MEMORANDUM **Job 11076**

To:	Jon Williamson, WWLA
From:	Stefi Romero, Brian Ellwood, and Katie Beecroft, LEI
Date:	10 August 2026
Subject:	Treated Wastewater Cascading Wetland for Milldale Stages 14-17 Report Review

This memo provides LEI's review of the revised WWLA technical report for the proposed treated wastewater cascading wetland for Milldale Stages 14–17.

INTRODUCTION

LEI has reviewed the revised WWLA technical report titled *Treated Wastewater Cascading Wetland – Milldale Stages 14–17 Fast-Track*, Rev. 2, dated 10 August 2026. This review has considered whether the report provides sufficient information to support the treatment wetland concept's feasibility. It is not intended to confirm design details or to provide a quantitative assessment of discharge quality. Geotechnical stability and construction design are outside the scope of this review.

The revised report provides useful additional detail of the proposed cascading wetland, including site-specific phosphorus sorption testing, hydraulic residence time assessment, wetland establishment requirements, maturation, algal monitoring and a framework for an Operation, Maintenance and Monitoring Plan (OMMP).

Overall, LEI considers the concept to be technically feasible and broadly consistent with constructed wetland treatment principles. The remaining issues are the degree of certainty placed on predicted phosphorus and nitrogen removal before the wetland has been constructed, commissioned and monitored under field conditions.

KEY REVIEW FINDINGS

We consider that the use of a cascading wetland structure provides an opportunity for a low-input, nature-based system that can be adapted to provide further treatment or polishing of wastewater. Better wastewater quality and physical diffusion can be anticipated to improve the discharge. We note that the wetland inlet concentration of the wastewater is low and the proposed WWTP is designed to provide highly treated wastewater prior to discharge.

The concept described provides a range of treatment zones expected to result in transformation and removal of a number of chemical and biological contaminants prior to eventual discharge to surface water. Specific technical comments previously raised by LEI and relating to treatment and discharge performance have largely been addressed. The residual matter for the assessment is uncertainty around full-scale wetland performance over time.

Outstanding areas of differing opinion are; uncertainty over the long-term performance, and the ability to achieve the reported levels of phosphorus reduction. The risk associated with these matters is potential future non-compliance with discharge quality limits, including receiving water standards. The revised report acknowledges uncertainty in the areas of; long-term phosphorus performance, wetland maturation, algal dynamics, monitoring and the role of an OMMP. LEI considers that this is appropriate.

LEI has considered the question "are there practical and achievable options to manage the remaining uncertainty?". LEI considers that the residual uncertainty can be managed through detailed design, commissioning, monitoring and adaptive management. The OMMP framework outlined in Section 5.1 of the WWLA report provides a practical management tool that requires monitoring for detection, clear monitoring locations, baseline confirmation, trigger levels, response actions, review timeframes, and reporting requirements.

We further recommend that predicted treatment performance should be presented as expected performance requiring verification, rather than as a certain outcome. This applies particularly to long-term phosphorus retention, nitrogen removal and effective hydraulic residence time.

LEI has considered the question "can the risk due to lower treatment performance from the wetland be mitigated or avoided?" Feasible adaptive response options are available if monitoring identifies elevated phosphorus, nitrogen or other performance issues. These include optimising the upstream treatment plant, chemical phosphorus removal before discharge to the wetland, flow redistribution, increased residence time, resting or rotating parts of the wetland, targeted sediment management, reactive media polishing, and alternative discharge durations during higher-risk periods with storage or water reuse.

1. TREATMENT PERFORMANCE

The revised report predicts removal rates for nitrogen, phosphorus, pathogens and other contaminants using literature-derived removal efficiencies and site-specific information.

However, constructed wetland performance is influenced by hydraulic loading, flow distribution, residence time, vegetation density, nutrient speciation, wetland maturity, carbon availability and seasonal conditions. For that reason, the predicted removal rates should be described as expected outcomes to be verified through monitoring.

2. PHOSPHORUS RETENTION AND LONG-TERM PERFORMANCE

The site-specific phosphorus sorption testing demonstrates that the native soils can adsorb phosphorus under laboratory conditions. This supports the use of the wetland as a polishing system, but it does not remove the need to verify field-scale performance.

Phosphorus retention will only occur where wastewater is in effective contact with reactive soil or sediment surfaces. LEI's previous screening calculation, based on a 100 mm reactive contact depth, indicated a finite storage capacity of approximately 788 kg P/ha per 100 mm of soil. For a 3.5 ha system receiving approximately 485 kg P/yr, this equates to about 5.7 years of storage per 100 mm of effective reactive soil depth.

