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To: Hannah Goslin
Consultant Planner
Otago Regional Council

Queenstown Lakes District Council's application for resource consent to discharge treated wastewater to the Kawarau River: Initial review of surface water matters

Hello Hannah,

My initial assessment of Queenstown Lakes District Council's *Resource Consent Application to Otago Regional Council for Discharge of Treated Wastewater & Associated Activities – Shotover Wastewater Treatment Plant* is presented below:

1 Background

The applicant is seeking resource consent for activities associated with the establishment and operation of the long-term wastewater discharge from the Shotover WWTP to the Kawarau River. Otago Regional Council (ORC) has asked me to assess the effects of the activity by responding to a series of specific questions. These questions are answered in Sections 4 to 8 below.

2 Materials considered

- *Resource Consent Application to Otago Regional Council for Discharge of Treated Wastewater & Associated Activities – Shotover Wastewater Treatment Plant* (the application/AEE/report) – Landpro;
- *Shotover WWTP Surface Water and Groundwater Assessment* (the Surface Water and Groundwater Assessment) – GHD;
- *Shotover WWTP Periphyton Risk Assessment* (the Periphyton Risk Assessment) – BML;
- *Shotover WWTP Ecological Impact Assessment* (The Ecological Impact Assessment) – BML
- *Compliance of Kawarau and Shotover with Appendix 2A of the NPSFM 2020 (amended 2025)* – ORC; and
- The proposed conditions.

3 Scope and limitations

Upon reviewing the QMRA provided with the Surface Water and Groundwater Assessment, it has become apparent that it requires specialist review. Consequently, I do not comment on it further in this memorandum, other than to note that it incorporates underestimated contaminant concentrations (see Section 4.1.2), which may have implications for the reliability of its findings and conclusions.

4 Is the technical information provided in support of the application robust, including being clear about uncertainties and any assumptions? Yes, or no. If not, what are the flaws?

In my view, the reports I have reviewed do not provide a sufficiently robust basis for assessing a proposal of this scale. In addition, they do not clearly communicate the degree of uncertainty associated with the methodologies used or the implications of those uncertainties for the conclusions reached. The key issues identified in each assessment are discussed in Sections 4.1 to 4.5 below.

4.1 Key issues across all reports

4.1.1 Assumed zone of reasonable mixing is exceptionally long

The zone of reasonable mixing adopted throughout the application and the supporting technical reports is based on the recommendations set out in Section 6.3 of the Surface Water and Groundwater Assessment. That section indicates that the extent of the mixing zone has been determined with reference to:

1) *The point at which the effluent discharge is mixed with a reasonable percentage of river water. Consideration of this is suggested by Cook et al. (Cooke, Milne, & Rutherford, 2010) as being preferable for rivers.*
2) *The point prior to an identified commonly used public bathing location.*
3) *The point after which compliance with various water quality standards is considered reasonable as a means of controlling potential adverse effects to water quality and the environment.*

While these considerations are relevant, the resulting mixing zone is exceptionally long. The nominal mixing zone extends approximately 800 metres downstream of the discharge point and, when the location of the downstream monitoring site is taken into account, the effective assessment distance is closer to 950 metres. This is substantially greater than the maximum distance specified in a number of regional planning documents.

For context, the wastewater treatment plant discharge from Palmerston North to the Manawatū River, which is nationally one of the largest treated wastewater discharges to a river, has an associated mixing zone of approximately 400 metres.

More fundamentally, my understanding is that the determination of a reasonable mixing zone is not solely a technical or scientific exercise. It also involves policy and legal considerations regarding what can appropriately be regarded as "reasonable" in a particular receiving environment. As a result, I consider that further evaluation from ORC's planning and legal team is required before the appropriate extent of the zone of reasonable mixing can be determined with confidence.

This uncertainty is important because the conclusions of several assessments are dependent on the adopted mixing-zone length. If a shorter zone of reasonable mixing were ultimately determined to be appropriate through the consenting process, then the predicted effects at the downstream boundary of the mixing zone may be greater than those currently presented in the application documentation.

