Proposed Southland Water and Land Plan
Wilkins Appeal – Groundwater Allocation
Southland, New Zealand
Project #31137-02

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PROPOSED REVISIONS TO PROPOSED ANNUAL GROUNDWATER ALLOCATIONS FOR THE CATTLE FLAT, UPPER MATAURA, AND WENDONSIDE GMZS BASED ON BEDROCK/HILLCOUNTRY WATERSHEDS

1.0 CURRENT PROPOSED GROUNDWATER ALLOCATION

According to Environment Southland (2017, p.17)[1], "Primary allocation volumes for groundwater management zones defined in the pSWLP were calculated based on updated estimates of rainfall recharge calculated using the methodology outlined by Chanut (2014) … it is considered the best available estimate of rainfall recharge available at the time the pSWLP was drafted." Environment Southland (2017, p.18-19) also states: "Primary allocation volumes for each groundwater management zone were calculated as equal to 35 percent of the mean annual rainfall recharge … **It is considered the proposed primary allocation represents an appropriately conservative percentage of recharge which can be allocated while avoiding significant hydrological alteration to the groundwater system** ..."[2]

As a result, Environment Southland (2017, p.19, their Table 3) has assigned primary groundwater allocations to the Upper Mataura, Waipounamu, and Wendonside groundwater management zones as shown in Table 1.

Table 1. Primary Groundwater Allocation Volumes Calculated for pSWLP for Selected Groundwater Management Zones

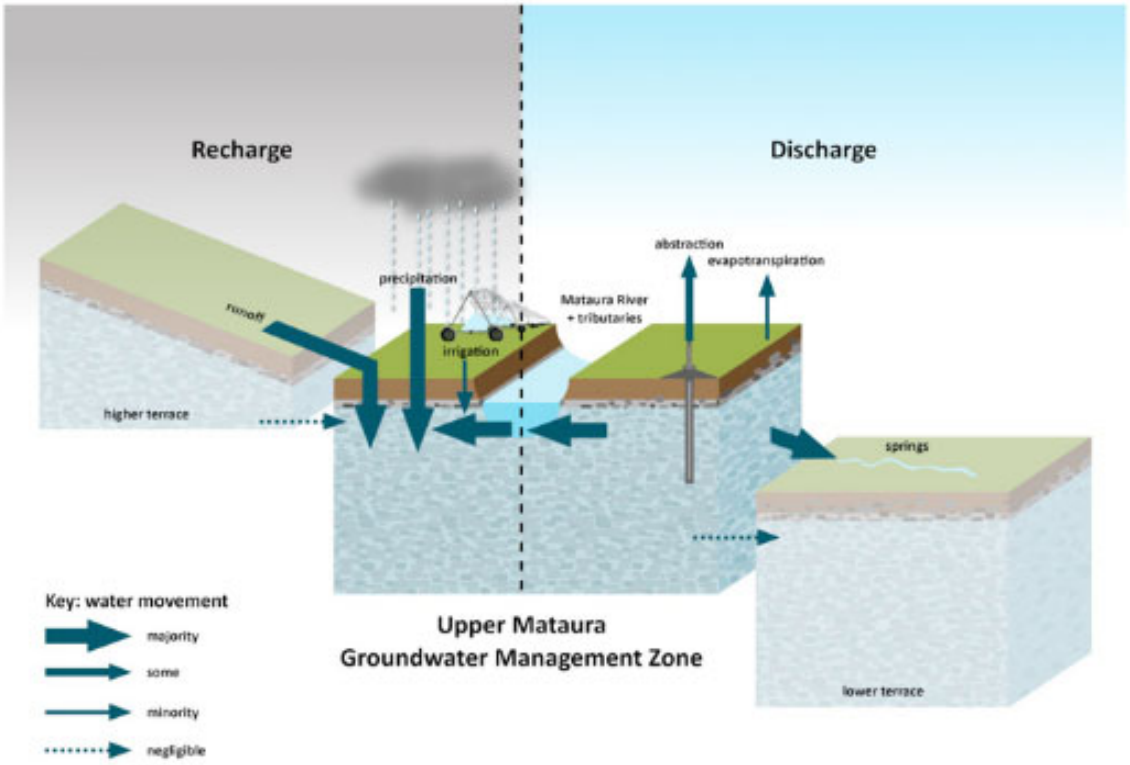
Groundwater Zone	*Area (Ha)*	*Mean Annual Rainfall Recharge (mm)*	*Annual Recharge (m^3/year)*	*Primary Allocation (m^3/year x 10^6)*
Upper Mataura	9,897	300	26,691,900	10.39
Waipounamu	1,743	190	3,314,615	1.16
Wendonside	12,968	211	27,310, 819	9.56