The revised WWLA report adopts a deeper active soil depth than 100mm and identifies additional biological and soil processes that may extend performance. LEI agrees those processes may contribute to treatment, but the magnitude and persistence of that contribution cannot be confirmed until the wetland is operating. Phosphorus removal should therefore be presented as an expected performance range, supported by monitoring and contingency measures.

Monitoring should include influent and effluent phosphorus concentrations, downstream receiving environment monitoring, checks for phosphorus accumulation in wetland soils or sediments, and inspection of flow paths to confirm that short-circuiting is not occurring. If elevated phosphorus is identified, response options are available, which include upstream treatment optimisation, chemical phosphorus removal, targeted sediment management, reactive media polishing or changes to discharge duration.

3. NITRATE REMOVAL ASSESSMENT

The proposed TN removal rate of 85% appears to be at the higher end of expected performance and should be treated as an expected outcome requiring verification.

The report correctly identifies nitrification and denitrification as key removal mechanisms and acknowledges that denitrification will rely largely on internally generated carbon from wetland vegetation and accumulated organic matter. The availability and persistence of bioavailable carbon will be important, particularly because the wastewater is already highly treated and has a relatively low organic carbon load. The design incorporates multiple aerobic and anaerobic zones that support nitrification and denitrification.

Given the uncertainty associated with predicting nitrogen removal in a proposed wetland system from the already highly treated wastewater, monitoring and adaptive management measures should be designed to verify whether the assumed TN removal rates are achieved in practice and to identify any management actions that may be required if removals are lower than anticipated.

4. HYDRAULIC RESIDENCE TIME

The report calculates a hydraulic residence time (HRT) of approximately 8–9 days based on the estimated storage volume of the wetland system.

Hydraulic residence time design is supported, it is a key factor influencing the high constructed wetland performance, as sufficient contact time is required to support physical settling, microbial transformations, nutrient uptake and other attenuation processes.

In practice, effective residence time may differ from the theoretical value due to factors such as preferential flow pathways, hydraulic short-circuiting, variable water levels and increased inflows during wet weather conditions. These factors may influence the extent to which the wetland achieves the assumed treatment performance.

LEI also acknowledges that the full design wastewater flow will not occur from the start of discharge. As development progresses, lower initial flows are expected to provide a longer effective HRT than in the full design case. This staged loading period provides a useful opportunity to verify wetland treatment performance, confirm flow distribution and residence time, and implement any system adjustments through the OMMP framework before full design flows are reached.

The OMMP should also include assessment of flow paths through the wetland to confirm that short-circuiting is not occurring. This is particularly important because effective contact time may be lower if flow becomes concentrated through preferential pathways. Periodic visual inspections and flow distribution checks would assist in confirming that the wetland is operating as intended.

5. CONCLUSIONS REGARDING COMPLIANCE

The report concludes that the wetland will comply with WEPS concentration limits and provides strong statements regarding contaminant attenuation and long-term treatment performance.

Given that these conclusions are based on predicted rather than measured wetland performance, it would be more appropriate to state that modelling indicates the system is expected to comply for most parameters, subject to verification through monitoring once the wetland is operational.

Phosphorus compliance remains uncertain because the assumed 95-97% TP removal relies on finite soil adsorption capacity, effective hydraulic contact with reactive soil, and the absence of preferential flow or short-circuiting. Similarly, the predicted TN removal rate of 85% is based primarily on literature-derived removal efficiencies and remains subject to uncertainty associated with carbon availability, vegetation establishment, and seasonal impacts.

Compliance for TP and TN should therefore be verified through operational monitoring and supported by clear adaptive management triggers. This approach would align more closely with the proposed monitoring programme and acknowledge the inherent uncertainty associated with predicting treatment wetland performance prior to operation.

Our conclusion is that the proposed wetland is expected to provide nutrients attenuation, but that the degree and long-term consistency of phosphorus and nitrogen removal require confirmation through monitoring once the system is operational.

OVERALL COMMENTS

Overall, LEI considers the proposed cascading wetland to be technically feasible and supported by credible treatment mechanisms for polishing the highly treated wastewater.

The main residual issue is uncertainty around the degree and long-term consistency of phosphorus removal once the system is operating at full scale. That uncertainty does not necessarily prevent the proposal from progressing, but it should be expressly acknowledged in the consent documentation.

