Freshwater Management Units for the Canterbury Region

Review of existing water management spatial frameworks

October 2018

Prepared By:

Brydon Hughes

Ton Snelder

For any information regarding this report please contact:

Brydon Hughes

Phone: 021495229

Email: brydon@landwaterpeople.co.nz

Land Water People Ltd
PO Box 70
Lyttelton 8092
New Zealand

LWP Client Report Number:	LWP Client Report 2018-11
Report Date:	October 2018
LWP Project:	ECan FMU

Quality Assurance Statement

Version	**Reviewed By**	
Draft	Ton Snelder	August 2018
Draft	Client	September 2018
Final	Ton Snelder	5 October 2018

Table of Contents

Executive Summary

The National Policy Statement for Freshwater Management 2014 (NPS-FM) directs regional councils to develop regional plans for planning and managing freshwater resources. Plans must contain freshwater objectives, policies and limits.

Under the NPS-FM, freshwater objectives must strike a balance between enabling use of water resources and sustaining other values associated with water. Freshwater objectives form the basis and justification for defining limits and management actions that are required to achieve (or maintain) the values identified. Such management actions may include limits on resource utilisation (for example including volumetric or nutrient allocation limits), specific policies and rules that control the way freshwater resources are utilised or other management actions implemented via non-regulatory initiatives. Monitoring is then required to ensure that the specified objectives are being achieved.

The NPS-FM requires that regional councils subdivide their regions into Freshwater Management Units (FMUs). The NPS-FM defines a FMU as a water body, multiple water bodies, or any part of a water body determined by a regional council as the appropriate spatial scale for setting freshwater objectives and limits and for freshwater accounting and management purposes.

FMUs subdivide water bodies and their catchments into groups to which differing management regimes apply. FMUs are therefore a spatial framework for freshwater management that can enable:

- Water bodies with similar physical characteristics and values to be grouped together for the purposes of management;
- A single objective (or set of objectives) to be applied consistently to all similar water bodies (which are not necessarily hydraulically connected), thus reducing the number of plan provisions compared to what would be required to manage each water body separately; and
- Management activities (e.g. setting of freshwater objectives and limits, application of rules and policies, monitoring of environmental outcomes) to be undertaken at an appropriate spatial scale.

Implicit in the NPS-FM definition is the idea that FMUs are to be established based on how water bodies, or parts of water bodies, are valued. There is therefore interdependence between establishing FMUs and determining the values (and associated objectives) for which they are to be managed.

The NPS-FM does not prescribe a set methodology for defining FMUs, rather it allows regional councils to develop management units in a manner that is appropriate to the specific circumstances of their region. Given definition of FMUs is integral to the development of a regional water plan, we recommend that the methodology used to define the spatial framework for FMUs should:

- Recognise spatial variation in the bio-physical and ecological function of water bodies;
- Be applied in a comprehensive manner across the region to enable a consistent management approach to be adopted;

- Recognise the hydraulic connection between water bodies, particularly where management actions applied to a specific area may also influence water quality or water quantity outcomes in downstream receiving environments;
- Be defined using a methodology that is transparent and reproducible to enable decision-maker(s) to weigh up alternative options;
- Support the development and application of management actions (i.e. limits, policies and rules) to land areas that drain to specific water bodies or groups of waterbodies, rather than necessarily to the waterbodies themselves; and
- Be developed at an appropriate scale to ensure management actions are sufficient to enable freshwater objectives to be achieved, while avoiding unnecessary or overly complicated regulation.

Our recommended approach to defining FMUs for Canterbury Region comprises three components:

1. The water bodies that are designated to be managed for a particular purpose (i.e., freshwater objective), termed the *management classification* in this report;
2. The land area (catchment or sub-catchment) that drains to an individual management class, termed the *management zone*, and
3. The points in the hydrological network where the *management zone* changes, which are termed *administrative points*.

Our recommended approach recognises that water bodies vary in their environmental and biophysical characteristics, associated values and their capacity for resource use. This variation can be accounted for by appropriate classification of water bodies into management classes. It follows therefore that management zones are the areas the drain to water bodies that belong to a specific class. FMUs are then defined by layering and merging *management zones* in an order that allows the definition of policies and limits that achieve the most restrictive downstream objectives. This layering and merging of management zones must be undertaken as part of the policy development process with the overall aim being the production of a simple and clear set of justifiable plan provisions.

Location-specific *special management zones* may be defined to reflect the unique values associated with individual water bodies, and for which specific plan provisions (limits, objectives, policies and rules) would apply to their upstream catchments. However, it is recommended that criteria used to define management classes should be sufficiently broad to avoid a proliferation of special management zones that may essentially create ad-hoc exceptions to the management provisions applied to general management classes.

The LWRP establishes a spatial framework for managing freshwater resources in the Canterbury Region. We consider these provisions provide an ideal base to assist definition of FMUs for the Canterbury Region. However, in order to ensure that FMUs and associated management actions (limits, policies and rules) are developed and applied in a justifiable manner that reflects the bio-physical context of individual water bodies, we suggest that Council give consideration to further development of some aspects of the existing LWRP provisions.

To delineate surface water quality FMUs we recommend that the Council:

- Delineate management zones (i.e. catchment areas) associated with each management class in the existing LWRP water quality management classification;
- Identify appropriate management actions (e.g. limits, policies and rules) required in individual management zones to:
  - maintain/achieve water quality objectives for the relevant water quality class, and
  - achieve the *most constraining* downstream water quality objective within a given hydrological system; and
- Identify appropriate locations at a sub-catchment or catchment scale to be utilised as administrative points for accounting and reporting purposes.

Surface water allocation zones defined in the LWRP provide a framework of management zones and associated administrative points that are consistent with our recommended approach to defining surface water quantity FMUs. However, in order to ensure that freshwater quantity objectives are achieved we recommend that the default management regime defined in the LWRP should be refined using the River Environment Classification (REC) to reflect spatial variation in bio-physical characteristics of all rivers and streams including:

- The different minimum flow and flow allocation regimes required to support values associated with different management classes; and
- The difference in the susceptibility to effects of abstraction for streams of different size (defined by mean flow statistics) within individual management classes.

Given the relatively ubiquitous nature of groundwater throughout the Canterbury Region it follows that a large proportion of the region may, to some extent contribute to recharge of groundwater in underlying geological materials. We therefore recommend that FMUs for groundwater (quality and quantity) may be best defined at a sub-regional scale, with localised management zones defined to specify groundwater abstraction limits and (if required) address existing groundwater quality state or trends, particularly in areas where significant interaction occurs between groundwater and surface water.

1 Introduction

1.1 National Policy Statement for Freshwater Management

The National Policy Statement for Freshwater Management 2014 (NPS-FM) directs regional councils to develop regional plans for planning and managing freshwater resources. Plans must contain freshwater objectives, policies and limits.

The NPS-FM requires councils to identify community values that are associated with water bodies in their regions[1]. These values must include compulsory values identified in the NPS-FM (ecosystem health and human health for recreation), as well as any other values that are identified by the community. Councils must then establish freshwater objectives to achieve those values using a range of attributes which relate to specific, measureable characteristics of fresh water including physical, chemical and biological properties. Objectives must express numerically (where practicable) the desired environmental state of water bodies[2].

Under the NPS-FM, freshwater objectives must strike a balance between enabling use of water resources and sustaining other values associated with water. However, freshwater objectives established in regional plans must also provide for overall maintenance or enhancement of regional water quality[3]. In addition, the NPS-FM requires councils to set objectives that are above specified minima or 'national bottom lines'[4].

Numeric freshwater objectives are the basis for development of management actions, which include limits, policies, rules and other management actions specified in regional plans or implemented via non-regulatory initiatives, required to achieve the freshwater objectives[5]. Collectively, the freshwater objectives, limits and methods ensure what is valued about a water body is maintained (or improved). Where objectives are not currently being achieved, the NPS-FM directs regional councils to determine how and over what timeframes, the objectives will be achieved[6].