2.0 CONSISTENCY IN ESTIMATING ANNUAL RECHARGE TO SOME GROUNDWATER MANAGEMENT ZONES

Although on its face, Environment Southland's approach seems fair for managing these groundwater resources, their approach is inconsistent with their own recharge conceptualizations presented in the Beacon website. The contributing watershed areas for the Upper Mataura and Wendonside groundwater GMZs are in fact larger than their respective GMZ areas. In other words, the "watershed" feeding precipitation recharge to these GMZs are not simply the area of the GMZ, the watersheds include the area draining surface runoff, groundwater discharge, and stream losses from the surrounding hills.

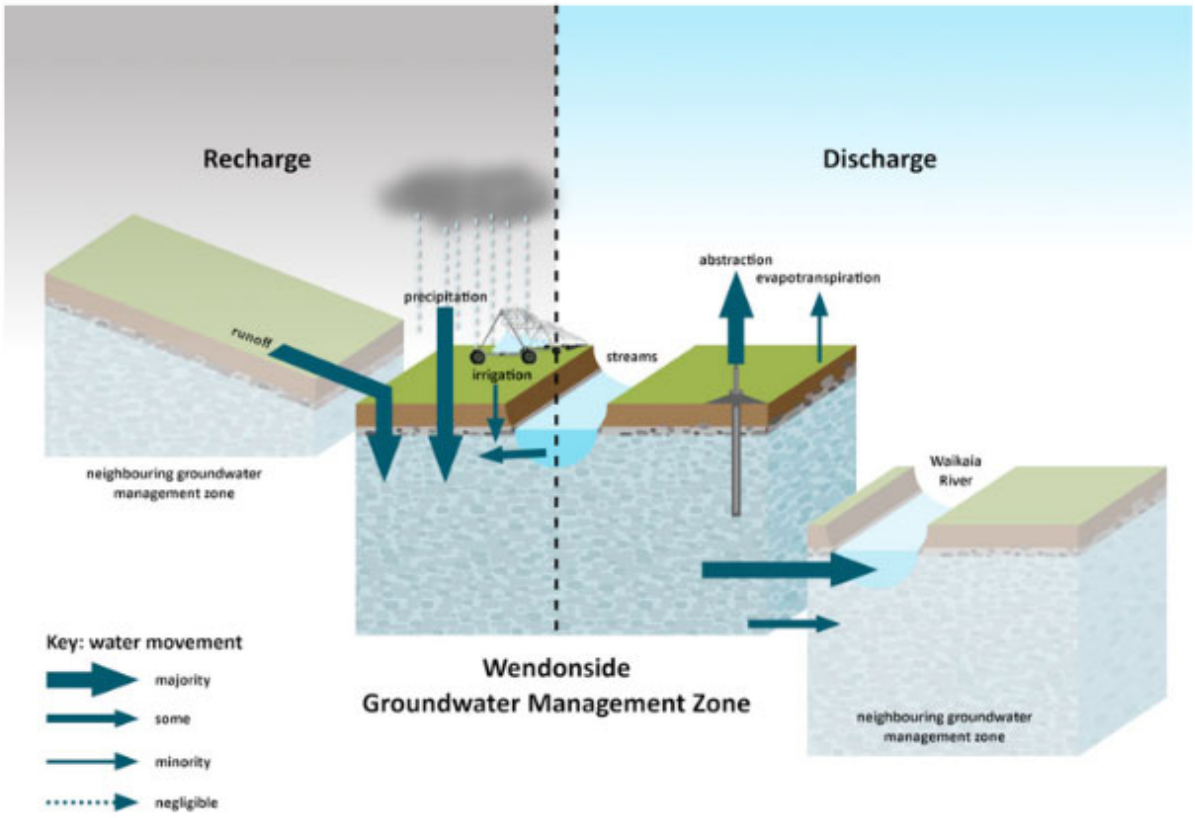
[1] Environment Southland. 2017. Water and Land Plan. Part A. – Decisions Version
[2] Bold type added by author.

