant/equipment to prevent or minimise the potential for abnormal or unplanned operation that may increase odour emissions;
- Contingency procedures for abnormal or unplanned operation that may increase odour emissions; and
- Maintenance of critical spares on-site (or at least at a nearby location from which the spares are readily retrievable) for and provision of a back-up electrical supply (via generator and/or UPS) sufficient to supply key plant and equipment for odour management, including:
    - Process monitoring and control equipment
    - Extraction fans/blowers
    - Aeration blowers
    - Tank mixers
    - Wastewater and dosing pumps.

Rigorous implementation of the specified procedures with regular audit and review would serve to reduce the potential risk of abnormal or unplanned operation that could result in increased odour emissions.

Overall, with appropriate design and operation and rigorous implementation of the measures discussed in the preceding paragraphs, odour emissions beyond the WWTP area during normal operation should be minimal. The potential for abnormal or unplanned operation that could increase odour emission should be minimised through documentation and rigorous implementation of management and monitoring procedures for the WWTP.

5.4 Consideration of FIDOL factors and summary of odour nuisance effects

The potential for odour nuisance, and the potential for objectionable or offensive effects in particular may be assessed by considering what are termed the FIDOL factors (frequency, intensity, duration, offensiveness/character and location) at locations where odour may be observed.

These factors are considered in Table 5.3 in relation to the potential for odour nuisance in the local environment as a result of emissions from the proposed WWTP.

Table 5.3: Consideration of FIDOL factors in relation to odour from the proposed WWTP

Factor	Consideration
Frequency/ duration	The frequency and duration of odour experienced at off-site locations will be dictated by the frequency of emissions from the WWTP and by wind conditions. In terms of downwind exposure to wind from the WWTP, prevailing winds will mean receptors to the northeast (including adjacent residential properties within the development) will be downwind of the WWTP most frequently. Light winds, in which dispersion of odour will be reduced, blow most frequently to the northwest. In terms of the frequency of emissions, the WWTP and associated odour sources will operate continuously. However, as described in section 5.2, a high standard of odour control and management will be required to mitigate potential impacts on adjacent dwellings within the development. With the management regime discussed in section 5.2 in place there should be little appreciable odour emitted beyond the WWTP area during normal operation. Odour emissions are likely to be limited to occasional activities, such as removal of waste solids skips or maintenance of equipment, or unplanned incidents, such as equipment failure or outages, which would occur on an irregular basis. Overall, provided the proposed management regime is implemented rigorously and effective management and maintenance procedures are put in place to manage the potential for unplanned emissions, the frequency of odour exposure at local receptor locations should be low.
Intensity	The intensity of odour experienced at off-site locations will be dictated by the intensity of emissions from the WWTP and the degree of dispersion that occurs prior the emissions reaching receptor locations. The degree of dispersion of odour will be influenced by weather conditions (described in Section 4.4) and the degree of geographical separation between emission source and receptor location (described in sections 4.1 and 4.2 and below in this table). In this instance dwellings associated with the development are located in reasonably close proximity, which will reduce the degree of dispersion. This necessitates a high standard of odour management to reduce intensity of odour emissions and exposure at these locations. The intensity of odour emissions from the WWTP without control is expected to be highest where anaerobic degradation of waste occurs, either intentionally or unintentionally. The WWTP process sources where anaerobic conditions are more likely to occur and with the potential to generate stronger intensity of odour are proposed to be controlled through enclosure, forced air extraction and treatment through carbon adsorption prior to discharge. Odour from other sources is to be controlled through avoidance of anaerobic conditions or through low levels of organic matter towards the end of the WWTP process. As noted in relation to frequency/duration, with the proposed control measures in place there should be little appreciable odour beyond the WWTP area during normal operation. The intensity of odour emissions could increase as a result of unplanned incidents, such as equipment failure or outages and robust management and maintenance procedures are required to avoid this type of emission.

Factor	Consideration
Character/ offensiveness	Uncontrolled or untreated odour produced from WWTP processes typically have a negative hedonic tone. Odour from anaerobic degradation of waste can have a particularly unpleasant character (strongly negative hedonic tone). Odour from aerobic processes is likely to be less offensive, and typically have an earthy or musty character. Odour from anoxic processes is expected to be negligible if anaerobic degradation is avoided.
Location	The surrounding area is predominantly comprised of rural pastoral activities interspersed with rural residences and with a small village centre to the southeast. The WWTP is located centrally within an 81 ha site and is separated by at least 500 m from existing local odour sensitive activities. The development will introduce 850 residential properties to the site, the nearest of which will be located within 40 m of the WWTP. The odour control and management regime for the WWTP will need to cater for the proximity and density of sensitive activities associated with the development. A high standard of odour management will be required to manage the frequency, intensity and duration of odour experienced at these locations.

