DEFINING GROUNDWATER PROTECTION ZONES FOR WELLINGTON WATER IN THE HUTT VALLEY AQUIFER

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ABSTRACT

Wellington Water Ltd operate two major drinking-water supply wellfields near the coastal end of the Hutt Valley (Waterloo wellfield and the Gear Island wellfield). These bores abstract water from the highly permeable Waiwhetu gravel aquifer derived from the Hutt River. Greater Wellington Regional Councils' (GWRC) Proposed Natural Resources Plan specifies Groundwater Protection Zones (GPZs) for these bore supplies. GPZs define areas where land use activities and discharges to land and water require special controls to protect the quality of community drinking-water supplies. This example represents a development from sole-source use of a model prediction to an 'in-concert' approach where; model predictions, careful hydrogeological investigation, realisation of real-world risks, and sensible use of policy has achieved an outcome that provides a framework to better protect this component of the Wellington water supply. This paper describes the evolving methods that have been used to develop GPZs in the Hutt Valley during the hearings for the proposed plan.

KEYWORDS

Drinking water, contamination, groundwater, protection zone, hearing mediation.

PRESENTER PROFILE

Geoff Williams - Senior Advisor Strategy at Wellington Water Ltd (WWL). Geoff prepared the WWL submission on source protection aspects of the GWRC Proposed Natural Resources Plan, and provided expert evidence at the hearing and panel directed conferencing.

Aslan Perwick – Groundwater Services Leader at Pattle Delamore Partners Ltd. Aslan prepared and presented expert evidence relating to groundwater aspects at the hearing and inputs during the expert causing associated with WWL submission.

1 INTRODUCTION

In 2017-2018, Greater Wellington Regional Council (GWRC) undertook a process to develop Groundwater Source Protection Zones (GPZs) for key aquifers as part of the Proposed Natural Resources Plan (PNRP) for the Wellington Region, including the Waiwhetu Aquifer in the Lower Hutt Valley. The Waiwhetu Aquifer and the two WWL wellfields (Waterloo and Gear Island) are critical parts of the municipal drinking water supply network. The aquifer provides on average 45% of the total supply to the cities of Wellington, Hutt, Upper Hutt and Porirua, however this increases to nearly 70% during dry summer periods. From a WWL perspective, the proposed GPZ were not viewed as sufficient to protect this key resource. WWL challenged the proposed GPZ through a submission, which eventuated into a hearing and expert caucusing process. This paper describes the process and evolution of the GPZ to produce the finally agreed area and policy framework.

2 HUTT VALLEY GPZ DEVELOPMENT

2.1 GWRC PROPOSED GPZ

The initial Hutt Valley GPZ was developed by GNS, at the request of GWRC. The approach was to utilise the existing calibrated groundwater model for the Hutt Valley aquifer system (HAM3) and undertake simulations of

particle tracking to estimate time-based capture zones for the Waterloo Wellfield, Gear Island Wellfield and the Buick Street public drinking water supply bore in Petone. The assessment simulated capture zones based on 1-year, 2-year and 5-year groundwater travel times.

GWRC's initial recommendation adopted the 5-year capture zone as the Waiwhetu Aquifer GPZ (the red shaded area in Figure 1). It should be noted that this recommendation was based on the interpretation (and modelling assumption) that a confining layer overlying the Waiwhetu Aquifer extended north of the Waterloo Wellfield. This confining layer or aquitard was understood to comprise low permeability marine deposits of the Petone Marine Beds (extending over the Gear Island Wellfield), and the Melling Peat around the Waterloo Wellfield. The conceptual understanding of the aquifer system at this time was that the confining layer separated both Waiwhetu Aquifer wellfields from the overlying unconfined Taita Alluvium. Groundwater within the Taita Alluvium is more influenced by the contaminant sources present within the Lower Hutt valley, including: industry, underground services, and stormwater run-off, and is generally considered to be of poorer quality.