1.2 Freshwater Management Units

The quality and quantity of water in water bodies, the values they support and the appropriate balance between water resource use and other values vary spatially. This means that it is generally inappropriate to set specific (i.e. numeric) freshwater objectives that apply broadly to all water bodies in a catchment or region. Rather, development of freshwater objectives at a catchment scale is more likely to reflect bio-physical characteristics of individual waterbodies and achieve values sought by the community.

The NPS-FM addresses this issue using the concept of the freshwater management unit (FMU). A FMU refers to a water body, multiple water bodies, or any part of a water body

[1] For example, environmental, cultural and social values such as recreation as well as economic use values including contaminant assimilation and water supply

[2] Policy CA2 NPS-FM

[3] Objective A2 and Policy A1, NPS-FM

[4] Policies CA2 and CA3, NPS-FM

[5] Policies A1 and B1, NPS-FM

[6] Policies A2 and B6, NPS-FM

designated to be managed for a particular value(s)[7] and for freshwater accounting and management purposes.

By definition FMUs are made up of fresh water bodies. Managing fresh water is, however, inherently linked to managing the land that feeds into the freshwater body, or the catchment that drains to it. As a result, definition of FMUs requires consideration of the land comprising the hydrological catchment of individual FMUs and its potential influence on the quality and quantity of freshwater both on a local scale, as well as in terms of downstream receiving environments. A regional plan that addresses the management of water bodies in a catchment or region requires a spatial framework of FMUs that subdivides water bodies and their catchments into groups for which differing management regimes will apply.

The NPS-FM requires all water bodies in a region to be included within a FMU[8]. Subject to progressive implementation up until 2025, Councils are required to establish the following for each FMU:

- A freshwater quality and quantity accounting system when setting or reviewing limits in accordance with Policies A1, B1 and CC1
- Identify values, formulate freshwater objectives, set limits and targets to achieve those objectives, and choose methods to achieve those freshwater objectives, limits and targets (Policy CA2).
- Develop a monitoring plan that identifies at least one representative site for monitoring progress against freshwater objectives, once freshwater objectives are set (Policy CB1).

1.3 Scope of this report

This report is intended to provide advice to Environment Canterbury regarding the development of FMUs for the Canterbury Region. The scope of the report includes the following:

- A review of the purpose and function of FMUs as defined in the NPS-FM and supporting documents;
- An assessment of the LWRP spatial framework including any relevant considerations for the definition of FMUs, implementation and management;
- A review of how FMUs have already been defined within the Canterbury Region and those currently under development;
- Identification of shortcomings in the existing spatial framework and/or advantages associated with making changes to it; and
- Recommendations for the definition of FMUs, where possible resulting in the smallest possible deviation from the spatial framework represented by the current LWRP.

[7] The NPS-FM defines a FMU to be '*A water body, multiple water bodies or any part of a water body determined by the regional council as the appropriate spatial scale for setting freshwater objectives and limits and for freshwater accounting and management*'

[8] Policy CA1, NPS-FM

2 Purpose, Function and Definition of FMUs

2.1 Background

The NPS-FM requires regional councils to identify the 'values' that are associated with the water bodies in their regions. These values must include the two compulsory values in the NPS-FM of *ecosystem health* and *human health for recreation*, as well as any other values that are appropriate. Councils must then establish the minimum physical condition of the resource (defined by *freshwater objectives*). Freshwater objectives are specified in terms of a range of metrics (referred to as *attributes)* which characterise the physical, chemical or biological condition of a water body.

Freshwater objectives form the basis and justification for defining limits and management actions that are required to achieve (or maintain) the values identified. Such management actions may include limits on resource utilisation (for example including volumetric or nutrient allocation limits), as well as specific policies and rules that control the way freshwater resources are utilised. Monitoring is then required to ensure that the specified objectives are being achieved. This process, by which values associated with water bodies form the basis for establishing freshwater objectives, and these in turn are used to define management actions (limits, policies and rules) to ensure freshwater objectives and limits are met, is illustrated in Figure 1 below.

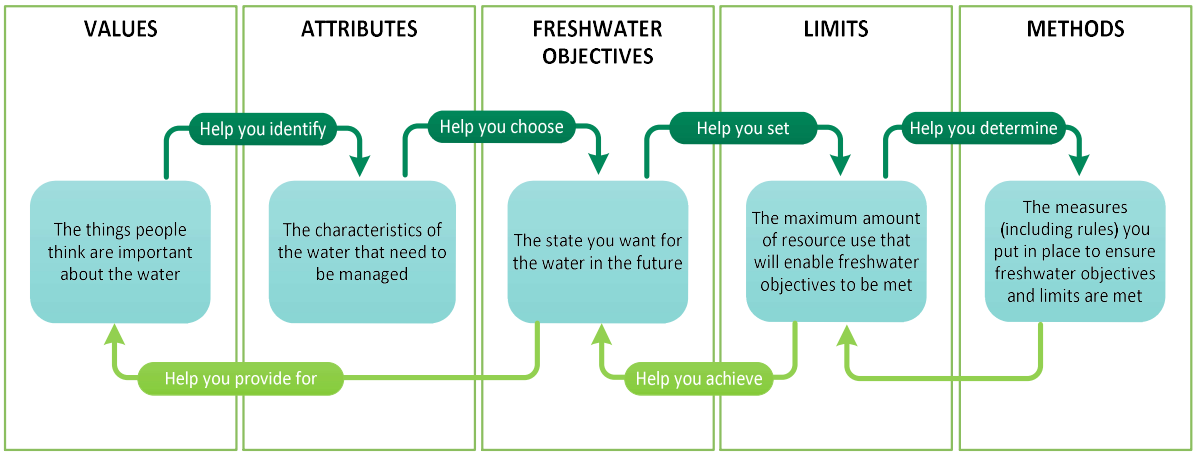

Figure 1. The NPS-FM framework from values to methods (from MfE, 2018[9])

In summary, management of the quality and quantity of freshwater resources under the NPS-FM requires an approach that:

- Identifies and incorporates community values associated with individual waterbodies or groups of waterbodies (including compulsory values specified in the NPS-FM as well as those identified by the community);
- Defines management objectives in terms of numeric attributes which establish the minimum environmental condition required to maintain the identified values;

[9] Ministry for the Environment. 2018. *A Draft Guide to Attributes in Appendix 2 of the National Policy Statement for Freshwater Management (as amended 2017)*. Wellington: Ministry for the Environment.

- Determines an appropriate balance between resource use and maintenance (or achievement) of management objectives through specification of management actions (including limits, policies and rules) that control use and development of the resource; and
- Provides for environmental monitoring and accounting of resource use to enable pressures on the resource, and the condition of the resource itself, to be measured over time.

Freshwater Management Units provide a spatial framework for implementation of the NPS-FM management framework.

2.2 Purpose and Function of FMUs

Given the quality, quantity, physical and bio-physical characteristics of water bodies and the values they support vary spatially, it is generally appropriate to establish specific (i.e. numeric) freshwater objectives at a catchment or sub-catchment scale.

The NPS-FM addresses this issue by requiring that regional councils subdivide their regions into FMUs which are defined by Ministry for the Environment (2016)[10] as:

> *A water body, multiple water bodies or any part of a water body determined by the regional council as the appropriate spatial scale for setting freshwater objectives and limits and for freshwater accounting and management.*

A regional plan that addresses water management at the regional scale requires a spatial framework of FMUs that subdivides water bodies and their catchments into groups to which differing management regimes apply. This provides a spatial framework for application of different plan provisions and management functions including:

1. Setting of freshwater objectives
2. Defining management actions including water quality and quantity limits, to achieve the objectives;
3. Accounting for resource use (within limits); and
4. Monitoring progress towards, and the achievement of, freshwater objectives.

The concept of FMUs provides for a pragmatic approach to freshwater management that enables:

- Water bodies with similar physical characteristics and values to be grouped together for the purposes of management;
- A single objective (or set of objectives) to be applied consistently to all similar water bodies (which are not necessarily hydraulically connected), thus reducing the number of plan provisions compared to what would be required to manage each water body separately; and

[10] Ministry for the Environment. 2016. *A Guide to Identifying Freshwater Management Units Under the national Policy Statement for Freshwater Management 2014*. Wellington: Ministry for the Environment.

