Expression of Interest

Working Group: Mapping Freshwater Contaminants from Source to Sink

Background

The Our Land and Water National Science Challenge (Toitū te Whenua Toiora te Wai) (OLW) has a vision which looks to a future where catchments contain mosaics of land uses that are more resilient, healthy and prosperous than today. This is a future in which all New Zealanders can be proud of the state of our land and water and share the economic, environmental, social and cultural value that te Taiao offers.

Te Taiao is the environment that contains and surrounds us. It has four major components, Whenua (land), Wai (water), Āhuarangi (climate) and Koiora (all living communities). It encourages us to aspire to a future where humanity and the natural world sustain each other in an interconnected relationship of respect.

OLW and MfE have called for the following scope for an expression of interest to be developed to inform both national and local government policy and planning on the management of the fate of freshwater contaminants, specifically nitrogen and phosphorus species, sediment, and microbes in our environment.

The work is to be conducted within the Future Landscapes theme of OLW, which has a 2024 impact goal that "decisions on land-use change and management practises can be made with confidence that they will lead to improvement in te Taiao", and by 2030 "the vitality of te Taiao is improving in response to our decisions as land stewards" (see Research Workplan Update 2020, ourlandandwater.nz/workplan-pdf).

MfE requires information to support the Essential Freshwater work programme. This includes future policy analysis and options development, as well as implementation of existing policy like the National Policy Statement – Freshwater Management (NPS-FM). Policy options must have robust enough information to evaluate likely system transition and subsequent operational pathways. Principles of Te Mana o te Wai and Te Tiriti o Waitangi play critical roles in this process.

Regional councils are required to work with their communities to set limits through their regional plans incorporating NPS-FM attributes by 2024. To achieve this target, they require some certainty about available tools, national direction, and any agreed Crown-Māori approach. To assist this process, MfE needs to better understand the landscape properties critical for fine spatial scale contaminant risk assessments. This includes investigation of current data availability, data limitations/uncertainties to support the resource management policy making process at the national and local levels. Therefore, work needs to:

- Provide MfE with better landscape biogeochemical information in relation to contaminant risks, for the use of various policy option assessments. Local government would benefit from this information to operate management scenarios at a catchment to farm scale.
- Provide information on current data availability and associated uncertainty at various spatio-temporal resolutions. Report the geographic heterogeneity of this information, to inform sensitivity analyses of data quality on the application of different policy needs.
- Be cognizant of current efforts around catchment modelling, land use suitability assessments, lag times and assessments of assimilative capacity leveraging these where possible.

MfE would like to test data fitness on the policy options related to water quantity and contaminant discharge. Input into these data requirements is to be met through this mapping project programme.

As part of its Future Landscapes research theme, OLW is establishing a Working Group to map and classify New Zealand landscapes according to their nutrient (nitrogen and phosphorus species), pathogen, and sediment delivery from source to sink. The classification will inform the policy-making process by displaying the heterogenic diffuse contamination risks.

Timeframe and Budget

Up to $2,000,000 will be allocated among the working group as determined by the Lead Contractor to undertake this project over a term of 30 months between January 2021 and June 2023.

Summary of Deliverables

- National Landscape Classification for Freshwater Management – including contaminant flow-paths and attenuation coefficients
- National maps of groundwater redox and denitrification potential
- National maps of attenuation coefficients for nitrogen and phosphorus species, sediment, and microbial contamination
- Assessment of uncertainties and information gaps in the above deliverables
- Recommendations of data availability regarding spatial and temporal resolution needs

Project timeline and workstream deliverables are summarised in Figure 1. Further detail is provided on each of the proposed workstreams in Appendix I.