2.1.1 GWRC S42A REPORT UPDATE TO THE GPZ (GPZ UPDATE #1)

Following the Kaikoura earthquake in November 2016, WWL noted increasing detections of coliforms and occasionally E. coli at bores within the Waterloo Wellfield. This led Wellington Water, in conjunction with GWRC, to undertake more detailed investigations into the permeability and continuity of the confining layer during their assessment of bore security. As part of this investigation, GNS developed a detailed geological model of the shallow geology across the Lower Hutt Valley (see Figure 2 for example sections). The results of this investigation indicated the following:

- The aquitard varies significantly in the lateral extent and vertical thickness;
- The 'core' of the Petone Marine Beds (aquitard) includes a fine-grained laterally extensive horizon that thins northwards from Wellington Harbour foreshore and pinches out in the vicinity of the Ewen Bridge;
- The Melling Peat contains thin fine-grained horizons which are not laterally continuous across the region, although generally present at a reasonable thickness below Lower Hutt CBD;
- The Waterloo Wellfield is located in an area where no significant aquitard is present i.e. fine-grained horizons are thin and not continuous, or absent, indicating the wellfield is potentially vulnerable to contaminants from the overlying Taita Alluvium;
- Limited geological data is available for the Woburn, Waiwhetu, Moera and Epuni suburbs – which represent knowledge gaps on the aquitard presence and hydraulic properties in those areas.

To incorporate the above findings, the Section 42A report recommended the GPZ be extended southwards to the Ewen Bridge i.e. an extension from the 'Original Proposed GPZ', but only providing coverage to the southward extent of the Ewen Bridge, leaving the remainder of the Lower Hutt valley outside the proposed GPZ. Note - Within this paper, this GPZ update is termed GPZ Update #1 (see purple shaded area in Figure 1).