Environment Southland states: "**Groundwater recharge in the Upper Mataura GMZ is derived from infiltration of local rainfall and runoff from the surrounding hills. Many streams draining the surrounding hills lose water as they flow across the alluvial terraces along the valley margins."**[3] The conceptual model for Upper Mataura recharge and discharge prepared by Environment Southland, shown below, indicates runoff from the surrounding hills, either through the hillslope or via streams from the hillslope losing water to the ground, is as important as direct recharge of precipitation onto the Upper Mataura GMZ footprint alone.



Similarly, Environment Southland states: "**Groundwater recharge in the Wendonside GMZ is largely derived from infiltration of local rainfall and runoff from the southern flanks of the Garvie Mountain foothills."**[4] The conceptual model for Wendonside recharge and discharge prepared by Environment Southland, shown below, indicates runoff from the Garvie Mountain foothills, either through the hillslopes or via streams from the hillslopes losing water to the ground, is as important as direct recharge of precipitation onto the Wendonside GMZ footprint alone.

[3] Bold type added by author.
[4] Bold type added by author.



According to Environment Southland (2021, p. 1)[5], the Bedrock/Hill Country physiographic zone consists of prominent landforms below 800 masl (metres above sea level) where soils overlie bedrock or glacial till, and where there is a history of dense vegetation cover. Environment Southland (2021, p. 2) states that the Bedrock/Hill Country (o) variant (overland flow) occupies 86% of this physiographic zone and is characterized by higher elevations and overland flow due to a combination of steeper slopes, less well-drained soil, and greater precipitation. As indicated in the title of the following figure from Environment Southland (2021), "Runoff from the Bedrock/Hill Country zone may also recharge groundwater resource in lower-lying zones." Similarly, Environment Southland (2021, p.8) also states: **"Many small streams draining this zone are observed to lose flow and dry up as they emerge from the foothills. Such loss may account for a significant component of the water balance in the alluvial aquifer systems in inland basins."**[6]

In summary, Environment Southland's proposed groundwater allocations for the Upper Mataura, and Wendonside groundwater management zones "… were calculated as equal to 35 percent of the mean annual rainfall recharge…" which is considered "… an appropriately conservative

[5] Environment Southland. Southland Physiographic Zones: Bedrock/Hill Country Technical Information.
[6] Bold type added by author.

percentage of recharge which can be allocated while avoiding significant hydrological alteration to the groundwater system ..."[7] However, based on other Environment Southland documents, the Upper Mataura and Wendonside groundwater management zones receive substantial amounts of recharge annually from contributing Bedrock/Hill Country.