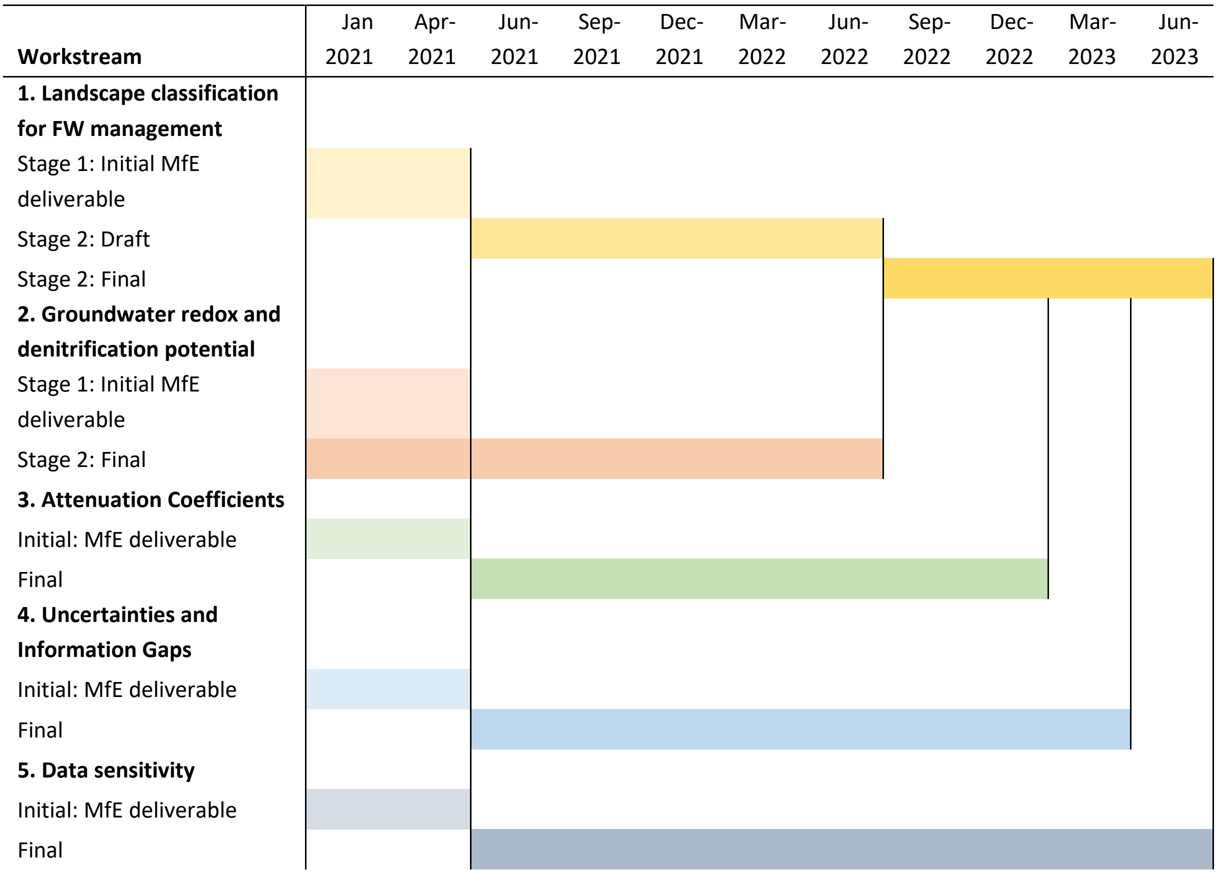

Figure 1. Gantt chart of the project timeline.

Eligibility Criteria of Working Group Members

Applicants must have a willingness to collaborate in mission-led research and take a multi-disciplinary, co-innovation approach that has te ao Māori at its centre.

The intention is to form a team of individuals who hold a diverse, yet relevant, skill/competency set that includes knowledge about:

- The current freshwater issues and management frameworks in New Zealand and/or overseas
- The principles of Te Mana o Te Wai
- Freshwater values (including ecological, recreational and cultural values) and linked attributes and indicators
- Groundwater denitrification potential
- Contaminant attenuation coefficients
- Groundwater–surface water interactions
- Contaminant transfers in landscapes

Collectively the team should have skill sets to map and classify New Zealand landscapes according to their contaminant delivery from source to sink.

