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Dear Helen and Ian,

Letter Report: Shotover WWTP Odour Effects Assessment

1. Introduction

Air Quality Consulting NZ Limited (AQCNZ) has been engaged by GHD Limited to undertake a desktop assessment to understand the potential odour effects from the Shotover Wastewater Treatment Plant (WWTP) and the proposed outfall using the FIDOL approach. The assessment has been carried out in accordance with the Ministry for the Environment's Good Practice Guide for Assessing and Managing Odour (MfE GPG Odour, 2016), which outlines a range of tools for evaluating odour effects. The FIDOL framework considers the key factors that influence odour impacts, namely Frequency, Intensity, Duration, Offensiveness, and Location.

The odour assessment has been based on the anticipated level of effects at the time of commissioning the proposed outfall, which will include further wastewater treatment improvements as detailed in the Assessment of Environmental Effects (AEE) report.

2. Odour Effects Assessment

The assessment considers potential odour discharges from the WWTP and the proposed outfall. These source areas have been considered separately due to the large physical separation distance between the outfall and the WWTP, the different nature of the potential odour discharges, and the different receiving environments relevant to each source area.

The WWTP has the potential to generate odours associated with wastewater treatment activities. Key potential sources include the inlet works, where odours can be released from the inlet flume, rotary drum screens, screenings compactors, grit removal system and inlet works pump station. Other potential odour sources include the septage reception system, sludge storage and dewatering

activities, sludge conveyors and bins, the MLE reactors, clarifiers, scum handling system, return and waste activated sludge systems, and the WAS holding tank.

The legacy pond system may also have odour potential during dewatering, residual sludge management or biological process upsets, although the ponds are no longer part of the active treatment process.

Odours from WWTP processes may include sulphurous, septic, musty, or organic wastewater type odours, depending on the source area, wastewater condition, sludge age, dissolved oxygen levels, and operating conditions at the time.

Based on AQCNZ's experience with other wastewater treatment plants, odours from a WWTP of this size and design are most likely to be detectable within approximately 100 m to 300 m of the source areas, depending on the nature of the activity and meteorological conditions. Under adverse conditions, such as low wind speeds or stable atmospheric conditions, odours may occasionally be detectable further downwind. However, odour intensity would be expected to reduce with distance as emissions disperse and dilute in the surrounding environment.

In contrast, the proposed outfall will discharge treated wastewater following primary, secondary, and tertiary treatment. Based on AQCNZ's experience with other wastewater treatment plants, treated wastewater discharged at an outfall has some potential to generate odour. Such odours typically exhibit a musty, earthy, or algae like character. However, the intensity of these odours is expected to be no more than distinct, and they are more commonly described as very weak or not detectable. Odours associated with the outfall are likely to be detectable only within approximately 50 m of the discharge point and wouldn't typically be expected under day-to-day operation of the treatment plant.

The effects assessment has been informed by meteorological data from the nearby Queenstown Airport meteorological station, as shown in Figure 1.