- Management activities (e.g. setting of freshwater objectives and limits, application of rules and policies, monitoring of environmental outcomes) to be undertaken at an appropriate spatial scale.

Implicit in the NPS-FM definition is the idea that FMUs are to be established based on how water bodies, or parts of water bodies, are valued. There is therefore interdependence between establishing FMUs and determining the values (and associated objectives) for which they are to be managed. Consequently, the development of FMUs is integral to the plan development process and cannot be divorced from other normative[11] decisions that are required such as determining the level of protection for various water quality and quantity dependent values (i.e., setting freshwater objectives) and identifying appropriate management actions.

2.3 Definition of FMUs

The NPS-FM does not prescribe a set methodology for defining FMUs, rather it provides discretion for regional councils to develop management units in a manner that is appropriate to the specific circumstances of their region.

Given the development of FMUs is integral to the development of a regional water plan, we recommend that the methodology used to define the spatial framework should:

- Recognise spatial variation in the bio-physical and ecological function of water bodies;
- Recognise the hydraulic connection between water bodies, particularly where management actions applied to a specific area may also influence water quality or water quantity outcomes in downstream receiving environments;
- Be defined using a methodology that is transparent and reproducible to enable decision-maker(s) to weigh up alternative options;
- Support the development and application of management actions (i.e. limits, policies and rules) to land areas that drain to specific water bodies or groups of waterbodies, rather than necessarily to the waterbodies themselves;
- Be applied in a comprehensive manner across the region to enable a consistent management approach to be adopted; and
- Be developed at an appropriate scale to ensure management actions are sufficient to enable freshwater objectives to be achieved, while avoiding unnecessary or overly complicated regulation.

The following section outlines the methodology that that we have utilised to assist development of FMUs for several regional councils, specific details of which are provided in Section 2.4 below.

[11] Decisions that concern the prescriptive aspects of the plan such as the definition of objectives and rules and that are ultimately made by a political process.

2.4 Regional Approaches to Defining FMUs

Most regional councils have either developed regional water plans or are in the process of doing so. Some councils have operational second generation plans that were developed prior to the release of the NPS-FM, but which address many NPS-FM requirements including numeric objectives and limits. All regional councils have had to account for regional differences in the values and characteristics of water bodies and generally have plan objectives and policies that recognise this variation to at least some extent. Some councils are well advanced with development of second generation plans in response to the requirements of the NPS-FM (including defining FMUs). However, councils have approached this in various ways. The following is a brief summary of how four other councils in New Zealand have defined their FMUs.

Horizons (Manawatu-Wanganui) Regional Council has defined 44 water management zones and 117 subzones in the Manawatu-Wanganui region's One Plan. These zones are based on catchments or sub-catchments and encompass the water bodies within the zone and the surrounding catchment land area. Water quality and quantity related values for the water bodies in each zone have been identified and objectives defined. Because the Horizons water management zones/subzones are catchment-based, they enabled specific load-based nutrient limits to be defined for managing water quality in each zone. To assess compliance with the objectives and limits, a monitoring site is required at the downstream end of each zone. It is anticipated that some management functions will occur at the subzone level (e.g. surface water quantity allocation), while other management functions will occur at the zone level (e.g. water quality monitoring).

Taranaki Regional Council has defined freshwater management units in its draft second generation regional plan based on a subdivision of the region into four sub-regions that are primarily based on environmental characteristics. These sub-regions discriminate variation in the values, and physical and hydrological characteristics of the water bodies they contain. The sub-regions contain whole catchments and the sub-region boundaries therefore align with catchment boundaries. The Taranaki FMUs broadly differentiate the streams and catchments draining Mount Taranaki (the "ring plain"), the northern and southern coastal terraces and eastern hill-country. In addition, one FMU differentiates three non-contiguous "Outstanding" rivers and their catchments.

Greater Wellington Regional Council utilised a bio-physical classification to delineate preliminary FMUs for rivers and streams within different geographic areas of the region (large-scale management units referred to as *Whaitua*). The classification system utilised a modified version of the River Environment Classification (REC) system to classify the surface water drainage network based on bio-physical characteristics that are related to the management of water quality and quantity. The modified REC classes are used to define management classes and the land that drains to each class defines its management zone. It is expected that the preliminary FMUs will be modified as the Whaitua planning process proceeds to include additional considerations such as human rather than bio-physical factors and/or additional bio-physical factors of particular water bodies, objectives and policies.

Finally, Northland Regional Council (NRC) have considered how to define FMUs for their geographically complex region which comprises many (i.e. > 100) "sea-draining" catchments that exhibit considerable variation in natural factors such as topography, geology and land use. Data describing the characteristics of these water bodies is limited with long-term water quality monitoring restricted to 35 sites. In addition, some sea-draining catchments are too heterogeneous with respect to values and capacity for resource use for a single set of plan

provisions to be justifiably applied, and many catchments and sub-catchments are very similar to each other with respect to values and capacity for resource use.

The approach taken by NRC has been to define FMUs based on grouping water bodies into bio-physical management classes that are relatively homogeneous with respect to their values and capacity for resource use. These classes form the basis for plan objectives and it is anticipated that the detail of the classification (i.e. the number of classes) will allow objectives and subsequent policies to be drafted at an appropriate level of specificity. A benefit of this approach is that available data are used to represent the state of water quality in the FMUs and the current monitoring sites could be used to monitor their progress toward objectives in the future. The NRC FMUs define management zones as the land draining to each management class in the same manner as the GWRC Whaitua FMUs.

2.5 Our Recommended Approach to Defining FMUs

The following outlines our the approach we have developed for defining FMUs at a regional scale, specific examples of which in the Wellington and Northland Regions are detailed in the previous section.

2.5.1 Spatial Scale

The scale of FMUs is a key consideration for the definition of FMUs. Large FMUs may not provide sufficient resolution of values, community aspirations for freshwater management, and consequently result in plan provisions that lack adequate specificity to ensure management values are adequately maintained. By contrast, many independently defined and/or small FMUs may produce overly detailed plan provisions which potentially increase regulatory and financial burden and result in inefficient water resource management.

The purpose of FMUs is to provide a basis for setting water quality and quantity objectives and associated limits, and for managing and accounting for water resource use. Consequently, hydrological units (i.e., catchments, aquifers) typically form the basic units for defining FMUs. Delineation of FMUs based on catchments enables the overall function of the hydrological system (e.g. contribution of upstream drainage to downstream environments) to be accounted for. This linkage recognises that spatial variation in environmental characteristics (including climate, topography and geology) within a catchment exerts a major influence on the values, physical condition and ecological function of water bodies, and the nature of the resource use that occurs within a catchment (e.g., land use, water takes and point source discharges).

Catchments can be defined at different scales, for example, the entire land area that drains to a river mouth at the coast (e.g. a sea-draining catchment) or a smaller scale subdivision of a larger catchment into tributary streams. Management at a whole catchment scale may be appropriate for issues such as sedimentation rates or nutrient enrichment in estuaries and harbours. However, where there is spatial variation in values, water quality or resource use within a catchment (e.g., if the catchment includes a lake or parts of the same river system support significantly different values) management may be more appropriate at a sub-catchment scale.

The scale at which FMUs are defined ultimately depends on achieving reasonable (and practical) homogeneity (i.e., degree of similarity) with respect to key characteristics of the water bodies they contain, including;

- their values,
- their capacity for use, and
- management requirements resulting from their bio-physical functioning[12].

The size of a sub-catchment generally determines its homogeneity with respect to values and other characteristics. Water bodies in small sub-catchments such as headwater areas are likely to be relatively similar, whereas large sea draining catchments may contain a more diverse range of values and other characteristics. Defining a regional framework of FMUs therefore involves subdividing catchments such that the values and other characteristics they contain are sufficiently homogeneous that a set of plan provisions can be justifiably applied, and that the level of detail and complexity is minimised (e.g., the scale is as coarse as possible).