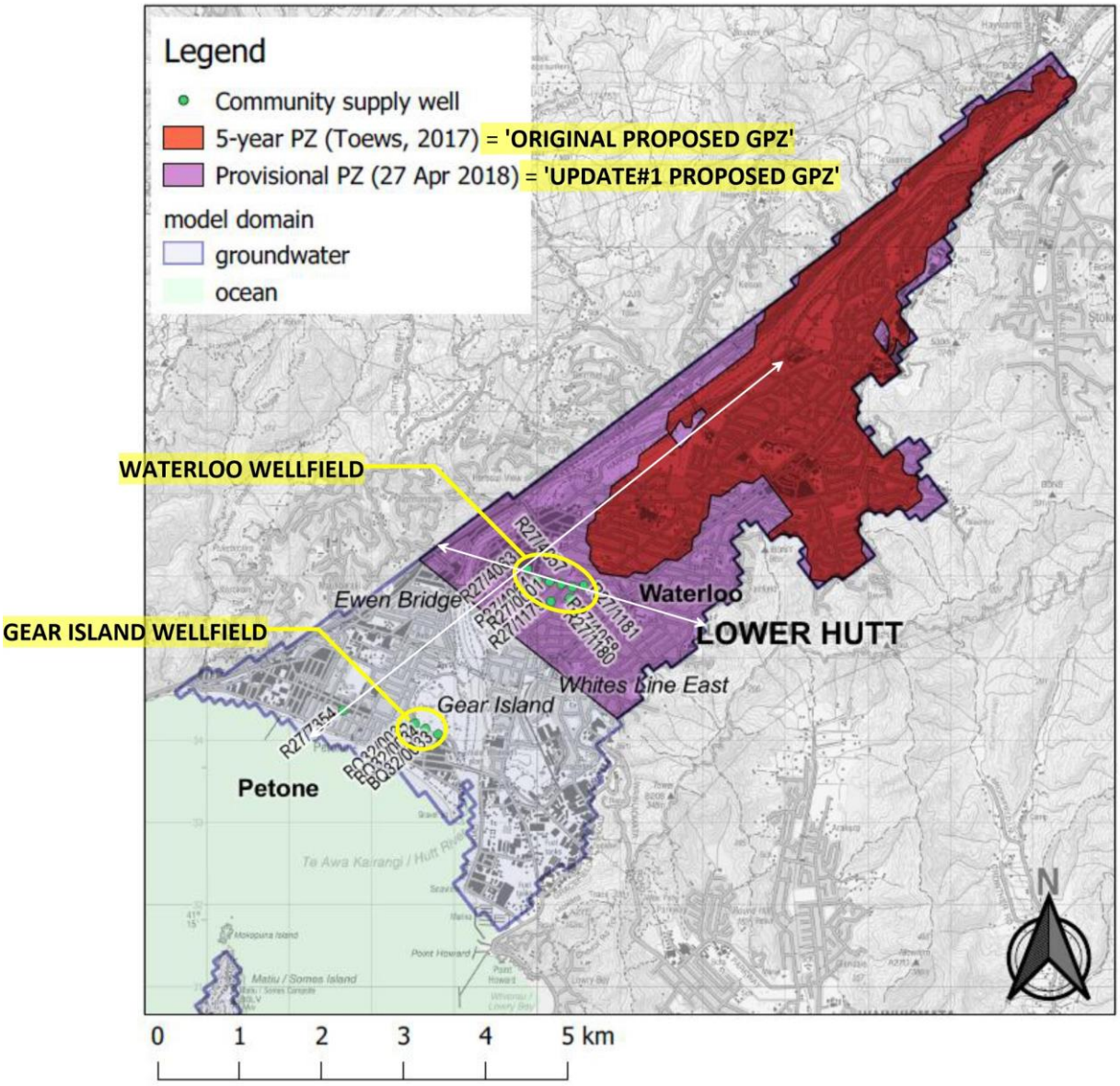

Figure 1: GWRC Proposed Lower Hutt Valley Drinking Water Supply GPZs (annotated from GWRC, 2018 Section 42A report). [Note – White polylines indicate section orientations for Figure 2]