Guiding Principles

The proposal must follow the following guiding principles and considerations:

1. The work must recognise Te Mana o te Wai. Upholding Te Mana o te Wai requires prioritising the health and wellbeing of water first. The second priority is the health needs of people (such as drinking water) and the third is the ability of people and communities to provide for their social, economic and cultural wellbeing.
2. The work must recognise the interactions, ki uta ki tai (from the mountains to the sea) between freshwater, land, associated ecosystems and the coastal environment.
3. The work must recognise that Te Mana o te Wai incorporates a range of "shared values" (of tangata whenua and the wider community) in relation to each water body.
4. The mapping and resultant classification must account for multi-contaminants, specifically nitrogen and phosphorus species, sediment, and microbes.
5. It should identify scalability, limitations and uncertainties of the framework within and across catchments and regions.
6. All outputs and data are to be open source.

Additional Considerations:

7. <u>Legislative framework</u>: It is recognised that the legislative framework is fast evolving, which creates uncertainty. The work should be consistent with the requirements of the freshwater legislation in force at the time of writing the outputs.
8. <u>End users/Audience</u>. The Landscape Classification Framework should be accessible and usable by a range of end users. To that end, the framework may include several "levels" of detail to suit the needs of different end users.
9. <u>Use of data</u>: The Landscape Classification Framework must consider how the information and data are handled, analysed, reported and communicated in a way it can guide decision-making for resource management.

10. Time scale: The Landscape Classification Framework should be useable on at least an annual timestep.
11. Spatial scale: The Landscape Classification Framework should be able to function at different scales, from sub-catchment to whole of FMU or catchment. It must provide guidance with regards to the appropriate scale at which modelling approaches are most suitable.
12. Sources of uncertainty: The Landscape Classification Framework should identify where possible, quantify sources of uncertainty, including (but not limited to) in modelling methods and measurements, attenuation quantification, and temporal analyses.
13. Data quality: The work must consider data quality (quality control and quality assurance) and provide explicit guidance as to the usability of various data.
14. End user engagement: The programme needs to identify and engage with potential key users of the science. OLW will help determine and establish some key connections.

MfE requirements for specific catchments for having enough relevant data

The following provides a list of catchments the Scoping Group recognised as potential data scalability analysis test sites. These catchments are recommended as they have enough data to test, but do not represent an exhaustive list. Others may be better suited and may be included in the work.

- Manawatu
- Reporoa
- Ruamahanga
- Wairoa, Northland
- Southland Central Plains
- Regions already hydrochemically calibrated to PENZ (Northland, Auckland, Waikato, Bay of Plenty, Manawatu-Whanganui, Canterbury, and Southland)

What Happens Next

OLW has appointed Dr Lisa Pearson (Land and Water Science) as the Lead Contractor, who will manage the programme of work and bring together a team of about 8 technical experts to collaborate to deliver the work. Expressions of interest should be made via email to ourlandandwater@agresearch.co.nz by **9am on the 14th of December 2020**.

If you require any further information regarding this EOI, please contact:

- Lisa Pearson (Lead Contractor) lisa@landwatersci.net (022 0199799)
- Dave Houlbrooke (Theme Leader 'Future Landscapes' – OLW) David.Houlbrooke@agresearch.co.nz (027 4544630)
- Richard McDowell (Chief Scientist – OLW) richard.mcdowell@agresearch.co.nz (021 569680)

Expressions of Interest should provide a CV and brief description of relevant technical experience including evidence of collaboration, delivery and impact.

We expect to notify people of the outcome of the selection process in mid-December with Land and Water Science commencing with contracting the successful individuals for the Working Group as soon as practical afterwards. OLW will put you in touch with Lisa Pearson for this process.

Appendix I: Detailed Workstream Scope

Workstream 1: Landscape Classification for Freshwater Management

Aim: An overarching landscape classification to support national-scale contaminant risk assessment for policy option developments.

Stage 1. Identify catchment characteristics to support MfE's landscape contaminant risk assessment needs

Scope: Use of existing landscape classifications and water quality and flow measures to support immediate analytical needs for MfE.

The landscape classification will be used to provide an assessment of the attributes relevant to water quality for selected catchments. This includes an ability to compare the climatic, hydrological, redox, weathering (physical and chemical) character, background reference conditions (Australian and New Zealand Governments 2018), and quantitative and/or qualitative attenuation of freshwater. When integrated with land use and land cover, the classification will provide direct context to MfE's catchment scale analysis. This work will require recalculation of background reference conditions using the most recent data.

Timeframe: Delivery April 2021.