The benefit of using a drainage network as a basis for defining FMUs is that the catchment upstream of any specific point along a water body can be defined. Each point in the drainage network has its own unique sub-catchment defined by all the upstream land draining to that point. Because a drainage network allows subdivision of the region's catchments to be carried out at any scale, the optimal scale (or alternative scales) of sub-division can also be explored.

2.5.2 Management Classification

The initial step in the definition of FMUs involves grouping of a region's water bodies into classes that are relatively homogenous with respect to management to produce a *management classification* which forms the basis for defining freshwater objectives for the water bodies in a region. Factors used to classify waterbodies typically include:

- Their environmental and biophysical characteristics and associated values; and
- The capacity of the water bodies and their catchments for resource use.

A *management classification* contains a number of individual *management classes*, many of which are likely to occur within multiple hydraulically separate catchments within a given region. In addition, individual catchments often comprise water bodies (or individual stream reaches in the case of surface waterways) that belong to differing *management classes* reflecting changes in their physical characteristics and ecological function between their source and furthest downstream extent.

Management classifications can potentially range from a simple categorisation of water body type (e.g., stream, lake, aquifer), through to more complicated bio-physical classifications based on physiographic 'factors' that drive variation in water quality and quantity (e.g. climate, slope, geology, river size). Management classifications may also include specific classes that are established to recognise existing water management arrangements (i.e. specific groupings of waterbodies managed for specific/localised uses or values).

One particular benefit of management classifications based on bio-physical characteristics is that the basis for delineation of FMUs is transparent and alterable (by changing the factors and/or their categorisation) and can be applied generally to an entire region.

[12] For example, differences in the flow regimes and morphology of streams and rivers within large sea-draining catchments may be sufficiently large that different minimum flow, flow allocation and nutrient concentration criteria are appropriate in different parts of the catchment.

The resolution (or level of detail) of the management framework can be altered by varying the number of classes within the *management classification*. Greater resolution can be achieved by defining more *management classes*. Higher resolution enables more specific objectives and more nuanced management actions (limits, policies and rules) to be defined. However, a greater number of management classes increases the effort and data needed to justify them and is likely to increase the complexity and detail of plan provisions that relate to individual management classes. There is also likely to be tension between the level of detail that is technically and scientifically justifiable (and achievable) and other considerations such as catering for the desire of stakeholders for spatially nuanced policies and limits.

Figure **2** shows a schematic illustration of the application of a basic management classification to a simplified hydrological system. As shown, management classes may be based on waterbody type (e.g., lake or aquifer), land use or land cover characteristics (e.g. natural state) or the physiographic and/or ecological characteristics of surface water bodies (e.g. alpine, hill and lowland streams).

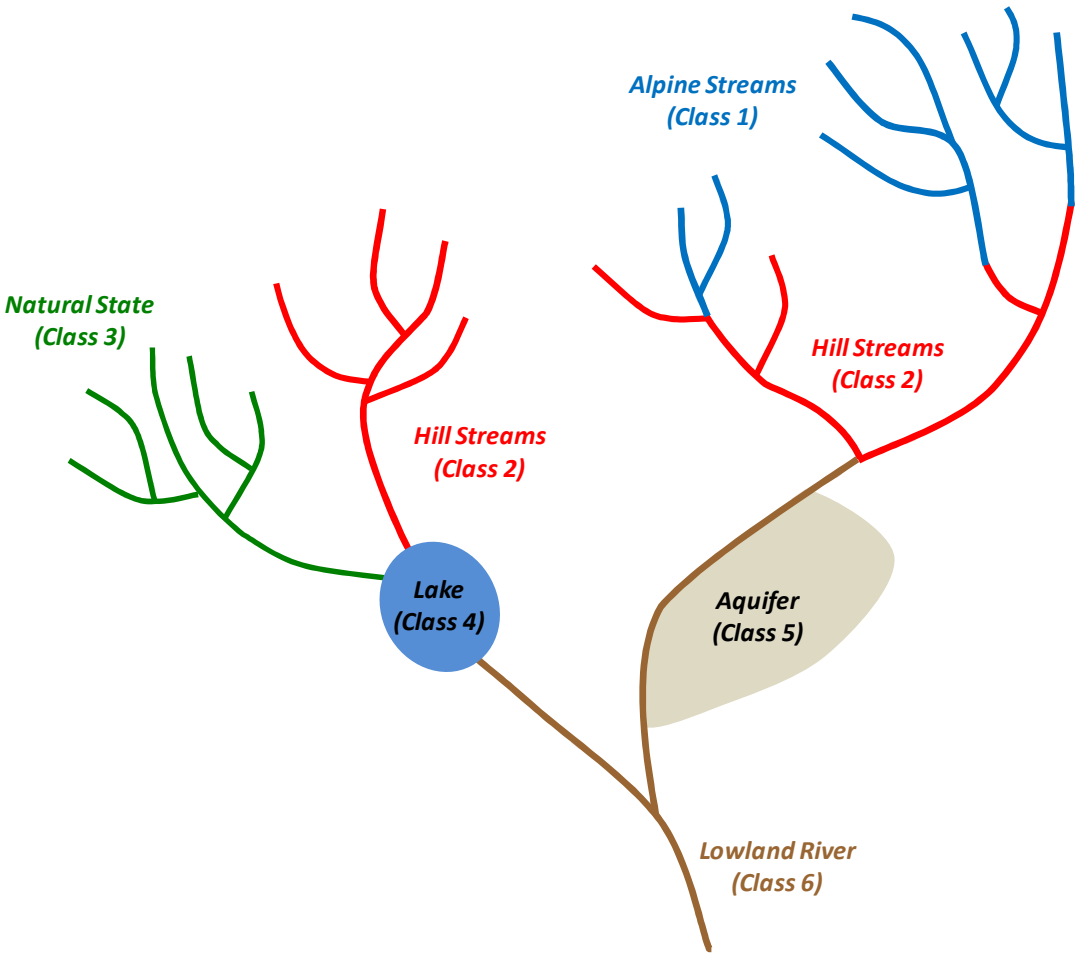

Figure 2. Schematic illustration of the application of a simple management classification to water bodies within a hydrological system

2.5.3 Management Zones

Management zones comprise all land areas that drain to a particular *management class.* The definition of management zones recognises that many of the management actions (i.e., limits, policies and rules) required to achieve freshwater objectives apply not only to the water bodies themselves, but to the land areas (and associated land use and development) that drain to them.

Like the *management classes*, *management zone*s are not restricted to a single catchment and may be spatially non-contiguous (i.e., recur in a patchwork across a region). In addition, individual locations can belong to more than one management zone because there may be more than one management class downstream of that point. Figure 3 provides a schematic illustration of selected management zones defined within a catchment.