4.1.2 The effects of the discharge have been assessed based on lower volumes than have been applied for

Across all of the reports listed above, the surface water modelling approach is described as conservative because it is intended to "*represent 2060 peak treated wastewater discharge under low-flow conditions*". However, the approach is not conservative for the following reasons:

- The assessment does not evaluate the discharge volumes provided for in the consent application. The proposed conditions would permit a discharge of up to 694 L/s of treated effluent to the Kawarau River at any time, which is approximately 1.9 times greater than the 360 L/s assumed in the surface water assessment. While the current assessment may be useful as a scenario analysis and may provide an indication of the potential range of effects, it is not sufficient on its own to evaluate the effects of the consents sought.
- The assessment also does not appear to reflect true low-flow conditions. The bathymetric survey used to inform the surface water effects assessment was undertaken when flow in the Kawarau River was approximately 129 m^3/s. This represents around 70% of the median flow and approximately 145% of the Mean Annual Low Flow (MALF) at the Chard Road flow site. As a result, there is limited evidence to support the conclusion that the predicted median concentrations are conservative. It is also possible that the methodology may underestimate concentrations under higher-percentile conditions.

This is a fundamental issue because it affects the validity of conclusions drawn across all of the reports reviewed. To address this matter, the applicant could consider one of the following approaches:

- Re-running the surface water assessment using the discharge volumes sought under the consent application; or
- Amending the proposed consent conditions to align with the assessed discharge volumes and ensure that average dry-weather discharges do not exceed 360 L/s over the life of the consent.

4.2 The potential effects on Lake Wakatipu and Lake Dunstan are not considered in adequate detail

The Surface Water and Groundwater Assessment and the Ecological Impact Assessment both conclude that effects on Lake Dunstan will be negligible, based primarily on the predicted fully mixed nutrient concentrations within the Kawarau River. While river concentrations are relevant, this approach does not appear to adequately consider the sensitivity of receiving lake environments to changes in nutrient loading.

In lake systems, ecological responses are often driven by the total nutrient loads delivered to the lake over time, rather than solely by the concentration of nutrients within inflowing waters. Consequently, an assessment focused primarily on fully mixed river concentrations may not provide a sufficient basis for evaluating potential effects on Lake Dunstan.

Under the proposed consent conditions, nutrient loads discharged from the treatment plant could increase substantially relative to those proposed under the current short-term consent to the Shotover River. Based on the information provided, the proposal may result in increases of approximately 150 t/yr of total nitrogen (TN) and 30 t/yr of total phosphorus (TP) entering Lake Dunstan. These are material increases in nutrient inputs and, in my view, warrant a more detailed assessment of potential ecological effects within the lake environment.

A related, although likely less significant, issue is the potential for reverse flow conditions in the Kawarau River, during which water can move back toward Lake Wakatipu. While this is not expected to be the primary pathway of effect, consideration should also be given to whether nutrient inputs associated with the proposed discharge could have any implications for Lake Wakatipu under such conditions. Even if effects are ultimately determined to be negligible, the basis for that conclusion should be clearly documented.

4.3 The Surface Water and Groundwater Assessment

4.3.1 The author uses a novel approach to assess ammonia toxicity risk, and then incorrectly applies that approach.

The Surface Water and Groundwater Assessment adopts a novel approach to applying the National Policy Statement for Freshwater Management 2020 (NPS-FM 2020) ammonia attribute states. Rather than applying the published attribute state thresholds directly, the assessment modifies those thresholds to reflect seasonal pH and temperature conditions in the receiving environment. While I appreciate the rationale behind attempting to account for site-specific conditions, I have several concerns regarding the methodology and its application.

- First, the approach relies on a very limited dataset. The revised thresholds appear to be based on a single year of temperature and pH monitoring, which is then assumed to be representative of conditions over the full 35-year consent duration. Given the natural variability in river temperature and water quality over time, and the potential impacts of climate change, I am not convinced that this assumption is sufficiently robust to support long-term effects assessment.
- Second, the use of median seasonal temperature and pH values does not adequately account for the fact that even sporadically elevated temperatures and pH are relevant when assessing 95th percentile concentrations. Summer temperatures and pH in the Kawarau River can exceed the NPS-FM 2020 default values of 20°C and 8.0 respectively (as demonstrated by monitoring data attached to the Surface Water and Groundwater Assessment). Given this, there is little justification for applying thresholds derived from median summertime conditions to the assessment of 95th percentile concentrations.
- Third, the assessment results themselves appear to indicate exceedances of the adjusted summertime threshold corresponding to the NPS-FM 2020 A attribute state. However, this is not discussed.