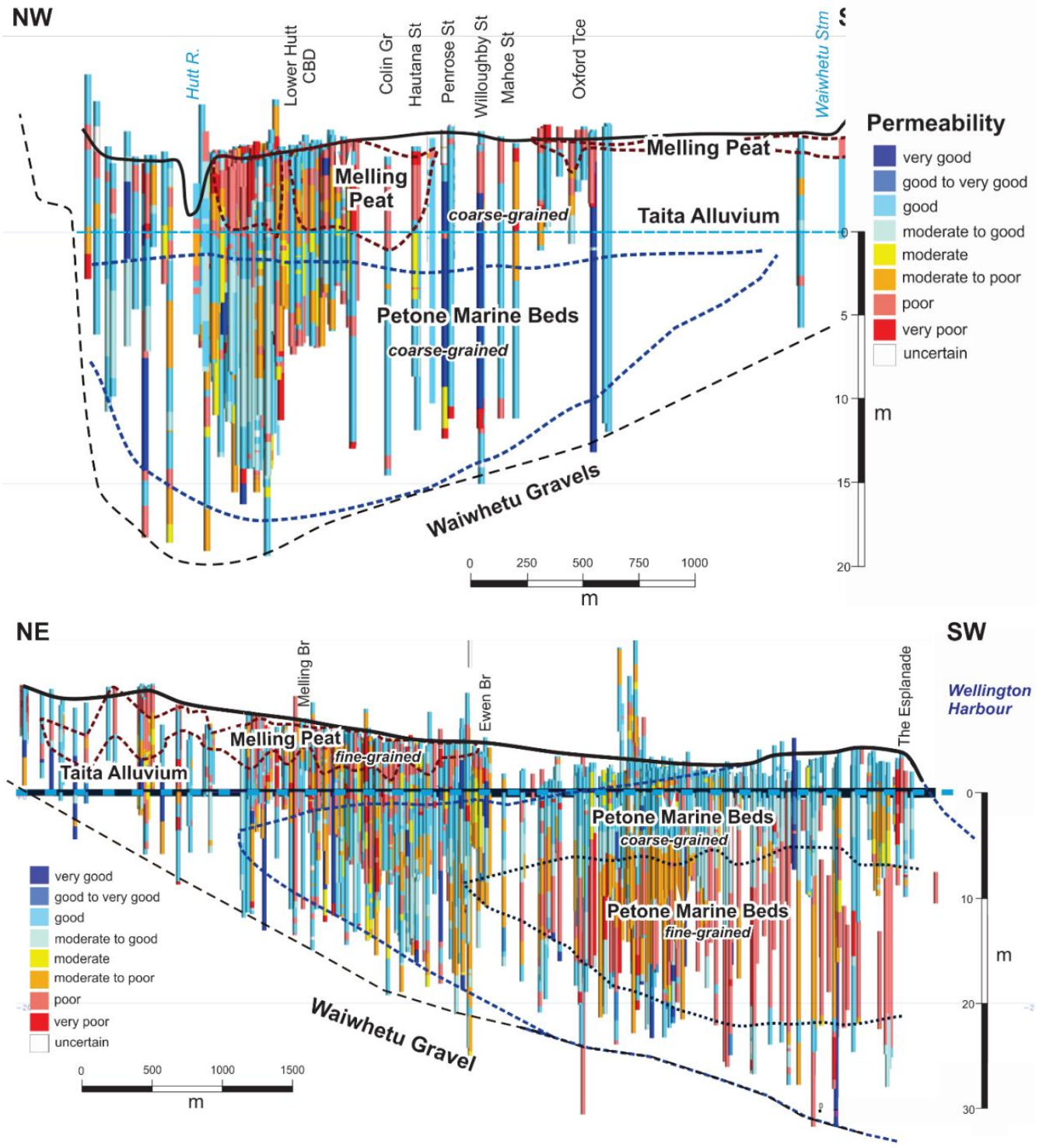

Figure 2: Sections showing the shallow geology of the Hutt Valley, classified by sediment permeability (taken from GNS Science Consultancy Report 2017/216, 2017). Top: Lower Hutt Valley cross-section (as per Figure 1). Btm: Lower Hutt Valley long-section (as per Figure 1).

2.2 BASIS OF THE WWL SUBMISSION

WWL did not consider the original or Update #1 proposed GPZ provided sufficient protection to the Waiwhetu Aquifer resource, and prepared expert evidence outlining the residual risks and need to extend the GPZ in both the downstream and upstream directions. Two extensions were sought:

- Extension in the downstream direction was requested to cover the entire Lower Hutt Valley floor, all the way to the Wellington Harbour coastline.
- Extension in the upstream direction was requested to cover the entire catchment of the Hutt River.

The basis for these requested extensions are outlined in the below sub-sections.

2.2.1 WWL PROPOSED DOWNSTREAM EXTENSION

The downstream extension was requested to cover the whole Lower Hutt Valley floor, all the way to the Wellington Harbour shoreline + toe of the flanking hill country. This request was in part to address the variation seen within the permeability of the confining layer, but also to address residual risks that WWL considered were still present from the GPZ Update #1. From a WWL perspective, the key risks to the Waiwhetu Aquifer and the public drinking water supply wellfields were identified as:

- The considerable uncertainty regarding the degree of natural hydraulic confinement between the Waiwhetu Aquifer and potential contaminant sources at ground surface (but outside the Update #1 GPZ);
- The geological modelling indicated that alluvial/detrital fans from the surrounding hills may form more permeable pathways around the edge of the valley floor (providing a potential contaminant pathway), although there was insufficient borehole logs to define these areas more precisely.
- The 'piercing' of any natural confinement due to the drilling of boreholes, and/or installation of deep engineering structures such as building foundations/piles – which has occurred at numerous locations in the vicinity of both wellfields. The installation of boreholes and subsurface structures can create preferential flow pathways for contaminant migration into the Waiwhetu Aquifer i.e. a connection(s) to 'short-circuit' through the aquitard, but these pathways were not / are not able to be incorporated into the model derived Update #1 GPZ.
- The influence of groundwater abstraction from other third-party boreholes within Waiwhetu Aquifer in the areas outside of the Update #1 GPZ, which have the potential to locally reverse the natural artesian gradients and draw contaminated shallow water into the Waiwhetu Aquifer/abstraction bores.
- The November 2016 Kaikoura Earthquake raised questions about the integrity of borehole seals as sufficient protection. The presence of shallow groundwater within the coarse-grained upper portion of the Petone Marine Beds and the Taita Alluvium means that near surface contamination could travel laterally within the strata and potentially enter Waiwhetu Aquifer or a supply borehole if the annulus seal is compromised.
- Similarly, should contamination enter the Waiwhetu aquifer, the capture zone at this depth is laterally large, and contaminants could also move laterally under the influence of hydraulic gradients induced from heavy pumping/abstraction, drawing water and contaminants towards them.
- WWL are also mindful that operational shifts in the 'centre of pumping' are possible under the present abstraction consent and wellfield configuration. It is also possible that future wellfield configuration (including bore locations) is likely to change and therefore designating the entire valley floor is akin to future proofing the protection area for WWL and other resource users.

2.2.2 WWL PROPOSED UPSTREAM EXTENSION

The WWL submission requested that the GPZ extend upstream of the aquifer infiltration zone[1] to include the entire catchment of the Hutt River. The PNRP methodology for protecting surface water catchments did not consider the potential for surface waters to transport contaminants to aquifer recharge zones. The areas omitted from surface water protection included: metropolitan Upper Hutt and significant tributaries of the Hutt River including the Whakatikei, Akatarawa, Mangaroa and Pakuratahi rivers. The evidence provided to support expanding the GPZ included:

- Some chemical contaminants do not readily break down in the environment and could be transported to the groundwater abstraction points from sources outside the proposed surface water protection areas.