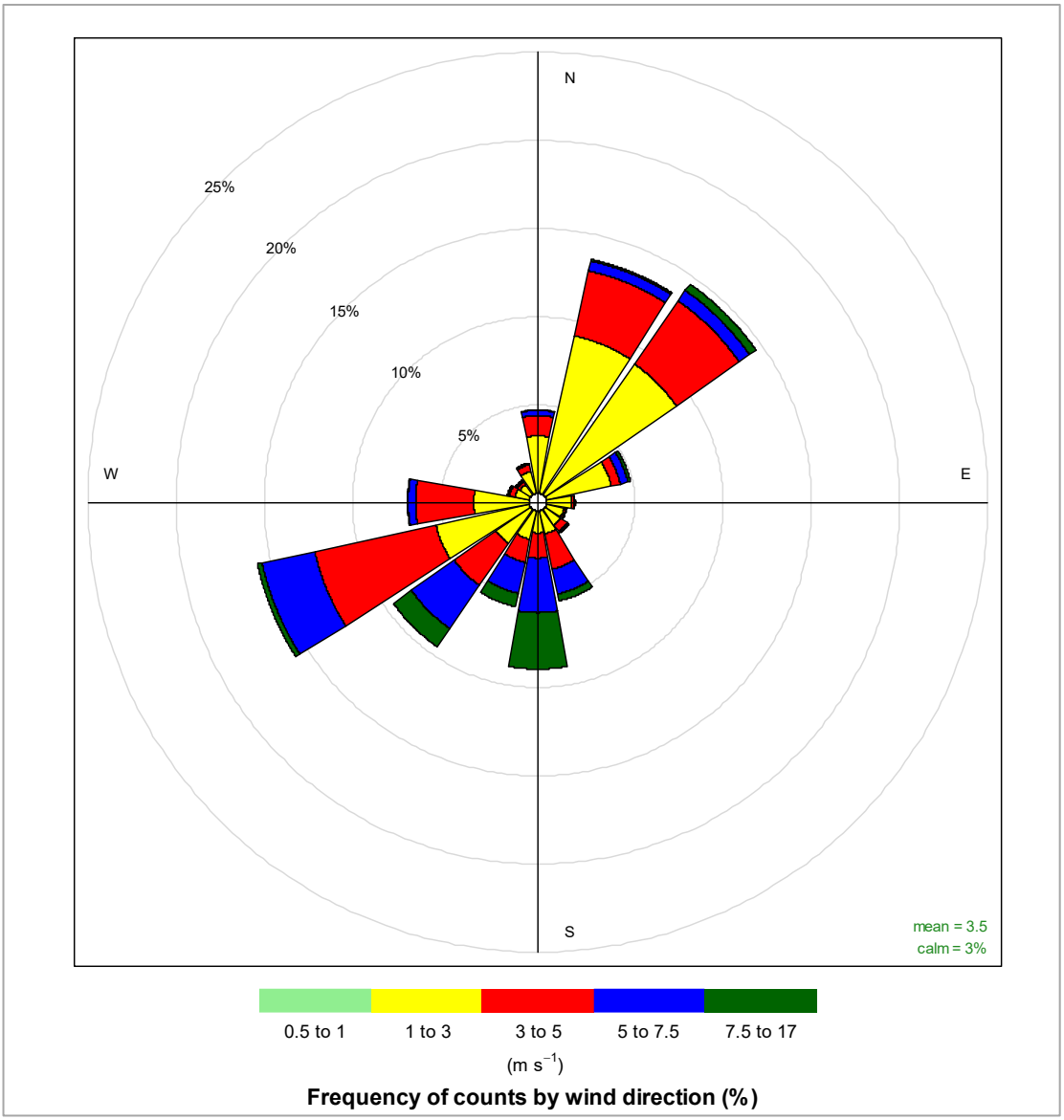

Figure 1 Queenstown Airport wind data presented as a windrose, 2022 to 2024 (years inclusive)

The purpose of the assessment is to characterise the potential for off-site odour effects from both the WWTP and the proposed outfall, taking into account the nature of each source, the separation distance to sensitive receptors, and typical meteorological conditions.

Separate FIDOL assessments have been prepared for the WWTP and the proposed outfall, reflecting the different nature, location, and receptor environment associated with each source area. A summary of the FIDOL assessment for the main WWTP process areas is presented in Table 1, while the assessment for the proposed outfall is presented in Table 2.

Table 1 WWTP odour FIDOL factors

FIDOL	Findings
Frequency	Frequency refers to how often odours may be experienced at off-site receptor locations. For the WWTP, the frequency of odour exposure depends on both the occurrence of odour generating conditions at the plant and the frequency of low speed winds blowing from the WWTP towards nearby receptors. Low speed winds, being winds below 3 m/s, are most relevant to odour effects as atmospheric dispersion is more limited under these conditions. At higher wind speeds, there is generally greater mixing and dilution, which reduces the likelihood of odours remaining concentrated as they travel downwind. The windrose in Figure 1 shows that low speed winds occur from a range of directions, although the frequency varies by direction. The closest residential receptors are located approximately 200 m to the north of the main WWTP process areas, meaning winds from the south are relevant for potential odour transport towards these receptors. Residential receptors are also located approximately 350 m to the east, for which winds from the west are relevant. Commercial receptors are located approximately 230 m to the southwest and west, for which winds from the northwest and east are relevant, respectively. Based on Figure 1, the maximum frequency of low speed winds from any single direction is approximately 9%. Low speed winds from the directions relevant to nearby residential receptors are typically less than 6%, while low speed winds towards other nearby receptor groups also occur relatively infrequently. These conditions do not represent a dominant wind pattern, indicating that poorly dispersed odours are unlikely to be frequently transported towards any one receptor group.
Intensity	Wastewater treatment activities have the potential to generate sulphurous, septic, musty, earthy, or organic wastewater type odours. The highest odour generation potential is generally associated with raw wastewater handling, septage reception, screenings, grit handling, scum handling, and sludge storage or dewatering. Odour generation from the MLE reactors and clarifiers is expected to be lower during normal operation, as the process is aerated and managed to maintain biological treatment performance. Based on the nature of the sources and the controls in place, odour intensity beyond the site boundary is expected to generally be weak to distinct, with higher intensity odours only expected under abnormal or upset conditions.
Duration	Some WWTP activities occur continuously, including receipt and treatment of wastewater. However, the generation of more noticeable odours is expected to be intermittent and linked to specific activities or operating conditions, such as screenings handling, septage unloading, sludge handling, scum accumulation, low dissolved oxygen conditions, equipment failure, or biological process upset. The OMP identifies specific operational controls and monitoring requirements for key odour sources, including the inlet works odour treatment system, MLE odour treatment system, MLE reactors, clarifiers and WAS holding tank. While receptors may occasionally be downwind of the WWTP during light wind conditions, the likelihood of receptors experiencing odour for any meaningful duration is considered low, particularly given the separation distances to the nearest sensitive receptors and the treatment and management measures in place.
Offensiveness	Odours from untreated wastewater, septage, screenings, scum and sludge have the potential to be offensive if they are experienced at sufficient intensity and duration. However, odours associated with biologically treated wastewater and well operating activated sludge systems are generally less offensive and may be characterised as musty, earthy or organic. The potential for offensive odours is therefore most closely associated with raw wastewater handling, septage reception, sludge handling, process upsets, or failure of odour control systems. Provided the WWTP is operated in accordance with the OMP, including maintaining odour treatment systems, managing screenings and sludge, and responding to abnormal operating conditions, odours at off-site receptors are unlikely to be offensive or objectionable.
Location	The location of the WWTP relative to sensitive receptors is an important consideration. The nearest residential receptors are located approximately 200 m to the north of the main WWTP process areas, with further residential receptors approximately 350 m to the east across the Shotover River. Commercial receptors are located approximately 230 m to the southwest and west of the process areas. These distances provide some opportunity for odour dispersion before reaching off-site receptors, although the northern residential receptors are relatively close to the WWTP. The potential for odour effects at each receptor group depends on wind direction as well as distance. Winds from the south are required to transport odours towards the northern residential receptors, winds from the west towards the eastern residential receptors, winds from the northwest towards the