In summary:

- Treatment of wastewater can generate odour of an unpleasant character and negative hedonic tone if not well controlled.
- The WWTP is centrally located within an existing rural property and is reasonably well separated (by at least 500 m) from existing sensitive activities (mainly rural dwellings) in the area. However, the development will increase the sensitivity of the receiving environment through introduction of 850 residential properties (the nearest of which is within 40 m). With the development in place, the receiving environment will be highly sensitive to odour.
- The frequency, intensity and duration of exposure in the post-development environment to odour from normal WWTP operation should be minimal provided that
  - The proposed odour extraction and treatment systems to be used to control odour from the most significant potential odour sources are appropriately designed, operated and maintained
  - Anaerobic conditions in process odour sources that are not extracted (such as the anoxic, aerated and MBR tanks) are avoided.
- The intensity of odour exposure could be increased if abnormal or unplanned operation occurs. To minimise the potential occurrence of this type of scenario, odour management and monitoring procedures should be set out in the O&M Manual as described in section 5.2 and rigorously implemented.

Overall, taking account of the sensitivity of activities in the receiving environment and the negative hedonic tone of the odour resulting from the WWTP, provided that the proposed process is well controlled, managed and maintained, the intensity and frequency of odour beyond the site boundary is unlikely to be offensive or objectionable.

6 Conclusions

This report provides an assessment of the potential environmental effects of odour emissions from the WWTP proposed for the Karaka North Village development.

The following conclusions are drawn from this assessment:

- The WWTP is proposed to treat wastewater from properties within the proposed development and potentially properties from adjoining developments.
- The WWTP will be developed at an existing rural site adjoining an existing village centre and surrounding rural properties interspersed with rural dwellings. The WWTP is well separated from existing dwellings and other odour sensitive activities in the local area, but the sensitivity of the receiving environment will be increased through the introduction of 850 residential properties to the site as part of the development.
- Treatment of wastewater can generate odour from anaerobic degradation that is of an unpleasant character and negative hedonic tone. However, in this instance a high standard of control and management of the potential odour emissions can mitigate the potential impacts on properties within the development.
- Odour emissions beyond the WWTP area during normal operation should be minimal provided that:
  - The air extraction and treatment systems to be used to control odour from the most significant potential odour sources (where anaerobic degradation may occur during normal operation) are appropriately designed, operated and maintained including through implementation of the measures described in section 5.2; and
  - Anaerobic conditions are avoided in process odour sources that are not extracted (such as the anoxic, aerated and MBR tanks) through continuous process monitoring, automated control and rigorous manual operator oversight including through implementation of the measures described in section 5.2.
- Draft conditions of consent are set out in Appendix B to require implementation of the management measures recommended in section 5.2.
- The intensity of odour emissions could be increased if abnormal or unplanned operation occurs and to minimise the potential occurrence of this type of scenario, odour management and monitoring procedures should be set out in the O&M Manual to be developed for the WWTP in accordance with the draft consent conditions as described in section 5.2 and rigorously implemented.
- Overall, a review of the FIDOL factors for nuisance effects assessment indicates that odour beyond the WWTP area is not anticipated to be of an intensity or frequency to cause offensive or objectionable effects, provided that the WWTP and emission control equipment is well designed, managed, monitored and maintained in accordance with the draft conditions set out in Appendix B.

7 Applicability

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

We understand and agree that our client will submit this report as part of an application for resource consent and that the Covid Fast Track Consenting Panel will use this report for the purpose of assessing that application.