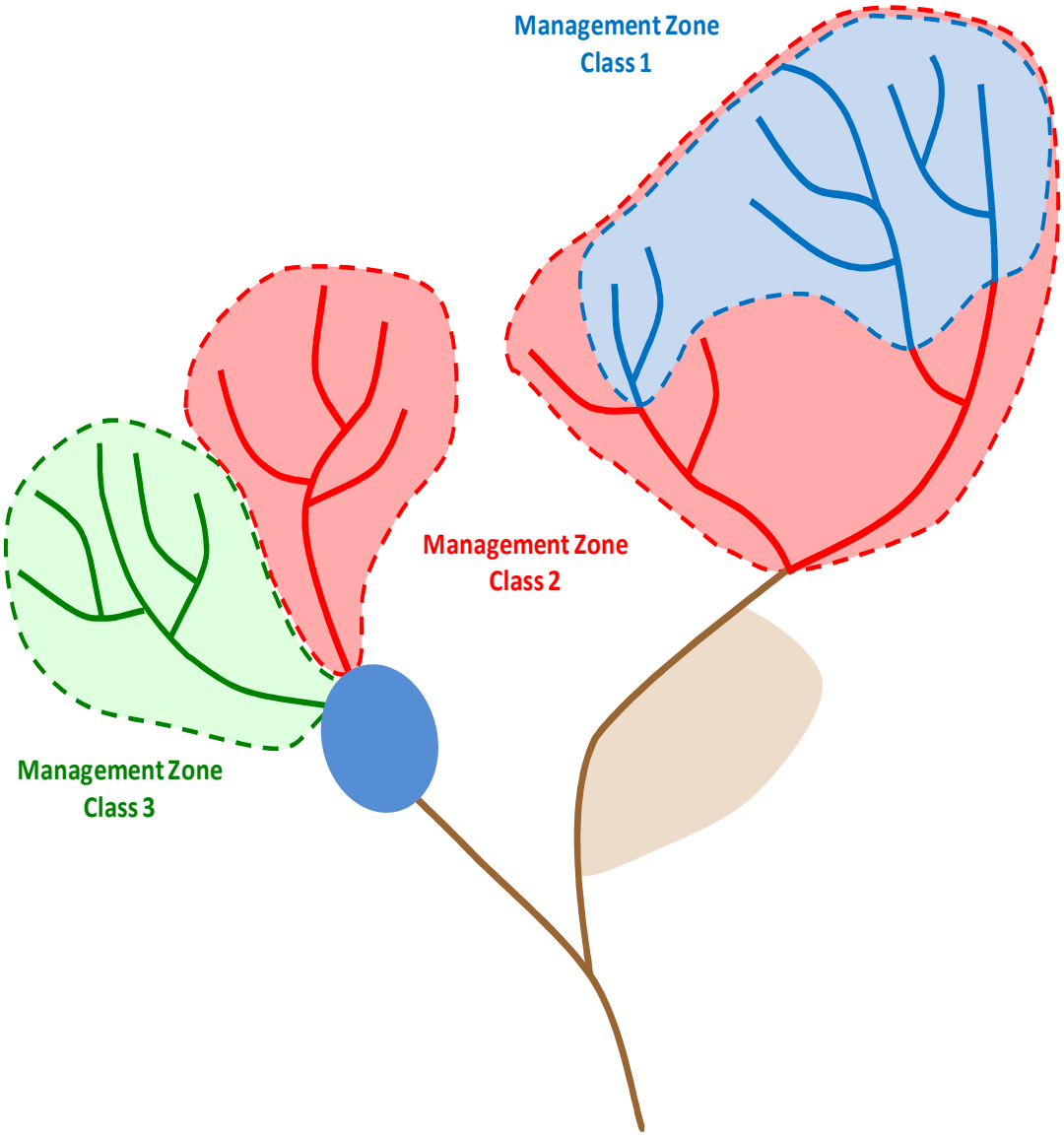

Figure 3. Schematic illustration of management zones for selected management classes within a simplified hydrological system (Note: for simplicity, management zones for the lake, aquifer and lowland stream classes from Figure 2 are not shown).

2.5.4 Special Management Zones

It is recognised that some water bodies may be associated with specific values or management issues that are not discriminated by generalised *management classification*s, but which may need to be provided for in a regional plan. These water bodies can be associated with location-specific *special management zones* that have the potential to over-ride the objectives set for the wider *management classes* defined in an FMU.

Examples of water bodies requiring separate management objectives could include sites of significance such as specific estuaries, swimming spots, or sites of special cultural or ecological significance. Another example of water bodies with specific localised values may be those in which significant infrastructure has 'permanently' modified the hydrological system such as large dams. Recognising the specific values associated with these water bodies, catchments upstream of such points may be designated special management zones for which specific plan provisions (objectives and policies) would apply.

It is noted that special management zones will add to the complexity of the plan (by creating exceptions to the policies that apply to the general FMUs). It is therefore recommended that specific criteria are derived that specify the circumstances in which special management zones may be defined to avoid undermining clarity and relative simplicity that is afforded by taking a more systematic approach to defining FMUs.

2.5.5 Administrative Points

The NPS-FM requires regional councils to undertake a range of functions related to the sustainable management of freshwater resources. Among these functions, councils are required to establish limits and other management controls to ensure that freshwater objectives are met and account for contaminant discharges and water use at an appropriate scale. *Administrative points* recognise that controls on contaminant discharges and water takes must occur and be accounted for within individual catchments and sub-catchments in order for freshwater objectives to be met.

Administrative points are locations at which for example, nutrient load limits (for water quality objectives) and volumetric allocation limits (for water quantity objectives) can be defined in absolute terms, and where resource use accounting can be undertaken. Contaminant load limits and volumetric allocation limits can be determined in absolute terms for each individual administrative point provided that they are defined for the FMUs on a scalable basis. Examples of scalable limits include a proportion of a nominated flow statistic that reflects stream size such as the Mean Annual Low Flow (MALF) for water quantity, and an areal loss rates for nutrients (e.g. kg/ha/year). It is noted that scalable limits are often used as default methods in regional plans and are justifiable provided a spatial framework of FMUs allows for the limits to vary appropriately with regional variation in values, capacity for resource use and management requirements.

A minimum set of *administrative points* can be pragmatically defined at locations in the drainage network where there is a change in the management zone. Figure 4 illustrates the location of administrative points within a nominal catchment. Each of these points may represent a sub-catchment or catchment for which a limit can be established in absolute terms (e.g., a nutrient load in kg/year, and allocation in l/s), or where resource accounting is undertaken. Additional *administrative points* may also be defined at a finer scale if necessary to support implementation of management actions required to achieve freshwater objectives.

Administrative points are important only in terms of plan implementation. There may be a large number of *administrative points,* but this need not result in a complicated plan or a large amount of environmental monitoring because freshwater objectives and water quality and quantity limits are set for a limited number of *management classes* and associated *management zones*.

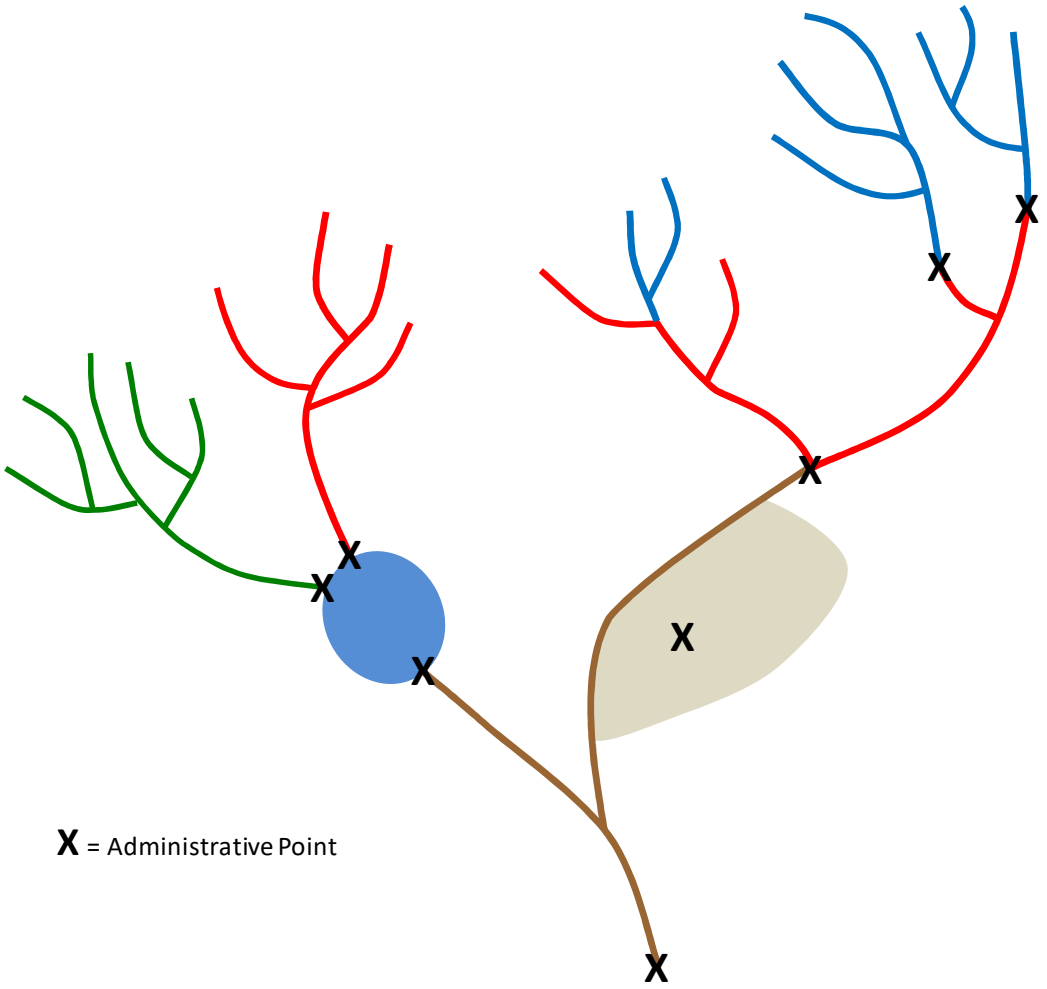

Figure 4. Example locations of administrative points within a simplified hydrological system