FIDOL	Findings
	southeast commercial receptors, and winds from the east towards the western commercial receptors. The windrose in Figure 1 indicates that low speed winds from these specific directions occur relatively infrequently. Overall, the separation distances, receptor sensitivity, low frequency of receptor relevant low speed winds, and odour management controls are expected to reduce the potential for offensive or objectionable odour effects beyond the site boundary.
Overall Odour Assessment	The main WWTP process areas have the potential to generate odours from raw wastewater handling, inlet works, septage reception, biological treatment processes, clarifiers, scum handling, WAS storage, sludge dewatering and related pump stations. Some of these odours have the potential to be offensive if they are experienced at sufficient intensity and duration, particularly during abnormal or upset conditions. However, the key odour generating areas are subject to operational controls, odour treatment, aeration, monitoring and maintenance under the OMP. The nearest residential receptors are located approximately 200 m to the north and 350 m to the east of the main process areas, with commercial receptors approximately 230 m to the southwest and west. The windrose indicates that low speed winds, being the conditions most relevant to poorly dispersed odour effects, occur from a range of directions. However, the maximum frequency of low speed winds from any single direction is approximately 9%, and low speed winds from directions relevant to nearby residential receptors are typically less than 6%. Considering the nature of the odour sources, the odour controls in place, the separation distances to receptors, and the relatively low frequency of low speed winds blowing from the WWTP towards nearby residential receptors, odour emissions from the WWTP are unlikely to cause offensive or objectionable effects beyond the site boundary. This conclusion is also supported by the limited number of odour complaints associated with the WWTP, which indicates that odour effects are not regularly experienced at off-site locations. AQCNZ notes that following the Stage 3 upgrades and with further proposed improvements prior to commissioning the new Kawarau River outfall, the likelihood of complaints is expected to further reduce.

Table 2 Outfall odour FIDOL factors

FIDOL	Findings
Frequency	Frequency refers to how often odours may be experienced at off-site receptor locations. The windrose in Figure 1 shows that light winds (i.e. winds below 3 m/s) occur from a variety of directions, with no more than 9% of light winds coming from any single direction. Light winds capable of transporting odours towards the nearest residential area to the north (i.e. winds from the south through to the southwest) occur less than 6% of the time. This represents a low frequency of occurrence. Given the infrequent nature of strong odours that could cause nuisance effects, combined with the low frequency of light winds blowing towards sensitive receptors, it is unlikely that odours will be regularly experienced at off-site locations.
Intensity	Treated wastewater has the potential to produce odours with a 'musty', 'earthy', or occasionally 'algae-like' character. These generally have a low odour intensity and are not considered offensive in most cases. Based on experience, odour intensity from the outfall is expected to be no more than "distinct", with typical observations being "very weak" or not detectable at all. Furthermore, as the odour travels downwind of the outfall, it will disperse and the odour intensity will reduce.
Duration	The generation of odour from the outfall is expected to be relatively continuous. However, it is unlikely that receptors would experience odour for any significant periods of time, given the other factors involved, such as the low odour intensity, distance to receptors and low frequency of suitable wind conditions (i.e. poor dispersive low-speed/calm winds). Overall, the likelihood of receptors observing odours for any meaningful duration of time is considered low.
Offensiveness	While treated wastewater can emit odour, the character ('musty', 'earthy', or 'algae-like') of such odour is not typically considered offensive, particularly given its low intensity and that as it disperses, it dilutes in the ambient environment.