- The Waterloo and Gear Island Water Treatment Plants (WTP) which treat water abstracted from the Waiwhetu aquifer do not have the ability to treat for chemical contaminants. It would be extremely costly to implement such treatment and may be practically unachievable at the existing Waterloo WTP site.

- The time-based GPZ delineation method described in the Section 42A report is appropriate when considering microbiological pathogens that exhibit die-off over time. However, this approach is not appropriate for chemical contaminants that may not break down or attenuate over time. An example relating to the Hutt Aquifer system is the chemical Bisphenol-A (BPA). Emerging contaminant sampling by GWRC detected BPA at many locations in the Hutt Aquifer including public water supply bores. BPA is a synthetic compound used in the manufacture of plastics. While the low BPA concentrations do not yet pose a health concern, the presence of the chemical indicated a contaminant pathway is present that is not understood.

- WWL needs to understand the changes to contaminant levels well in advance of them approaching harmful levels so that appropriate treatment or mitigation can be implemented. WWL also needs to have assurance that every effort is being made to identify the sources of these contaminants and prevent them from entering the groundwater source.

The GPZ should therefore consider the connected nature of the Hutt River and Hutt Aquifer system and include the full catchment area upstream of the aquifer recharge zone.

2.3 CAUCUSING PROCESS

Following a hearing, the panel of commissioners instructed expert caucusing to take place between GWRC and WWL and their respective expert advisers, to seek technical agreement on the below scope:

1. *To extend the Groundwater Supply Protection Area to include all the valley floor to the foreshore of Wellington Harbour*.

2. *To extend the Lower Hutt Groundwater Protection Zone to cover the Hutt catchment upstream of the infiltration zone.*

It was agreed in the scope that the outcomes of the conferencing ought not be applied or extrapolated to any other community drinking water supply catchments in the region. The submission points are unique to the Hutt catchment and the nature/mechanism of the groundwater abstraction from the Waiwhetu aquifer.

Caucusing occurred over a series of meetings and iterations to produce a joint witness statement, as per the standard process. The discussions were primarily based on the approach to risk management, rather than technical disagreements on hydraulics. This was because the technical information available was essentially agreed upon / wasn't brought into question, rather it was the approach and appropriateness of incorporating technical predictions from the groundwater model into the policy instrument of a GPZ – given the limitations of modelling, knowledge gaps, and the residual risks.

[1] The aquifer infiltration zone is marked on Figure 3 for reference.

3 AGREED OUTCOMES FOR THE GPZ

The following outcomes were agreed from the caucusing process:

For the downstream extension:

- Agreement that, in the absence of more concrete data about the potential role of the valley floor margins, there is technical justification for taking a more cautious interpretation of the protection area boundary (as opposed to full reliance on the modelled results).

- There was agreement that the GPZ should be extended to cover the entire Lower Hutt valley floor. That area can be considered to equate to the yellow area in Figure 3.

- The extended GPZ is expected to be used to update the map that delineates the groundwater community drinking water supply protection area that applies to all policies and rules in the PRNP regarding discharges to land and water in the area.