2.5.6 Environmental Monitoring Sites

Environmental monitoring sites are locations within the hydrological system where information is gathered to determine the condition of the resource. Monitoring of both water quality and quantity (e.g. monitoring flows or water levels) is typically undertaken at representative sites and the data collected at these sites used to determine if freshwater objectives are being met in management classes as a whole, or to provide proxy measurements (e.g., flows) at specific administrative points. Environmental monitoring also provides information to quantify and determine the effectiveness of management actions (e.g., limits, policies and rules).

Environmental monitoring sites are distinct from administrative points in that they provide representative data for individual management classes. This information is used to

determine if the management actions are adequate to ensure freshwater objectives are being achieved.

2.5.7 FMUs

As illustrated in

Figure ***5***, FMUs are defined by a pragmatic layering and merging of *management classes*, *management zones and administrative points* in an order that is dependent on the objectives, policies and limits set for each of the management classes and management zones within the FMU itself. This structure:

- Recognises the “mountains to sea” nature of the hydrological system, which is a key driver of variation in characteristics, values and objectives within a catchment. For example, upland rivers are typically associated with different values (and hence objectives requiring different limits, policies and rules) than lowland rivers. Likewise, aquifers are managed for different values than lakes or wetlands.
- Provides a spatial framework for identification and application of different plan provisions. For example, freshwater objectives are applied to water bodies within a particular management class while policies and rules are applied to the land areas that drain to that specific management class. Limits may apply to combinations of management zones ensue the objectives of a specific class are met;
- Enables management of different resource management issues (e.g. water quality versus water quantity, and surface and groundwater);
- Provides a basis for administration of different management functions including setting objectives, defining policies and limits, accounting for resource use and assisting in consenting processes;
- Provides a logical framework for evaluation of monitoring data. Monitoring data can be used to determine the current state of the resource with respect to nominated objectives, identify compliance with limits and evaluate the effectiveness of management actions (e.g. policies and rules) in achieving freshwater objectives.

The layering and merging of spatial entities to define FMUs recognises that locations that lie in multiple management zones must be subject to management actions (e.g. limits, policies and rules) that are sufficient to achieve the *most restrictive downstream objectives*.

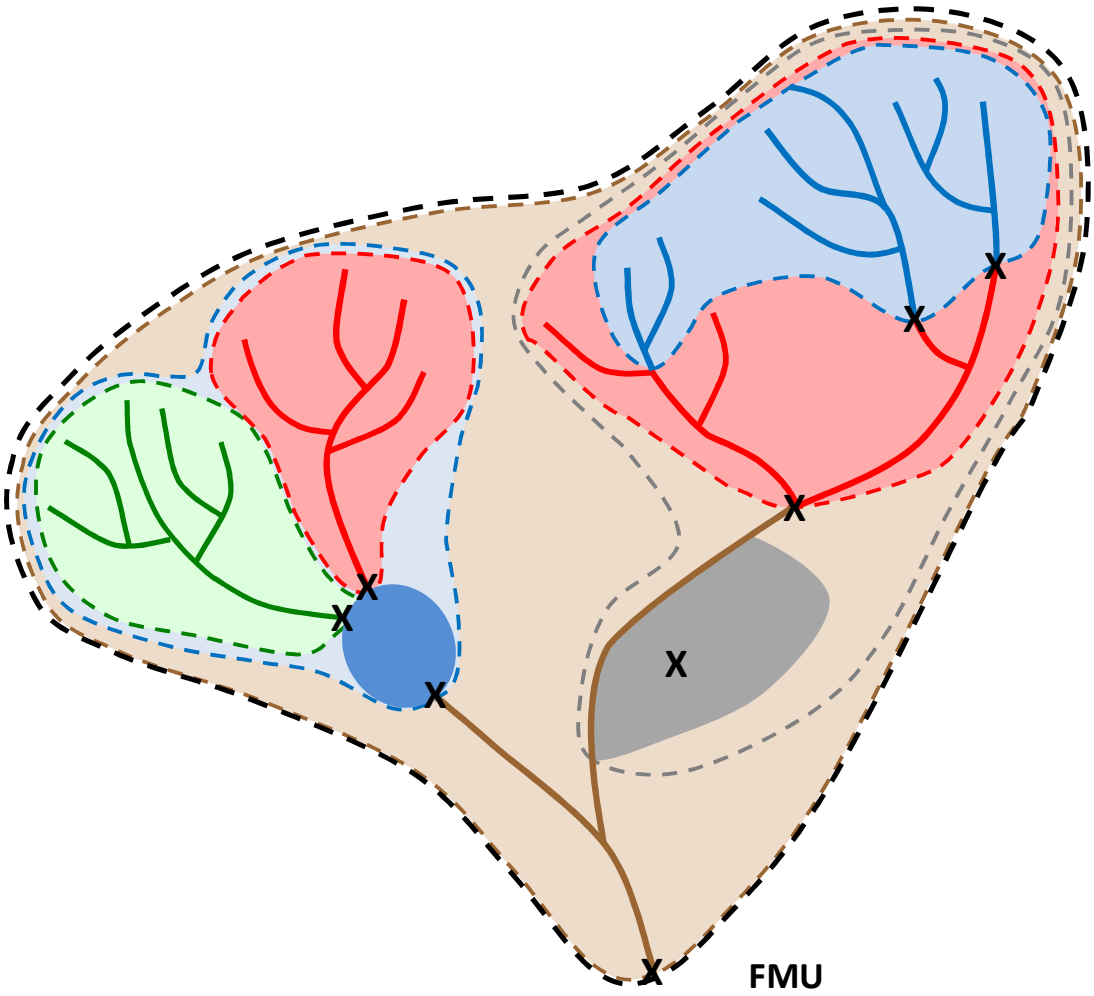

Figure 5. Schematic illustration of the layering of management classes, management zones and administrative points within an FMU

For example, in some circumstances land may drain to a river segment that is relatively insensitive to the effects of nutrient concentrations. However, further downstream, the river may flow into a lake or estuary that is more sensitive to elevated nutrients. In this case, limits set for point and diffuse source discharges in all upstream catchments need to ensure that the more restrictive management objective for the (downstream) lake or estuary is achieved. Thus, the management regime applied to individual management zones must be sufficient to meet both local freshwater objectives (i.e. those established for that specific management class), as well as those applying to management classes downstream of that point.

This concept is illustrated in Figure 6 below. In the example shown, if freshwater objectives sequentially decrease from management class A to management class C, then the management regime applied to management zone A must be sufficient to meet freshwater objectives for management class A and ensure that in objectives can be met in management classes B and C. Likewise, in Zone B, the management regime must be sufficient to ensure that (in combination with Zone A) management objectives are achieved in both management class B and C.

However, if freshwater objectives established for management class C are more restrictive than those applying to classes A or B, then the management regime applied to both upstream Zone A and B will need to be more restrictive than that required to achieve objective for each of the respective management classes (i.e., it will be determined by the most constraining downstream objective).