Tonkin & Taylor Ltd

Report prepared by:	Authorised for Tonkin & Taylor Ltd by:
	
.....	.....
Jason Pene	Jenny Simpson
Principal Environmental Engineer	Project Director

JAP
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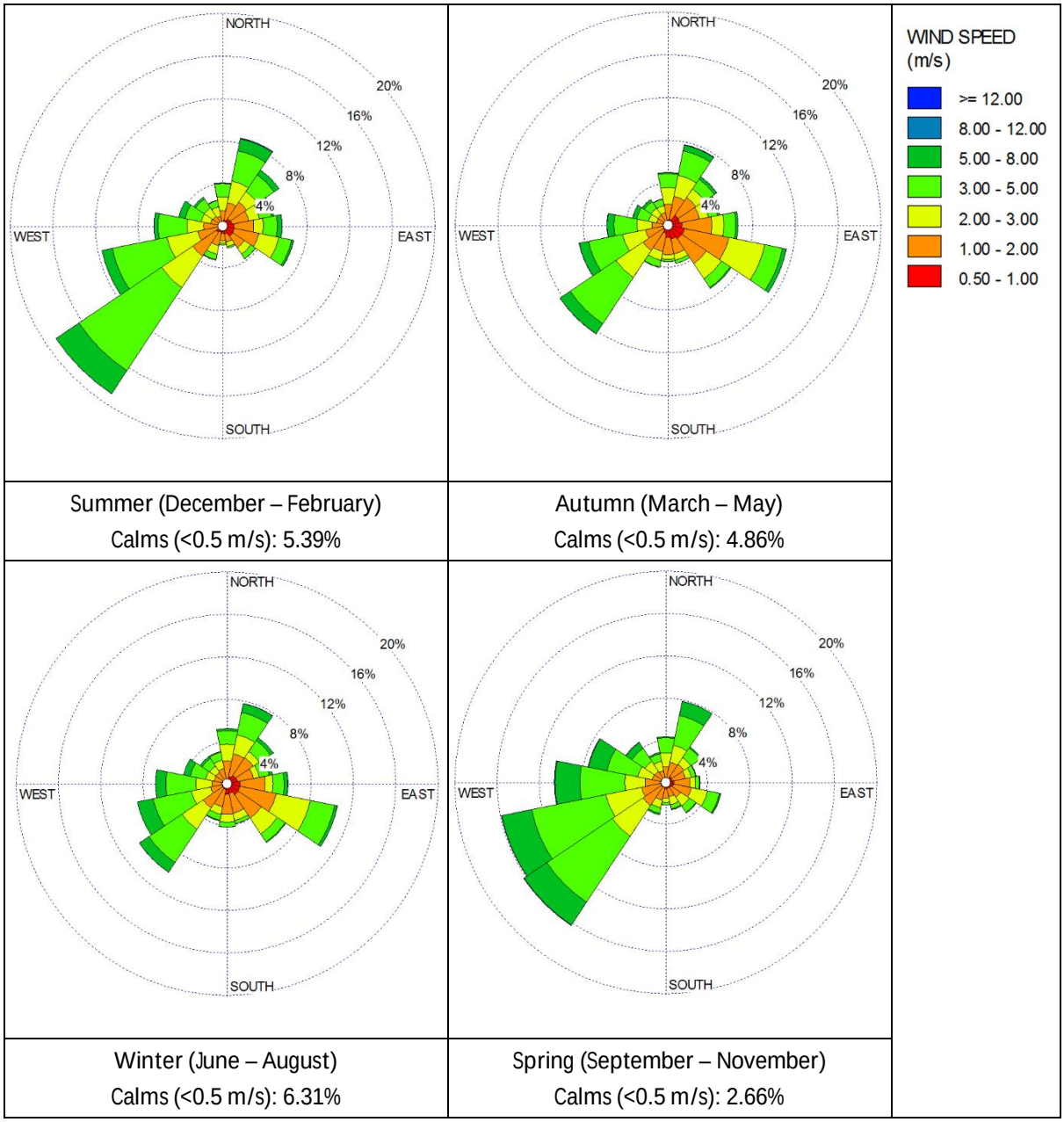
Appendix A: Diurnal and seasonal wind frequency



Summer (December – February)
Calms (<0.5 m/s): 5.39%

Autumn (March – May)
Calms (<0.5 m/s): 4.86%

Winter (June – August)
Calms (<0.5 m/s): 6.31%

Spring (September – November)
Calms (<0.5 m/s): 2.66%

Figure A1: Seasonal comparison of frequency of wind speeds and directions measured at the Pukekohe Electronic Weather Station 2010-2019 (1-hour average data)