Taken together, these issues indicate that the ammonia toxicity assessment presented in the Surface Water and Groundwater Assessment is not an appropriate basis for assessing potential ammonia-related effects, even before accounting for use of discharge volumes that are substantially lower than those sought under the proposed consent conditions. Accordingly, the assessment does not provide a reliable characterisation of the potential ammonia-related effects of the proposed discharge.

Note: *a back of the envelope calculation suggests that when the proposed effluent volume is considered, 95th percentile ammonia concentrations after the applicants definition of resemble mixing could approach 0.2 mg/L which far exceeds the relevant ANZG 99% species protection DGV.*

4.3.2 The risk of zinc toxicity effects is underestimated

It appears that the risk of zinc toxicity effects is significantly underestimated in the Surface Water and Groundwater Assessment. Specifically:

- Current exceedances of the ANZG 99% species protection threshold downstream of the proposed discharge are attributed to natural background concentrations, despite the available evidence suggesting they are a result of the emergency discharge. Mass-balance modelling is therefore not required to demonstrate that the discharge has the potential to cause significant zinc toxicity effects. The risk currently exists under the emergency and will likely increase under the proposed consent, which would allow a three-fold increase in zinc load (as a function of volume).
- The effluent zinc concentration used in the mass-balance assessment does not reflect:
    - The total or dissolved concentrations recorded on 22nd April 2026 (as suggested elsewhere in the report); or
    - The median or 95th percentile total zinc concentrations recorded in the effluent since October 2025 (as suggested elsewhere in the report).

  Indeed, the concentration adopted in the assessment is substantially lower than all of these values. Given the way the ANZG DGVs are applied (as 95th percentiles), and the high degree of solids removal achieved by the treatment process, I consider it would be appropriate to use the 95th percentile total zinc concentration recorded in the effluent since October 2022 (0.28 mg/L).

Note: *A back-of-the-envelope calculation suggests that, when both an appropriate effluent zinc concentration and the proposed discharge volume are used, 95th percentile zinc concentrations at the downstream boundary of the applicant's defined zone of reasonable mixing could exceed the ANZG 99% species protection threshold by a factor of approximately 4.5.*

4.4 The Periphyton Risk Assessment

4.4.1 Key issue

Aside from relying on the underestimated nutrient concentrations identified in the Surface Water and Groundwater Assessment, a key limitation of the Periphyton Risk Assessment is that it is informed by only a single round of periphyton and substrate monitoring.

Despite this very limited dataset, the assessment draws conclusions with a high degree of confidence regarding:

- The current extent of periphyton growth in the Kawarau River;
- The flushing flow requirements for the Kawarau River; and
- The extent to which flow conditions and bed substrate characteristics will prevent periphyton blooms resulting from increased nutrient concentrations under the proposed discharge regime.

In my view, these conclusions are not adequately supported by the available evidence. A single monitoring event does not provide a sufficient basis for assessing the spatial and temporal variability of periphyton growth, substrate conditions, or flushing flow dynamics within the river system. Consequently, the assessment does not provide a robust foundation for concluding that the risk of periphyton proliferation is low, and little weight should be placed on its findings until more comprehensive monitoring data are available.

4.4.2 Other Substantive Issues

I also have concerns regarding the following aspects of the Periphyton Risk Assessment:

- Generalised nutrient criteria have been used to assess periphyton growth risk. However, such criteria are of limited applicability downstream of wastewater treatment plant discharges, where elevated concentrations of ammoniacal nitrogen can produce a substantially greater periphyton growth response than would be predicted from TN concentrations alone.
- Flushing flows have been derived from bed substrate characteristics at RS10. However, aerial imagery indicates that bed substrate composition varies considerably within approximately 100 metres of that location, despite nutrient concentrations likely remaining broadly similar. It is not sufficient to demonstrate compliance with periphyton-related objectives at a single point below the zone of reasonable mixing; the assessment should consider potential effects across all downstream reaches that may be affected by the discharge.
- The assessment suggests at several points that low-flow conditions occur primarily during winter, when water temperatures limit periphyton growth. This is incorrect. As shown in Table 3.2 of the Surface Water and Groundwater Assessment, autumn flows are comparable to winter flows, while water temperatures during autumn have been recorded to exceed 15°C.
- The suggestion that jet boating is an important mechanism for controlling periphyton growth in the Kawarau River is not adequately supported. Such a conclusion would require substantial evidence, including peer-reviewed research, data on boat traffic frequency and intensity, and a significantly larger body of periphyton monitoring data.
- The assessment also suggests that light availability may limit periphyton growth. However, there is insufficient evidence to support this claim. Only five water clarity measurements were collected, and three of those exceeded the maximum length of the clarity tube.

It is important to note that I am not suggesting there is necessarily a high risk of periphyton proliferation. Rather, my concern is that the applicant has not provided sufficient evidence to support its conclusion that the risk is low.

4.5 Ecological Impact Assessment

I have no substantive concerns regarding the methodology adopted in the Ecological Impact Assessment itself. However, because the assessment incorporates the findings of both the Surface Water and Groundwater Assessment and the Periphyton Risk Assessment, it cannot be considered a robust assessment of the likely effects of the proposed discharge.

In particular:

- The assessment relies on underestimates of future contaminant concentrations. As a result, it is likely to underestimate the potential risks associated with ammonia and zinc toxicity.
- The assessment incorporates the conclusions of the Periphyton Risk Assessment, despite those conclusions being based on a limited dataset and therefore lacking sufficient reliability.

Accordingly, the Ecological Impact Assessment does not provide a sufficiently robust basis for assessing the full ecological implications of the proposed discharge.

5 Are there any other matters that appear relevant to you that have not been included? Or is additional information needed? Please specify what additional info you require and why?

5.1 Surface Water and Groundwater Assessment

- Please re-run the mass balance assessments using the actual discharge quality and discharge volumes sought through the application, including measured effluent zinc concentrations. The assessment should also evaluate resulting 95th percentile ammonia concentrations against the NPS-FM 2020 default A Attribute State thresholds (see Section 4.1.2 for reasoning).
    - Please provide a detailed assessment of current and future external nutrient loads to Lake Dunstan, including the potential for nutrients discharged to the Kawarau River to be transported into Lake Wakatipu (see Section 4.2 for reasoning).
    - Please develop a synthetic flow record for the Kawarau River upstream of the proposed discharge location by adjusting the Chard flow record to account for inflows from the Shotover, Arrow and Hayes catchments (needed to inform the periphyton risk assessment).
    - Bathymetric surveys were undertaken at flow conditions substantially above MALF. Please explain whether the dispersion modelling is suitable for predicting peak contaminant concentrations under late summer and autumn low-flow conditions (needed to understand whether the mass-balance approach used I suitable for predicting peak concentrations during very low flows).
    - Section 6.5.4 states:

      "*The dispersion modelling considers peak dry weather discharge rates, into low flow conditions of the Kawarau and Kimiākau/Shotover Rivers. Higher rates of discharge are expected to occur during wet weather periods, as a result of inflow of stormwater into the wastewater network. These conditions are created during periods of significant stormwater and catchment run-off, and so coincide with periods when river flows are higher*."

      Please provide further justification for this statement. In particular, winter rainfall may generate infiltration and inflow (I&I) to the wastewater network without a corresponding increase in flows in the Kawarau or Shotover Rivers where precipitation in the upper catchment falls predominantly as snow (needed to understand the extent to which mass-balance results are conservative).
    - With respect to Table 6.3, please explain why the ammonia results have been assessed as complying with the revised NPS-FM 2020 A Attribute State thresholds when the reported 95th percentile concentration exceeds the summertime threshold (needed to understand toxicity risk).
    - Please explain why the first round of zinc monitoring undertaken on 22nd April has not been discussed in the report, given the elevated concentrations recorded at surface water monitoring sites (needed to understand current toxicity risk).
    - With respect to Tables 6.5 to 6.7, please explain why the use of median total metal concentrations is considered conservative for copper and zinc, having regard to (needed to establish whether mass-balance approach is consistent with national guidance):
        - The effectiveness of the wastewater treatment process in removing particulate-bound contaminants;
        - The fact that ANZG default guideline values (DGVs) are assessed using 95th percentile concentrations; and

- The observation that, on 22nd April, dissolved copper and dissolved zinc each comprised approximately 70% of their respective total concentrations.