Data inputs: Existing landscape classifications, flow and contaminant discharge data for MfE's analytical needs.

Stage 2. Landscape Classification for Freshwater Management

Scope: Update and refine landscape classifications based on input from other workstreams (workstreams 2 and 3) and including feedback from OLW, stakeholders, and end users. Landscape classification aims to include attenuation and/or export coefficients and background reference conditions for all water quality contaminants.

In collaboration with stakeholders, identify limitations and data gaps in current landscape classifications and recommend areas to prioritise where new in-field observations and modelling is required to aid in the prediction of contaminant (N and P species, SS, E. coli) flow-paths and their potential attenuation. Prioritisation of regions for development is dependent upon diversity of landscapes, pressure (environmental and productive) and political push. Phasing and iterations compatible with sample throughput are also likely. Classes are to be designed with key stakeholders to ensure that they can be used in farm to catchment to regional/national scale tools (e.g. Overseer, LUCI, MitAgator) and policy scenarios.

For final deliverable, integrate information developed in the other workstreams into the Landscape Classification for Freshwater Management framework to inform MfE's needs.

Timeframe: Draft landscape classification framework for end user feedback delivery June 2022 and Final Landscape Classification delivery June 2023.

Data inputs: All workstreams integrated into a spatial landscape classification system, updated hydrochemical and water quality data, and high-resolution spatial data.

Workstream 2: National-scale maps of Groundwater Redox and Denitrification Potential

Aim: Refine and improve a national-scale landscape classification with a specific focus on groundwater redox and denitrification potential.

Stage 1: Improve existing groundwater redox map to inform catchment characteristics to provide for MfE's policy assessment needs

Aims: Use of existing groundwater redox classifications and water quality and flow measures to support MfE policy development.

Scope: Improve national groundwater redox map by incorporation of additional existing data layers that have shown promise in other landscape classification assessments. Additional soil layers such as cracking soils, artificial drainage, and depth to groundwater levels. Additional data that may require further processing can be incorporated as stage 2 of this workstream. Discuss with stakeholder (MfE) to consider focused study approach based on the fitness of available data.

Timeframe: April 2021.

Data inputs: Phase 1 OLW research outputs and other existing data sets.

Stage 2. Update groundwater redox model using existing landscape classifications and new observations

Aims: Delivery of an integrated model to map redox status and denitrification potential for groundwater.

- Test, integrate, and improve the spatial resolution and accuracy of the current groundwater redox model using existing landscape classification assessments and new observational data
- Identify and prioritise areas for further investment

Scope: Spatial comparison and integration of existing landscape classification assessments, for example, the OLW funded Phase 1 outputs including national-scale groundwater redox model (Wilson et al., 2020), Massey University's Farmed Landscape Research Centre's sub-surface nitrogen attenuation mapping (Singh et al., 2019), and Land & Water Science's physiographic classification of the landscape attributes that govern redox gradients (Rissmann et al., 2019).

- Collaborative design of a refined groundwater redox criterion that identifies which layer to use where based on considerations of a) the classification target (i.e. shallow aquifer coupled to stream vs deeper groundwater), and b) data richness/sparsity (excess N_2, push-pull denitrification tests, redox assignment data in ground and surface water) and relevance of the data to the classification target.
- Identify critical methodological and/or relevant data limitations and specify improvement pieces (e.g., groundwater flux, water table layer, confinement status, lack of relevant measurement data) for next steps.
- Collate and incorporate new information into the outputs from above. This could include the status of subsurface nitrate reduction (i.e. complete 'benign' or in-complete denitrification), groundwater table (unsaturated zone lag) and flux layers to augment the Stage 1 groundwater redox layer into a national-scale groundwater redox and nitrogen attenuation potential layer. This stage of work could include both quantitative and semi-quantitative assessment of subsurface denitrification rate (groundwater surveys and in-field experiments), groundwater table (unsaturated zone lag) and groundwater flux, where:

- Catchments with available nitrogen attenuation measures and groundwater transport models will be used to provide quantitative constraint over nitrogen attenuation rates, groundwater table (unsaturated zone lag), travel times and groundwater flow paths relevant to a given classification target (e.g. surface water)
- Semi-quantitative representation of likely nitrogen attenuation rates, groundwater table (unsaturated zone lag), travel times and groundwater flow paths will be developed for catchments without available nitrogen attenuation measures and groundwater models. Semi-quantitative representation of nitrogen attenuation rates may be based on redox poise (buffering), availability of electron donors and likely groundwater flux (high, medium, low).