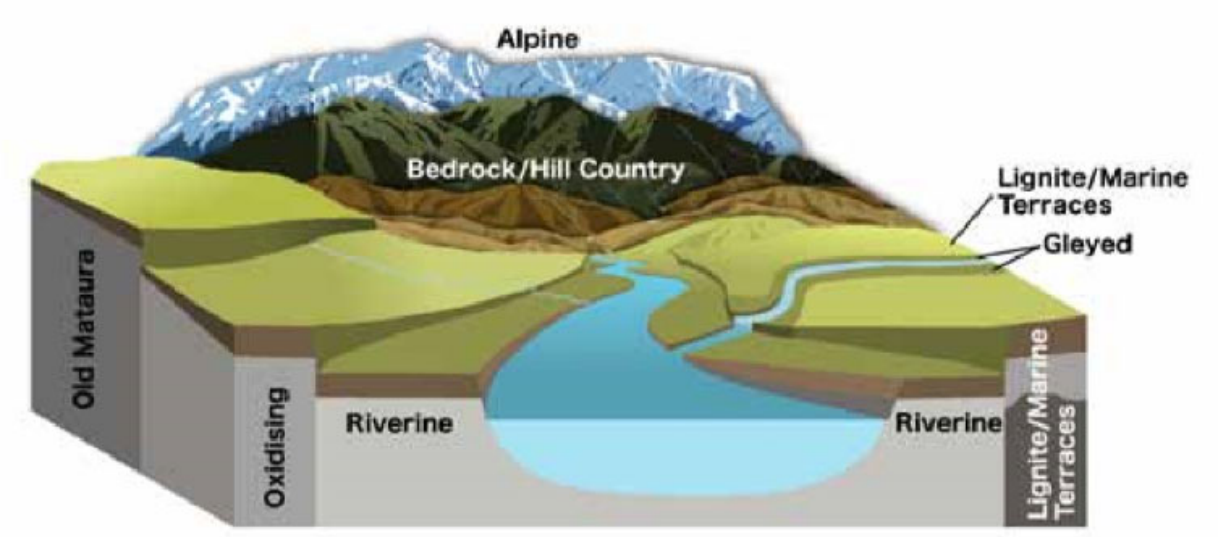


Figure 1: Landscape context image illustrating the relationship between the Bedrock/Hill Country zone and neighbouring physiographic zones. The Bedrock/Hill Country zone occurs at low to mid-elevations in hills and sub-alpine areas where rainfall is higher and more frequent. Some areas also receive runoff from the higher elevation Alpine zone. Runoff from these areas is the source of flow in the headwaters of many catchments draining lowland areas and makes a major contribution to cumulative discharge in downstream reaches of the main river systems. Runoff from the Bedrock/ Hill Country zone may also recharge groundwater resource in lower-lying zones.

3.0 CONTRIBUTIONS TO ANNUAL RECHARGE FROM BEDROCK/HILL COUNTRY

We estimated the area of the adjacent Bedrock/Hill Country watershed for the Upper Mataura and Wendonside GMZs using the Beacon groundwater management zones and the topographic map base map. We approximated the areas of the contributing Bedrock/Hill Country watersheds by encompassing the streams shown on the topographic map that directly or indirectly contribute to the adjacent groundwater management zone. Figures A1 and A2 compare the groundwater management zone areas to their respective contributing Bedrock/Hill Country watershed areas for the Upper Mataura and Wendonside GMZs. The Waipounamu GMZ does not have a Bedrock/Hill Country watershed.

The literature does not indicate exactly how much these Bedrock/Hill Country watersheds contribute to the annual recharge of the adjacent groundwater management zones through direct runoff and stream losses. Based on the Environment Southland conceptual models of recharge to

[7] Bold type added by author.

the groundwater management zones, the contributions are substantial. Furthermore, given the steeper slopes, thinner soils, and higher precipitation amounts that occur in the Bedrock/Hill Country watersheds, the contributions to annual recharge are expected to be proportionately (by area) at least as high as the GMZ itself.