5.2 Periphyton Risk Assessment

- Please update the Periphyton Risk Assessment when sufficient data become available to support a robust assessment. The revised assessment should incorporate updated contaminant concentration estimates from the Surface Water and Groundwater Assessment, and consider the risk to reaches downstream of RS10 (see Section 4.4 for reasoning).
- Please provide references supporting the shear stress methodology adopted in the assessment, including examples of its application for determining flushing flows in comparable river systems (needed to establish the methodology for establishing flushing flows is appropriate).
- Please explain why no assessment has been provided of periphyton accrual risk during autumn, when river flows are often low, but water temperatures remain conducive to periphyton growth (needed to understand periphyton growth risk).
- Please justify the use of national-scale nutrient criteria for assessing periphyton growth risk in the vicinity of a wastewater discharge. In particular, please explain why criteria developed for broader receiving environments are appropriate where elevated ammonia-to-nitrate ratios may influence periphyton growth responses (needed to understand periphyton growth risk).

5.3 Ecological Impact Assessment

- Please update the Ecological Impact Assessment to incorporate any revisions arising from the requested updates to the Surface Water and Groundwater Assessment and the Periphyton Risk Assessment (see Section 4.1.2 for reasoning).
- Please provide review the requested nutrient load analysis for Lake Dunstan and Lake Wakatipu and provide a robust, fulsome effects assessment for these water bodies (see Section 4.2 for reasoning).
- With respect to Section 4.2.4.3, please explain why measured exceedances of the ANZG 99% species protection guideline value resulting from the existing emergency discharge to the Shotover River have not been considered as evidence that zinc toxicity effects could occur under the proposed discharge regime (needed to understand current toxicity risk).
- With respect to Section 7.4.2:
  - Please explain how the Shotover River is considered to generate frequent flood events in the Kawarau River when the Surface Water and Groundwater Assessment indicates that flows exceeding three times the median flow occur less than once per year (needed to understand periphyton growth risk).
  - Please explain the basis for attributing elevated zinc concentrations downstream of the Shotover River to natural catchment mineralogy where upstream concentrations are reported as below detection limits and the wastewater discharge contains zinc concentrations of up to 0.4 mg/L (needed to understand current toxicity risk).
- With respect to Section 8.2.2.2, please expand on the rationale for not undertaking biomass monitoring. In particular:
  - Given that any response to a periphyton-related issue would likely involve engineering investigations, design, upgrades and potentially further consenting processes, please explain how laboratory processing times for biomass analysis would materially delay management responses.

- Please explain why a single instance of low periphyton cover, recorded prior to full implementation of the proposed discharge regime, should inform the design of long-term monitoring requirements.

6 If granted, are there any specific conditions that you recommend should be included in the consent?

It is not possible to answer this question until the effects of the proposed discharge are better understood.

7 Do you agree with the Applicant's assessment of effects on the discharge component of the application?

No, for the reasons described in Section 4 above. I consider that the discharge poses a greater risk of adverse effects on aquatic life than is suggested by the Applicant. Specifically, my initial calculations suggest that there is a risk of significant adverse effects arising from zinc and ammonia toxicity, even with the exceptionally long zone of reasonable mixing proposed by the Applicant. However, I require the information requested from the Applicant in Section 5 to confirm this position.

8 Have the cumulative effects of the discharge activity been appropriately assessed?

No. There is limited potential for cumulative effects in the immediate receiving environment due to the limited level of development in the upstream catchment. However, as set out in Section 1.2, the Applicant's assessment of effects on Lake Dunstan is wholly inadequate, and in Section 2 above I have requested that this be remedied.

Prepared by:

Dr Michael Greer
Principal Scientist, Director
Torlesse Environmental Ltd
M: +64 (27) 69 86 174
4 Ash Street, Christchurch 8011