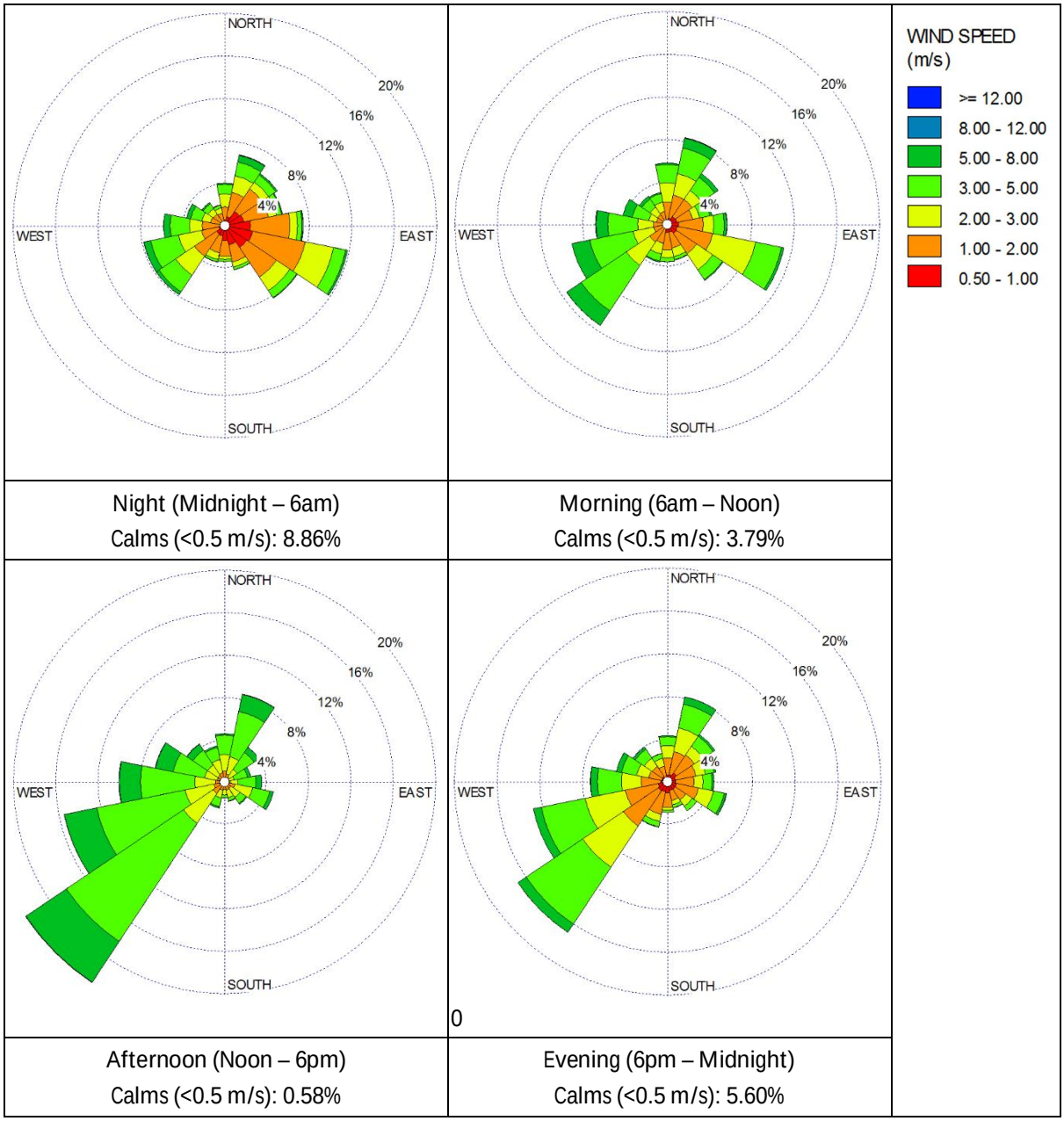


Figure A2: Diurnal comparison of frequency of wind speeds and directions measured at the Pukekohe Electronic Weather Station 2010-2019 (1-hour average data)

Appendix B: Draft conditions of consent for discharges to air

The following draft conditions are recommended for the resource consent for discharges to air from the WWTP.