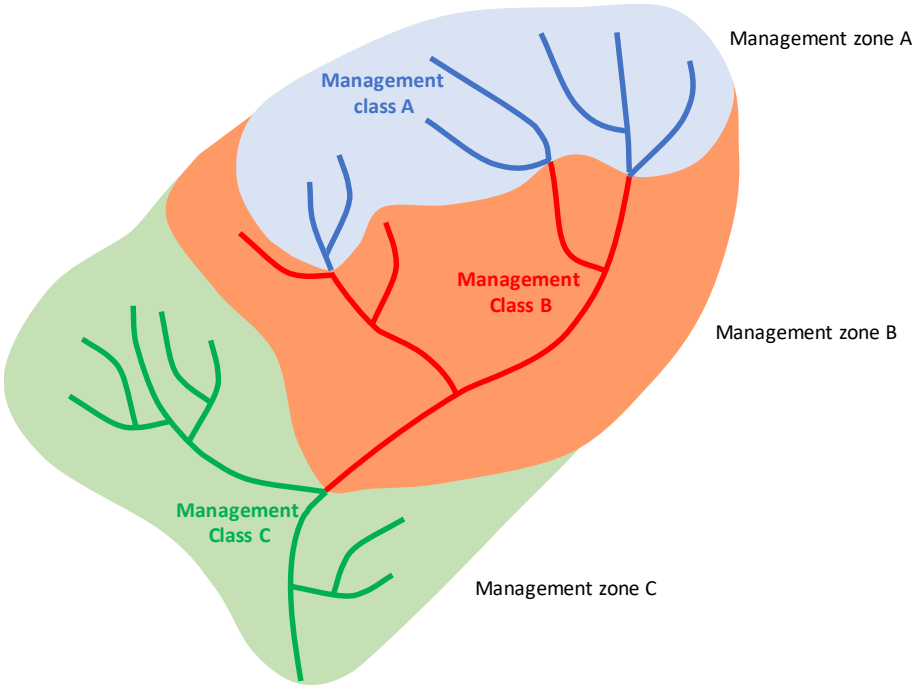

Figure 6. Schematic illustration of the management classes and management zones in a catchment

It is noted that the process of determining an appropriate management regime based on the most constraining downstream objective may result in some management zones effectively becoming 'redundant' and able to be merged with other management zones, thus simplifying the overall structure of the FMU.

Given that freshwater objectives and associated management regimes (e.g., limits, policies and rules) are established through the policy development process there is interdependence between defining FMUs and determining the plan provisions that apply to them. Consequently, the development of FMUs is integral to the plan development process and cannot be divorced from decisions that are required in the planning process such as determining the level of protection for various water quality and quantity dependent values (i.e., setting freshwater objectives) and identifying appropriate management actions required to achieve the nominated objectives. Definition of FMUs is therefore part of the development of a regional water plan and cannot be undertaken separate to the policy development process.

Figure 7 below is a schematic diagram of the relationship between FMU components (management classes, management zones and administrative points) and plan provisions and associated functions (resource allocation and monitoring).

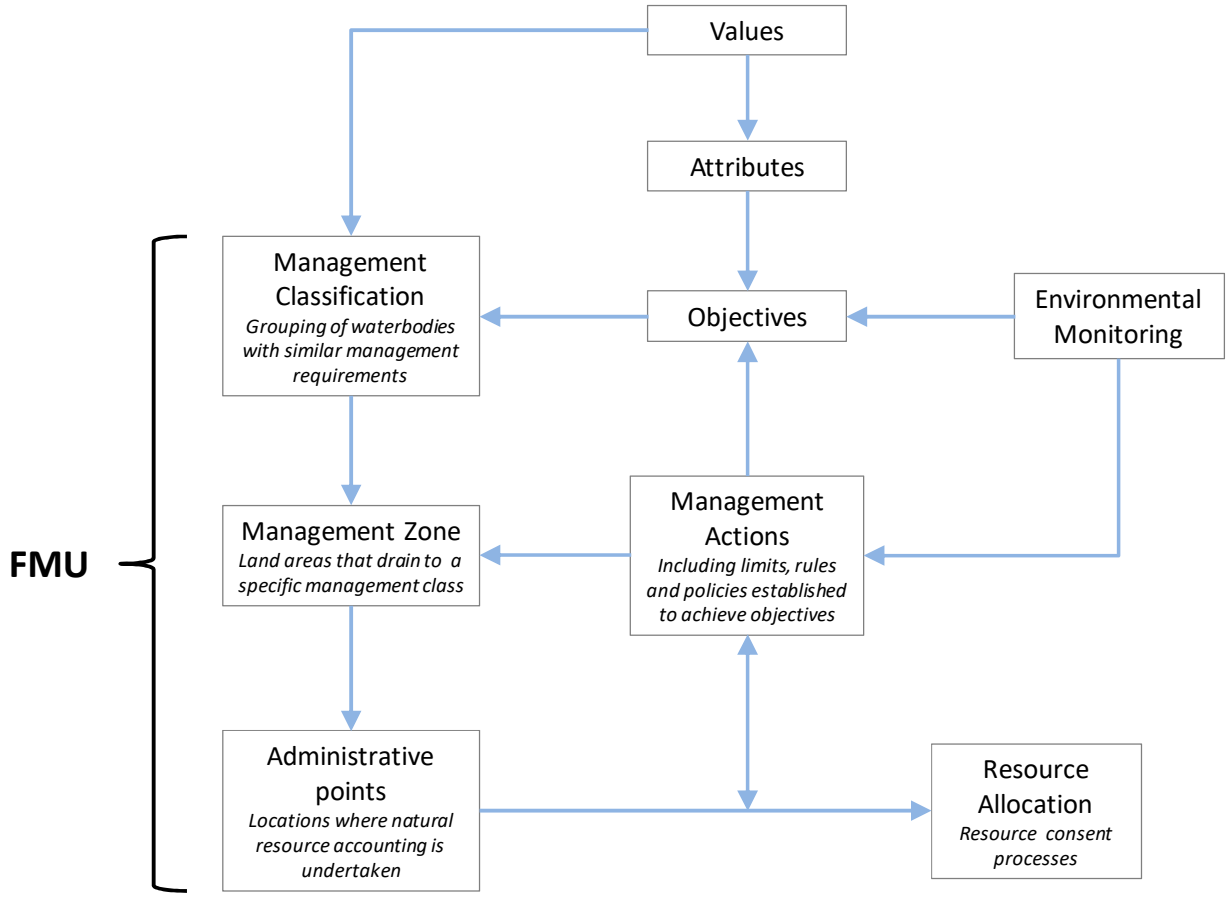

Figure 7. *Schematic diagram illustrating the relationship between FMU components and regional plan provisions and associated functions*

3 LWRP Spatial Framework for Water Management

3.1 Background

The Canterbury Water Management Strategy (CWMS) was initiated in 2009 to enable a more collaborative approach to water management across the Canterbury Region. Prior to this initiative development pressure on the region's water resources resulted in an adversarial approach to the allocation and management of freshwater resources, often resulting in sub-optimal outcomes.

The CWMS Strategic Framework established 10 separate management zones[13] across the Canterbury Region as illustrated on Figure 8 below. Each zone is overseen by a Zone Committee comprising iwi and representatives of the local community and regional and territorial council representatives, with representatives from each zone committee also forming a Regional Committee. Each zone committee is responsible for preparing a zone implementation programme (ZIP) outlining the zone committee's vision and community outcomes sought along with proposed actions to address fresh water management issues

[13] In this report we refer to *CWMS water management zones* as "CWMS zones" to limit potential confusion with other management zones used to delineate FMUs

for their zone. Each ZIP is the result of extensive community involvement and discussion to develop local solutions which give effect to the priorities for freshwater management articulated in the CWMS and relate to a specific sub-region defined in the Canterbury Land and Water Regional Plan (LWRP). Addendums to the ZIPs are developed through the same process that specifically provide recommendations for sub-regional planning provisions (including limits), along with other non-statutory actions.

MfE guidance on establishing FMUs (Ministry for the Environment, 2016) recognises that existing management arrangements and communities of interest are an important factor in determining the geographic extent of FMUs. Given the governance arrangements established under the CWMS and LWRP, the 10 CWMS zones form a logical framework underlying definition of FMUs across the wider Canterbury Region.