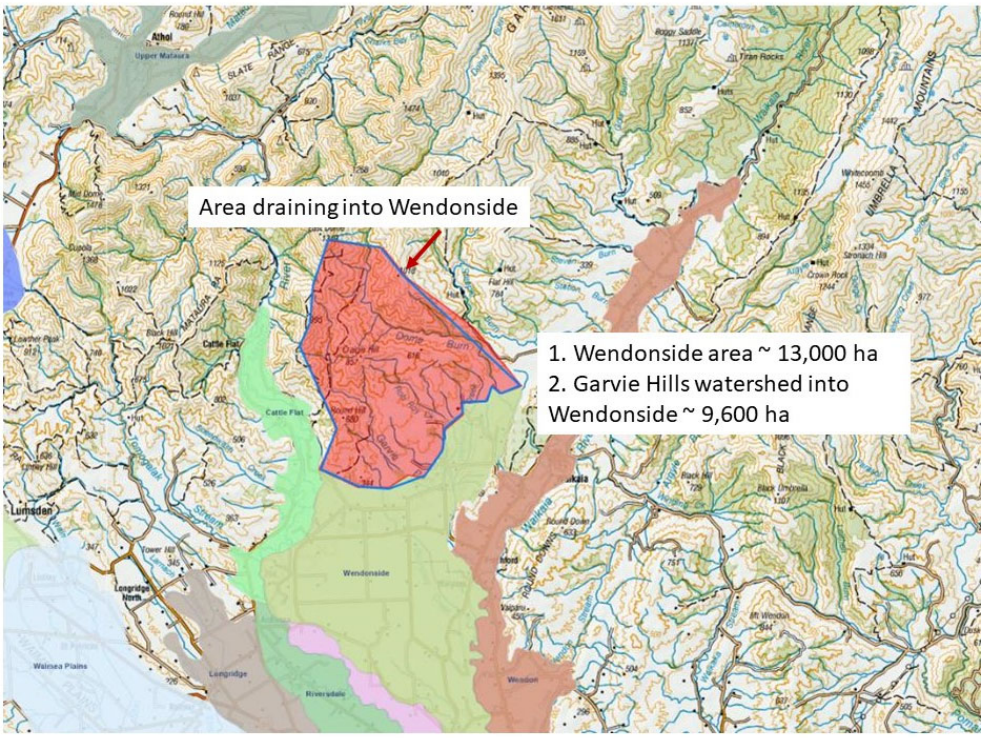


Figure A1. Estimated Bedrock/Hill Country Watershed to Upper Mataura GMZ

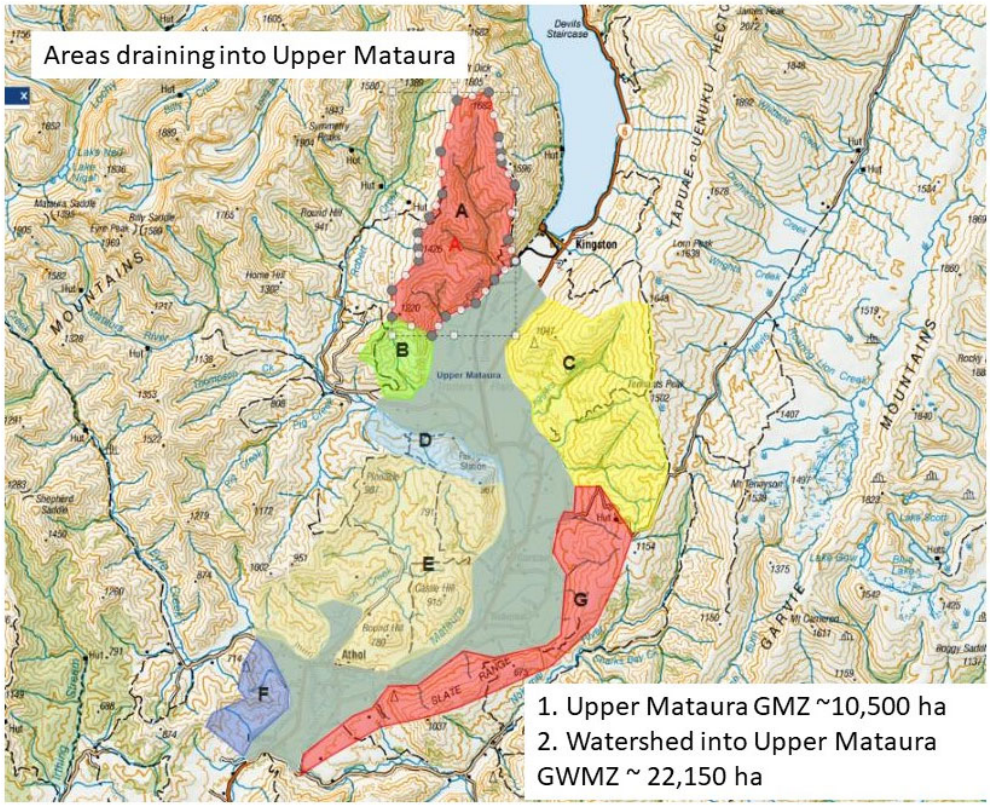


Figure A2. Estimated Bedrock/Hill Country Watershed to the Wendonside GMZ

Table 2 summarizes our proposed additional groundwater annual allocation for selected groundwater management zones based on their contributing Bedrock/Hill Country watershed and " …35 percent of the mean annual rainfall recharge…" that is considered an " … appropriately conservative percentage of recharge which can be allocated while avoiding significant hydrological alteration to the groundwater system."

Table 2. Proposed Additional Groundwater Annual Allocation for Selected Groundwater Management Zones

Groundwater Zone	*Approximate Bedrock/Hill Country Watershed Area (Ha)*	*Assumed Mean Annual Rainfall Recharge (mm)*	*Expected Additional Annual Recharge (m^3/year)*	*Proposed Additional Annual Allocation (m^3/year x 10^6)*
Upper Mataura	22,150	300	66,450,000	23.3
Waipounamu	Not applicable			
Wendonside	9,600	211	20,256,000	7.1

4.0 PROPOSED TOTAL GROUNDWATER ANNUAL ALLOCATION FOR SELECTED GROUNDWATER MANAGEMENT ZONES

Table 3 summarizes our proposed total groundwater annual allocations for the Upper Mataura, and Wendonside GMZs considering annual recharge contributions from their adjacent Bedrock/Hill Country watersheds.

Table 3. Proposed Additional Groundwater Annual Allocation for Selected Groundwater Management Zones

Groundwater Zone	*Environment Southland's Proposed Annual Allocation (m^3/year x 10^6)*	*Proposed Additional Annual Allocation (m^3/year x 10^6)*	*Proposed Total Annual Allocation (m^3/year x 10^6)*
Upper Mataura	10.39	23.3	33.7
Wendonside	9.56	7.1	16.7

5.0 SIGNATURE

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