Term	Definition
Council	Auckland Council
DO	Dissolved oxygen
OCU	Odour control unit operated in accordance with Condition 6
OMM	Operations and Maintenance Manual prepared in accordance with Condition 20
ORP	Oxidation-reduction potential
SCADA	Supervisory control and data acquisition system used to control the WWTP
RMA	Resource Management Act 1991
WWTP	Wastewater treatment plant

Condition No.	Condition
Accordance with the application	
1	The discharge of contaminants into air shall be carried out in accordance with the plans and information submitted with the application.
Discharge performance standards	
2	Beyond the boundary of the Site, there shall be no odour and/or dust caused by the discharges, which in the opinion of an enforcement officer, is the cause of a noxious, dangerous, offensive or objectionable effect.
3	Beyond the boundary of the Site there shall be no hazardous air pollutant, caused by discharges, which is present at a concentration that causes, or is likely to cause adverse effects to human health, ecosystems or property.
4	The wastewater treatment activities shall be operated, maintained, supervised, monitored and controlled to ensure that all emissions authorised by this consent are maintained at the minimum practicable level.
Enclosure and extraction of odour sources	
5	At a minimum the following must be enclosed and mechanically ventilated to an OCU: (a) headworks screens; (b) sludge storage tanks and skips; (c) sludge dewatering equipment; and (e) wastewater sump. The ventilation system is to be designed and operated to avoid fugitive emissions of odour from the ventilated sources or ventilation system.
Odour control unit performance	
6	All OCUs used to treat air mechanically ventilated in accordance with Condition 5, shall incorporate either:

	(a) one or more carbon adsorber units designed, constructed, operated and maintenance in accordance with Conditions 7; or (b) one or more biofilters designed, constructed, operated and maintenance in accordance with Conditions 8.
7	All carbon adsorber units shall be designed, constructed, maintained and operated in accordance with the following: (a) In-line duct heating shall be provided on the inlet side of each adsorber unit to ensure that the temperature of the saturated air to the OCU can be raised to achieve reduced humidity to prevent moisture entrainment and optimal adsorption in the activated carbon bed. The capacity of heaters used for this purpose shall be sufficient to reduce the relative humidity of the maximum design inlet air flow to no greater than 70% from 100% at 20 degrees Celsius. (b) The absorptive media shall comprise activated carbon that is steam activated and impregnated with sodium hydroxide or potassium hydroxide, potassium iodide or copper oxide. (c) The depth of adsorptive media shall be such that the minimum residence time of airflow through the media is no less than 3 seconds at the maximum design airflow. (d) The gas velocity of airflow through the adsorptive media shall be no greater than 0.2 m/s except with the prior approval of the Council where the manufacturer recommended gas velocity is greater than 0.2 m/s (in which case gas velocity through the activated carbon shall be not exceed the manufacturer recommended gas velocity). (e) The adsorptive media shall be evenly distributed in the bed so that no bypassing or short circuiting of inlet airflow occurs. (f) The media is to be replaced as soon as practicable (and no later than within one month) where testing conducted in accordance with Condition 14(b)(ii) indicates that saturation may occur within two months of testing.
8	All biofilters shall be designed, constructed, maintained and operated in accordance with the following: (a) The Empty Bed Residence Time at the maximum design airflow shall be no less than 72 seconds; (b) Bed media shall be visibly damp below the surface with a moisture content of generally between 50% and 70% on a dry weight basis; (c) The media pressure drop, measured at the exit from the air distribution system, shall be no greater than 150mm water gauge; (d) Even distribution of air flow through the filter bed; (e) There shall be no bypass of untreated air around the sides of or through fissures in the filter bed; (f) An operating pH, in the bed media between the surface and to a depth of 600mm, in the range of between 5 and 8.
Avoidance of anaerobic process conditions	
9	The anoxic balance tank and anoxic tanks processes shall be controlled to ensure that anaerobic conditions are avoided in each tank.
10	The DO concentration in any aeration tanks shall not be remain below 0.1 ppm for more than 12 consecutive hours.
11	If the DO concentration in an aeration tank is less than 0.2 ppm for more than 8 consecutive hours the consent holder shall notify the Consent Authority within 24 hours and investigate and determine the cause and take the action necessary to ensure the compliance limits are not breached. The consent holder shall document each trigger level exceedance and investigation and provide summaries in the annual report and provide to the Consent Authority within 48 hours of a request.
12	Membrane filter tanks shall be maintained in an aerobic state at all times.