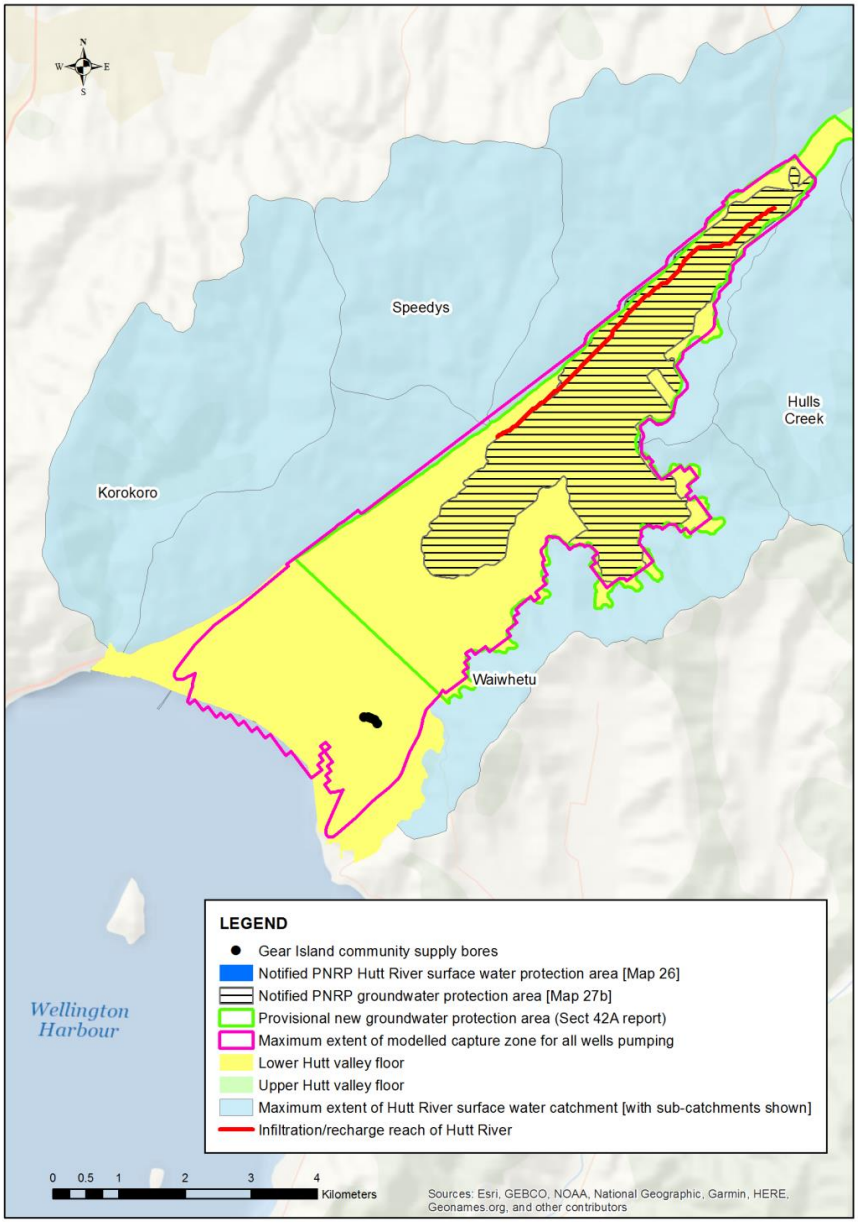

Figure 3. Map of the Lower Hutt area showing the notified PNRP groundwater protection area (black hashed), a subsequent [GPZ Update #1] revised proposal from the Section 42A report (green boundary), the yellow area is the 'Lower Hutt valley floor' and the slightly smaller area defined by the pink line represents the maximum extent of the deep Waiwhetu Aquifer modelled 5-year capture zone with all known wells pumping.

For the Upstream Extension:

- It was agreed that the Hutt Catchment should be recognised in the proposed NRP as an area from which chemical contaminants could potentially enter the community drinking water supply, and that the sensitivity and significance of this area needs to be recognised in resource consent processes.

- A new definition was created: "Hutt community drinking water supply catchment area" (shown in pink on Figure 4). This was defined as "The area… from which surface water or groundwater may flow to and impact the quality of the community drinking water supply". From a planning perspective this was given effect through the policy that implements the requirements of the National Environmental Standard for Sources of Human Drinking Water.

- There remains uncertainty around what activities in the wider catchment pose the most significant risk to aquifer water quality. This is because our knowledge of chemical sources and how they behave in the environment is still evolving. The real-world risk reduction from this change to the PNRP is constrained by the coverage in the plan and will not affect existing discharge rules which were considered low risk. However, there a significant benefit in terms of improving how we collectively view/consult on individual activities as well as setting up a framework for possible further planning refinement in the future.