FIDOL	Findings
	Overall, that odours associated with the outfall are unlikely to be considered offensive or objectionable.
Location	The location of the outfall relative to sensitive receptors is an important consideration. The nearest highly sensitive receptors (primarily residential receptor locations) are >1,000 m to the northeast of the outfall. There are commercial properties which have a lower sensitivity to odours located a similar distance to the northwest. There is also the potential for people using the Kimi-ākau/Shotover River to experience odour, however, it is likely that the frequency of exposure will be low. Overall, the buffer of ~1,000 m to fixed receptors should provide a sufficient distance for any residual odours to disperse and not result in offensive or objectionable odours at the nearest receptor locations. While there is potential for mobile receptors (i.e. recreational or commercial users of the Kawarau River and Shotover Delta) to be exposed to odours in close proximity to the outfall, this is highly localised, and objectionable or offensive odours are not anticipated under normal (day-to-day) operation of the WWTP.
Overall Odour Assessment	Considering the relatively low frequency of light winds that can cause effects, low intensity of odours discharged and distance to receptors, the odour emissions from the outfall are unlikely to cause offensive or objectionable effects at off-site receptor locations.

3. Cumulative Odour Effects

The assessment has considered the potential for cumulative odour effects associated with the WWTP and the proposed outfall.

The WWTP and the outfall are physically linked as part of the same wastewater treatment and discharge system. However, they have different odour source characteristics, are separated by more than 1 km, and have different receiving environments. The WWTP have the greater potential to generate odours, particularly from raw wastewater handling, inlet works, septage reception, screenings and grit handling, scum handling, sludge storage and dewatering, and abnormal biological treatment conditions. In contrast, the proposed outfall will discharge treated wastewater following primary, secondary and tertiary treatment and is expected to have a much lower odour potential, with any odour likely to be musty, earthy or algae like in character.

The cumulative effects of odour depend on whether odours from the WWTP and the outfall could be experienced at the same receptor at the same time, or whether the outfall would materially increase the frequency, intensity, duration or offensiveness of odours already associated with the WWTP. Based on the FIDOL assessments, odour from the outfall is unlikely to be detectable at sensitive receptor locations due to the low odour intensity, the separation distance to receptors, and the low frequency of meteorological conditions that would transport poorly dispersed odours towards those receptors.

Odour from the WWTP has a greater potential to be detected off site, particularly under low wind speed conditions or during abnormal operating conditions. However, the WWTP is subject to odour management controls, including odour treatment, aeration, monitoring, operational controls and maintenance under the OMP. The FIDOL assessment also indicates that low speed winds from directions relevant to nearby residential receptors are typically less than 6%, reducing the frequency with which poorly dispersed odours would be transported towards those receptors.

Given the spatial separation between the WWTP and the outfall, the different odour character and intensity of the two source types, and the low likelihood of outfall odours being detectable at off-site receptors, the outfall is not expected to materially add to odour effects from the WWTP. If odour from the overall wastewater treatment system were detected off site, it would be expected to be dominated by the main WWTP process areas rather than the outfall.

Overall, the risk of adverse cumulative odour effects is considered low. The outfall is not expected to significantly increase the frequency, intensity, duration or offensiveness of odours experienced at off-site receptors, nor is it expected to extend the area over which odour effects from the WWTP may occur. Therefore, cumulative odour effects from the WWTP and proposed outfall are unlikely to be offensive or objectionable beyond the site boundary.

4. Overall Odour Assessment Conclusion

Overall, odour effects from the WWTP and the proposed outfall are unlikely to be offensive or objectionable beyond the site boundary. The WWTP has the greater potential to generate odour, particularly from raw wastewater handling, septage reception, screenings, sludge handling and abnormal operating conditions. However, the key odour generating areas are subject to odour management controls under the OMP. The proposed outfall is expected to have a low odour potential and is unlikely to be detectable at off-site receptors. This conclusion is supported by the separation distances to nearby receptors, the low frequency of receptor relevant low speed winds, and limited number of odour complaints associated with the WWTP or outfall.

5. Closure

If you have any questions regarding the above assessment, please don't hesitate to contact the undersigned.

Yours sincerely,

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