LEI also notes that wastewater flows will increase gradually as development staging progresses, which should provide a longer initial HRT and a practical period for performance verification and system adaptation through the OMMP framework before full design flows are reached.

LEI considers the residual uncertainty can be managed through a detailed OMMP, provided it includes clear monitoring locations, trigger levels, reporting requirements and practical contingency measures. These should include options to optimise upstream treatment, add phosphorus removal, redistribute flows, adjust discharge duration, manage sediments, or provide additional polishing if monitoring shows performance is below predicted levels.

Statement of Qualifications and Experience

Authors

<u>Author 1</u>

My full name is Stefi Romero.

I am an Environmental Scientist at Lowe Environmental Impact Limited. My PhD research focused on nitrate attenuation from drainage water associated with wastewater land treatment systems, including the use of woodchip bioreactors to support denitrification and nitrogen removal. My technical experience includes environmental monitoring, GIS, field investigations, nitrate pollution mitigation, environmental compliance, data interpretation, soils research, field instrumentation, and soil and water dataset interpretation.

My experience relevant to this project includes wetland-related environmental monitoring, nutrient removal assessment, interpretation of soil and water quality data, GIS analysis, and support for wastewater, land treatment and nutrient-related assessments. This experience is relevant to the review of predicted wetland treatment performance because it includes assessment of nutrient attenuation, environmental monitoring data, and site factors that influence treatment outcomes.

Recent relevant project experience includes GIS and analysis work for biosolids mapping, land treatment and wastewater-related projects, soil and water investigations, nitrate mitigation workstreams, environmental compliance assessments, and interpretation of field datasets.

<u>Author 2</u>

My full name is Brian Neil Ellwood.

I am a Director and Senior Environmental Engineer at Lowe Environmental Impact Limited. I hold a Bachelor of Technology with Honours in Environmental Engineering and a Master of Applied Science with Honours in Agricultural Engineering from Massey University, a Graduate Certificate in Irrigation from Charles Sturt University, an Advanced Certificate in Sustainable Nutrient Management in New Zealand Agriculture from Massey University, and Project Management Professional accreditation from the Project Management Institute. I have 28 years of professional experience relating to nutrient and water management, irrigation scheme assessment, environmental impact assessment, site investigation and monitoring, project management, resource consenting, and expert evidence.

My experience relevant to this project includes wastewater treatment and land treatment assessments, nutrient removal and attenuation assessment, constructed wetland and nature-based treatment review, water and nutrient balance assessment, land application strategy development, resource consent applications, technical audits, expert conferencing, hearing evidence, condition drafting, and detailed design review for wastewater and land treatment systems.

This experience is directly relevant to the review of the proposed cascading wetland because the review required assessment of predicted treatment performance, nitrogen and phosphorus removal assumptions, hydraulic residence time, monitoring requirements, and adaptive management options for wastewater polishing systems.

Recent and relevant project experience includes wastewater land application, long-term nutrient management and land treatment assessments for developments and community schemes in Queenstown Lakes, Selwyn, Cardrona, Hawea, Gibbston Valley, Homestead Bay, Coleridge Village, Castle Hill, and other New Zealand locations.

Author 3

My full name is Katie Beecroft.

I am a Senior Environmental Scientist at Lowe Environmental Impact Limited. I hold a Master of Science with Honours in Earth Science and a Bachelor of Science in Earth Science from the University of Waikato. I am a member of Water New Zealand, the New Zealand Soil Science Society, and the New Zealand Land Treatment Collective.

My experience relevant to this project includes wastewater treatment and land treatment assessment, nutrient removal and attenuation, geology, soil science, soil chemistry, hydrogeology, geochemistry, site assessment and soil survey, land treatment of liquid and solid wastes, contaminated site assessment and management, nutrient management, land application feasibility assessment, wastewater discharge option assessment, soil mapping, soil water characterisation, and interpretation of soil and environmental constraints for land-based treatment systems.

This experience is directly relevant to the review of the proposed cascading wetland because it includes assessment of nutrient removal mechanisms, phosphorus retention, soil and sediment treatment processes, hydraulic and soil constraints, monitoring requirements, and the practical performance limitations of land-based wastewater treatment systems.

Recent relevant project experience includes municipal wastewater land discharge assessment and optioneering for South Wairarapa, Central Hawke’s Bay, Ruapehu, New Plymouth, and other land treatment and wastewater discharge projects.

Reviewer Qualification

Katie Beecroft undertook the final technical review.