Monitoring	
13	The Consent Holder shall monitor and record operational parameters of WWTP units as follows: (a) Continuous flow metering of all influent flows to the WWTP; (b) Continuous monitoring of DO concentration in each aeration tank; (c) Continuous monitoring of ORP in the anoxic balance tank and each anoxic tank; and (d) Continuous monitoring of operation of fans of the mechanical ventilation system. The data shall link to the WWTP SCADA system with alarms to indicate alert level exceedances as set out in the OMM prepared in accordance with Condition 20. All data, including flow records, shall be recorded for a minimum of five years and provided to the Consent Authority within 48 hours of a request.
14	The Consent Holder shall monitor and record operational parameters of the air ventilation system and OCUs as follows: (a) Vacuum pressure in the enclosed headspace of odour sources mechanically ventilated in accordance with Condition 5 on a weekly basis. (b) For carbon adoption units: (i) Temperature and relative humidity of air inflow to and outflow from each inline duct heater on at least a weekly basis; (ii) Saturation of the adsorptive media on at least a monthly basis; (c) For biofilters: (i) A visual and olfactory assessment of the condition of the biofilter bed media, including moisture content and the potential for short circuiting, cracking or clogging of the bed, on at least a weekly basis; (ii) Pressure drop across biofilter media bed, measured at post the air distribution system, on at least a weekly basis; (iv) A gravimetric determination of biofilter medium moisture content on a monthly basis for the first six months operation then six monthly thereafter; and (v) The pH of the biofilter medium on a six-monthly basis. A log shall be maintained of the results of monitoring conducted in accordance with this condition. The log shall be made available to the Council on request.
15	Prior to commissioning of the WWTP, the consent holder shall install and thereafter operate and maintain a meteorological monitoring station at or within 500 m of the WWTP site to record wind speed, wind direction, ambient air temperature and relative humidity. At a minimum: (a) The monitoring station shall include an ultrasonic anemometer or equivalent measurement device capable of measuring wind speeds at a resolution of no greater than 0.1 m/s and capable of measuring wind direction at a minimum wind speed of no greater than 0.1 m/s. (b) Weather parameters shall be measured continuously, at a frequency of not more than 1-minute intervals and recorded as 10-minute averages (d) 10-minute averaged meteorological data shall be retained in the form of an electronic record for a minimum of five years. Meteorological data shall be provided to the Consent Authority within 48 hours of a request. (e) The monitoring station shall be calibrated in accordance with the manufacturers' recommendations for each instrument, with the documentation of the calibration retained and shall be provided to the Council within one week of a request.
Operator availability	
16	An appropriately trained wastewater operator will be available twenty-four hours a day and seven day per week to respond to any plant contingencies that may cause an adverse odour nuisance effect outside the site boundary.
Preventative maintenance	

17	The consent holder shall implement a system of scheduling, undertaking and documenting preventative maintenance on all equipment critical to the effective operation of the odour control systems and other plant processes that affect odour as set out in the OMM prepared in accordance with Condition 20. An updated copy of the maintenance schedule shall be provided with the annual report each year. Information which demonstrates compliance with this shall be provided to the Consent Authority within 5 working days of a request.
Power outages	
18	The following management measures for power outages shall be implemented: (a) A power outage alarm system shall be installed and maintained which provides electronic notification of (via SMS and email at a minimum) of any loss of mains power supply to the WWTP. (b) The consent holder shall maintain a generator on site that is configured to automatically start upon loss of mains power supply. The generator shall be of sufficient capacity to power all aeration systems, recycle pumps, odour control and air extraction systems, at a minimum. (c) The alarm system, DO probe and supporting data telemetry system shall be powered by an uninterruptable power supply with a minimum 4-hour battery life.
Critical spares	
19	The consent holder shall implement the following, such that the equipment critical to the effective operation of the WWTP, OCUs and air extraction system and ongoing compliance with the conditions of this consent is operational as soon as practicable and no later than 24 hours after any failure or outage: (a) hold onsite or maintain reliable access to spare equipment critical to the effective operation of the WWTP, OCUs and air extraction system and ongoing compliance with the conditions of this consent; and (b) retain staff or contractors capable of installation and maintenance of the equipment.
Air discharge management procedures	
20	The consent holder shall within 3 months of the operation of the WWTP provide to the Consent Authority for certification, an Operations and Maintenance Manual ("OMM"). The OMM shall in adequate detail accurately record all monitoring, management and operational procedures, methodologies and contingency plans required to comply with the conditions of this consent. At a minimum, the OMM shall include: (a) An overview description of WWTP processes and activities and associated sources of odour and other air contaminants; (b) Identification of potential odour sources (including potential fugitive odour sources), risks of odour impacts associated with each source and procedures for minimising risks as far as practical. (i). For each odour source and emission control system, this is to include identification of key process operating parameters for odour management, how these will be monitored, alert level thresholds, and procedures to respond to alert level exceedances. (ii). procedures for scheduling, undertaking and documenting preventative maintenance on all equipment critical to the effective operation of each odour source and emission control system. (iii). Identification of critical spares and procedures to ensure availability of critical spares in accordance with Condition 19. (iv). Contingency procedures for each emergency, plant breakdown, equipment failure and malfunction scenario that could result in an increase in emissions to air.