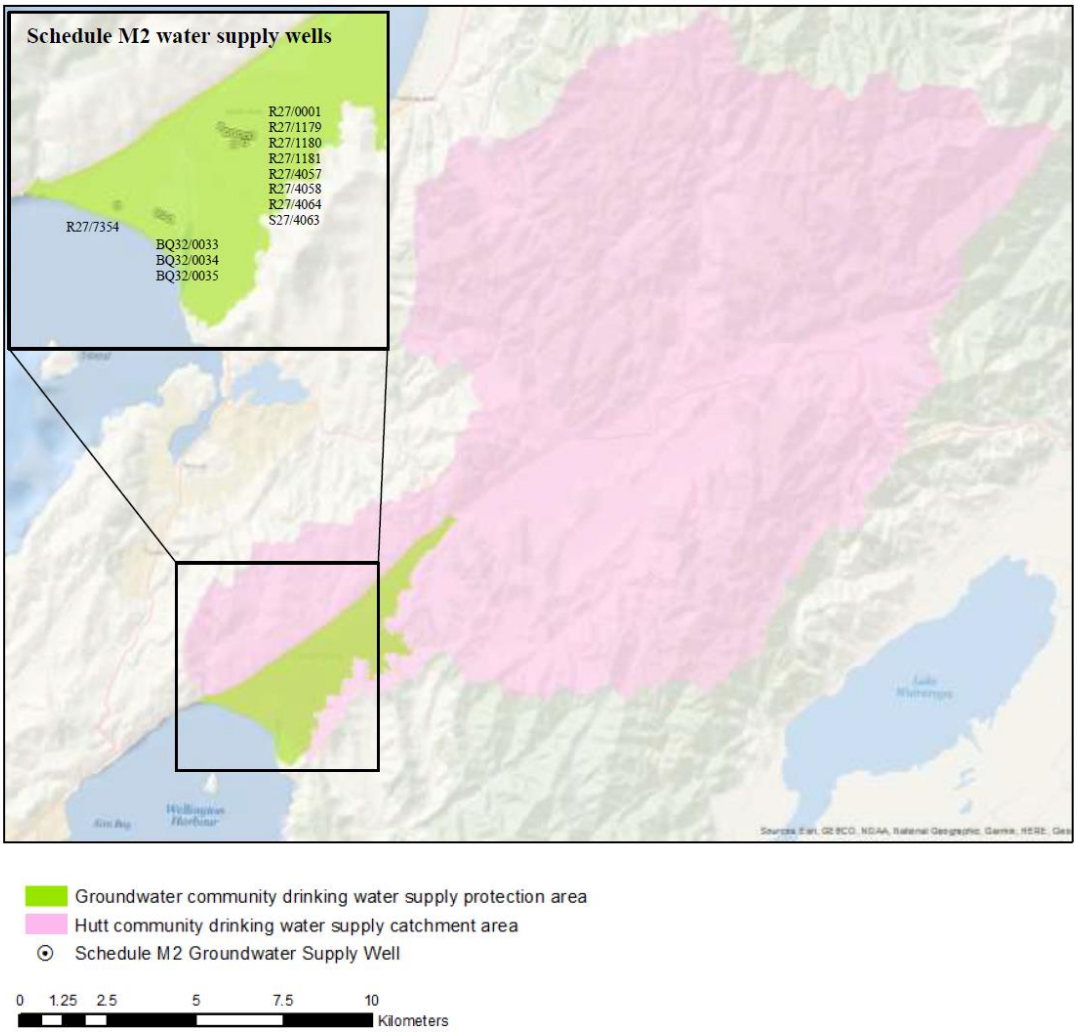

Figure 4. Amended Groundwater Protection Zone and new "Hutt community drinking water supply catchment area"

4 CONCLUSIONS

The different approaches to defining an appropriate GPZ were addressed through a conferencing process. This reached agreement that a more comprehensive GPZ framework should be defined that recognised all potential contaminant pathways that could affect the Waiwhetu Aquifer and the critical Waterloo Wellfield and Gear Island Wellfield.

The originally proposed GPZ were increased significantly in extent from those originally proposed in the PNRP. The finally agreed protection zones include incorporation of the entire Hutt River surface water catchment via the *"Hutt community drinking water supply catchment area"*, and the entire Lower Hutt valley floor via the Lower Hutt valley *"Groundwater Protection Zone"*. Relevant policy and planning requirements of the Proposed Natural Resources Plan will be implemented to these areas when the plan becomes notified (expected 31 July 2019).

Whilst numerical modelling will always have an important place in assessing and understanding groundwater processes, model predictions to inform policy should be treated with care. This example represents a development from sole-source use of a model prediction to an 'in-concert' approach where; model predictions, careful hydrogeological investigation, realisation of real-world risks, and sensible use of policy has achieved an outcome that provides a framework to better protect this component of the Wellington water supply.

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