- Identification of priority areas (and preliminary sampling) for investment in the measurement of groundwater denitrification processes and rates (push-pull tests in shallow groundwaters), excess N_2 and age dating.

Data inputs: Phase 1 research, new observations, and Stage 1 results from both Workstreams.

Timeframe: Deliverable June 2022 for integration into Workstream 1.

Workstream 3: National-scale maps of Contaminant Attenuation Coefficients and lag times

Aim: Modelling derived attenuation coefficients for N and P species, *E. coli* and sediment relevant to both surface and groundwater.

Scope: Use national-scale landscape classification assessments (Workstream 1 and 2 above), land use pressure and Land Air Water Aotearoa (LAWA) surface water monitoring sites and groundwater sites nationally to generate quantitative scores of attenuation rates and lag times for each main water quality contaminant.

- Develop or source a refined land use loading model to provide a quantitative estimate of land use pressure
- Use LAWA or equivalent surface water and groundwater monitoring networks to assess the difference between projected and actual load over time for N and P species, sediment, and *E. coli* thereby quantifying lag times between land use pressure and loads
- Quantify contaminant attenuation rates/coefficients in surface and groundwater and between surface and groundwater as a function of landscape classification (i.e. workstream 1)
- Assess the sensitivity of landscape factors over contaminant attenuation at catchment, regional and national scales and note differences associated with different pressures (e.g. land use and climatic history) and edaphic characteristics (e.g. geological)

Data inputs: Workstreams 1 and 2; relevant land use/management information (land pressures).

Timeframe: Initial estimates to support deliverables to MfE April 2021, Final estimates December 2022.

Workstream 4: Uncertainties and information gaps

Aim: To provide an assessment of likely uncertainties associated with the predictions of contaminant reductions for the different classes in the landscape classification.

Scope: Produce a combined assessment of likely uncertainties associated with the national-scale landscape classification, groundwater redox, and attenuation coefficients. Identify limitations and considerations for use. Recommend additional work to reduce uncertainty and information gaps.

Data inputs*:* Workstreams 1–3, other relevant investigations.

Timeframes: Initial to accompany catchment assessment to MfE April 2021, updated for final classification delivery March 2023.

Workstream 5: Examine data sensitivity in spatial and temporal scale

Aim: Assess sensitivity of spatial and temporal data resolution to provide for statistical uncertainties of policy considerations.

Scope: Using estimates of national-scale contaminant attenuation coefficients and their uncertainty at increasingly finer scales, assess the best approach to utilize the data on policy and provide information of uncertainty and data-use confidence level in various spatio-temporal resolutions. Identify the heterogeneity of such uncertainty and provide catchment specific technical limitation through discussion with MfE for their policy data needs.

Data inputs: All workstreams.

Timeframes: Initial (April 2021) and Final version (June 2023).

Relevant publications

Australian and New Zealand Governments 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Canberra, ACT, Australia, Australian and New Zealand Governments and Australian state and territory governments.

Rissmann, C.W.F., Pearson, L.K., Beyer, M., Couldrey, M.A., Lindsay, J.L., Martin, A.P., Baisden, W.T., Clough, T.J., Horton T.W., and Webster-Brown, J.G. (2019). A hydrochemically guided landscape classification system for modelling spatial variation in multiple water quality indices: Process-attribute mapping. Science of the Total Environment 672: 815-833. https://doi.org/10.1016/j.scitotenv.2019.03.492.

Singh, R., Horne, D., 2019. Water quality issues facing dairy farming: potential natural and built attenuation of nitrate losses in sensitive agricultural catchments. Animal Production Science 60(1), 67-77. https://doi.org/10.1071/AN19142

Wilson, S., Close, M., Abraham, P., Sarris, T., Banasiak L., Stenger, R., Hadfield, J. 2020. Achieving unbiased predictions of national-scale groundwater redox conditions via oversampling and statistical learning. Sci. of the Total Env. 705: 135877.