	(d) Procedures for implementing the monitoring requirements of this consent. (e) Training and induction of personnel operating the WWTP. (f) Procedures for responding to and investigating complaints relating to odour or other air contaminants emitted from the WWTP. (g) Roles and responsibilities of personnel for implementing the requirements set out in the OMM. (h) Contact details of key personnel including after hours. (i) Procedures for reviewing and/or improving the OMM. The OMM shall be reviewed and updated at least once every two years.
Annual reporting	
21	The consent holder shall provide to the Council a written report by 30-June (or at any other date with the written approval of the Council) each year for the activities authorised. At a minimum the report shall: (a) Assess compliance with each condition of this resource consent. (b) Analyse and provide reasons for any non-compliance or difficulties in achieving compliance with the conditions of this resource consent. (d) Summarise the result of monitoring conducted in the preceding 12 months in accordance with Conditions 13 and 14 and compare with the results of the previous annual reporting period. (e) Describe preventative maintenance completed in the preceding 12 months in accordance with Condition 17, provide reasons for any non-completion of scheduled maintenance and provide the maintenance schedule for the up-coming year. (f) Describe any works that have been undertaken to improve the environmental performance of the OCUs or ventilation system in the preceding 12 months or that are proposed to be undertaken in the up-coming year to improve or that may affect the environmental performance of the OCUs or ventilation system. (g) Identity and detail that location of critical spares maintained in accordance with Condition 19. (h) Summarise any complaints received in relation to discharges to air, the results of any investigations and corrective actions taken in response. (i) Describe any changes to the procedures of the OMM implemented in the preceding 12 months that may influence discharges to air from the WWTP and reasons for the changes.
Notification of potential non-compliance	
22	The consent holder shall notify the Consent Authority as soon as practicable, and as a minimum requirement within 24 hours, of the consent holder becoming aware of any accidental discharge, mechanical failure, or other circumstances which has resulted in, or is likely to result in, a breach of any condition of this consent. The consent holder shall, within 7 days of the incident occurring, provide a written report to the Council, identifying the condition breached, possible causes, steps undertaken to remedy the effects of the incident and measures that will be undertaken to ensure future compliance.
Complaint response	
23	28. The consent holder shall maintain a log of all complaints (including those received via third parties including the Council) regarding odour. The consent holder shall notify the Council of each complaint as soon as practicable. The consent holder shall record the following details in a complaint log: (a) Time and type of complaint including details of the incident, e.g. duration, location and any effects noted; (b) Name, address and contact phone number of the complainant (if provided);

	(c) The weather conditions at the time of incident and including the data collected from the weather station required by Condition 15; (d) The likely cause of the complaint and the response made by the consent holder including any corrective action undertaken if applicable; (e) Future actions proposed as a result of the complaint, if applicable; and (f) The response from the consent holder to the complainant. The complaint log shall be made available to the Council at all reasonable times,
Review of conditions	
24	The Council may, within one month following each anniversary of commencement of this consent, serve notice on the consent holder under section 128(1) of the Resource Management Act 1991, of its intention to review the conditions of this resource consent for the following purposes: (a) Deal with any significant adverse effects on the environment arising from the exercise of the consent which was not foreseen at the time the application was considered and which is appropriate to deal with at the time of the review. (b) Consider the adequacy of conditions which prevent nuisance and adverse effects beyond the boundary of the Site, particularly if regular or frequent complaints have been received and validated by an enforcement officer. (c) Consider developments in control technology and management practices that would enable practical reductions in the discharge of contaminants to air. (d) Alter the monitoring requirements, including requiring further monitoring, or increasing or reducing the frequency of monitoring.

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