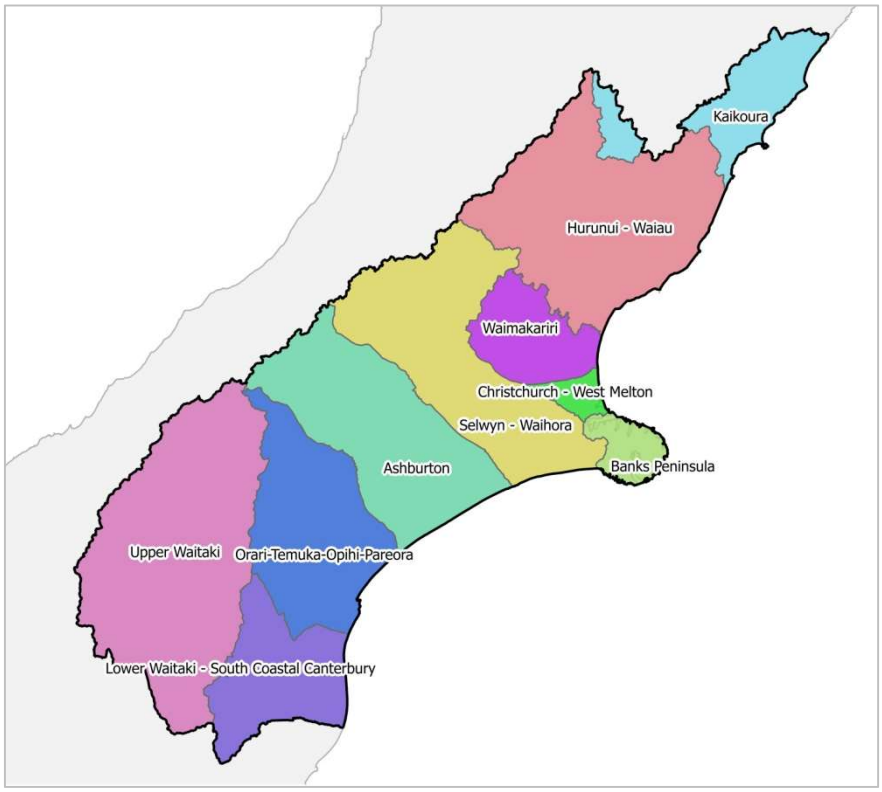

Figure 8. Canterbury Water Management Strategy (CWMS) zones

3.2 LWRP Spatial Framework

The Canterbury Land and Water Regional Plan (LWRP) provides direction and guidance for the sustainable management of land and water resources in the Canterbury Region. The LWRP was made operative in late 2016, replacing the earlier Natural Resources Regional Plan (NRRP). The LWRP is structured to give effect to the CWMS process, with 10 sub-regional chapters which relate to individual CWMS zones. Alongside these, the LWRP also specifies region-wide objectives, policies and rules which apply where location-specific provisions have not been established in the various sub-regional chapters.

At a regional-scale the LWRP defines default water quality and water quantity objectives for all water bodies in the region based on bio-physical classifications of ten river classes and

six lake classes. For rivers, the classes are based on the River Environment Classification (REC), which was developed by the Ministry for the Environment as a tool for various aspects of water management (Snelder and Biggs, 2002[14]).

Provisions in sub-regional chapters of the LWRP define water quantity limits (e.g., minimum flows and allocations), and nutrient load limits that have been set at catchment or sub-catchment scales. In some areas groundwater zones are also defined for groundwater allocation and these often have different boundaries than the surface water allocation zones.

Reflecting the outcome of specific CWMS sub-regional processes, the LWRP also defines surface water quality FMUs in the Waitaki catchment. Other sub-zones including the Orari-Temuka-Opihi-Pareora (OTOP) zone and the Waimakariri zone have defined draft FMUs as part of the ZIP process.

The following section provides a summary of components of the spatial framework for the management of water allocation and water quality specified in the LWRP that are of relevance to future development of FMUs in the Canterbury Region.

3.2.1 Surface Water Allocation Zones

The LWRP specifies environmental flows and allocation limits for surface waterways in the Canterbury Region either via catchment (or sub-catchment) specific limits established in sub-regional chapters[15] or the region-wide (default) allocation limits specified in Chapter 5.

The catchment-specific surface water allocation limits comprise minimum flows and allocation blocks specified for specific environmental monitoring or administrative points. The LWRP default minimum flow and allocation regime is based on a percentage of the 7-Day Mean Annual Flow (7DMALF) set at a threshold to achieve CWMS targets related to supply reliability and ecosystem health. Other methods specified in the LWRP to manage the abstraction of surface water include controls on stream depleting groundwater takes, partial restrictions on abstraction, restrictions on transfers within or between allocation zones, and provision for water user groups. Figure 9 below shows the geographic extent of surface water allocation zones specified in the LWRP.

[14] Snelder, T. H.; Biggs, B. J. F. 2002: Multiscale river environment classification for water resource management. Journal of the American Water Resources Association 38: 1–15

[15] Equivalent limits are also specified in the Hurunui and Waiau River Regional Plan, Opihi River Regional Plan, Pareora Catchment Environmental Flow and Water Allocation Regional Plan, Waimakariri River Regional Plan, Waipara Catchment Environmental Flow and Water Allocation Regional Plan and the Waitaki Catchment Water Allocation Regional Plan. These plans operate separately from the LWRP until such time as the CWMS zone process is complete at which point they (or their equivalent/replacement) will be incorporated into the relevant LWRP sub-regional chapter(s).

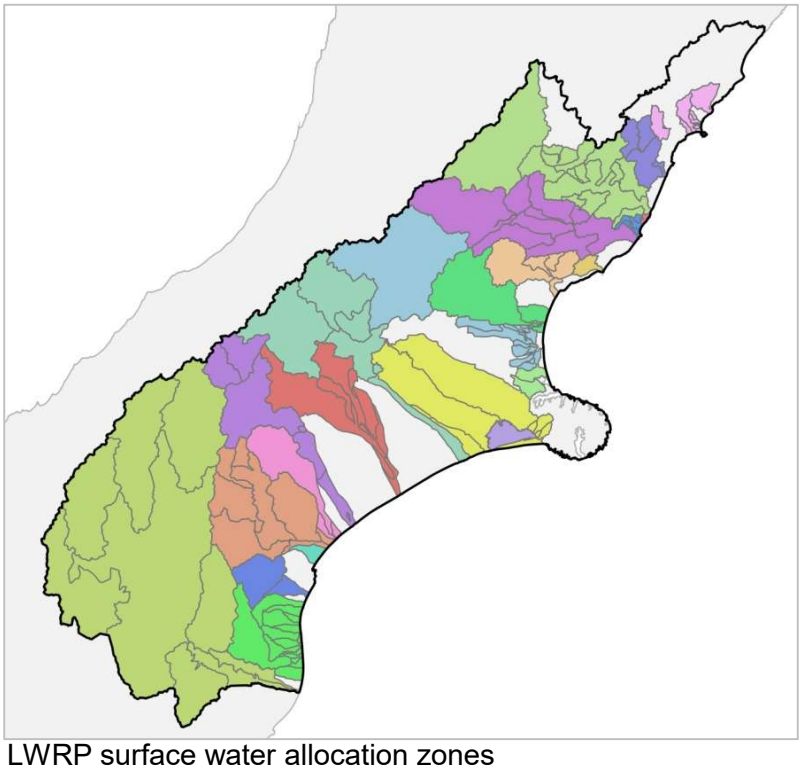

Figure 9. LWRP surface water allocation zones

3.2.2 Groundwater Allocation Zones

As illustrated on Figure 10 below, sub-regional chapters of the LWRP specify volumetric allocation limits for a significant number (in excess of 40) groundwater allocation zones. Outside of the defined zones, groundwater allocation is managed in terms of Policies and Rules outlined in Chapters 4 and 5, including limit on abstraction of groundwater as a permitted activity.

The groundwater allocation zones identified in the LWRP effectively delineate management zones (as defined in Section 2.5.3 above) for the purposes of managing groundwater quantity. In some locations these management zones are defined both spatially and with regard to depth. For example, Chapter 9 of the LWRP specifies a management regime within the Woolston/Heathcote allocation zone that differentiates management controls on groundwater takes according to depth.

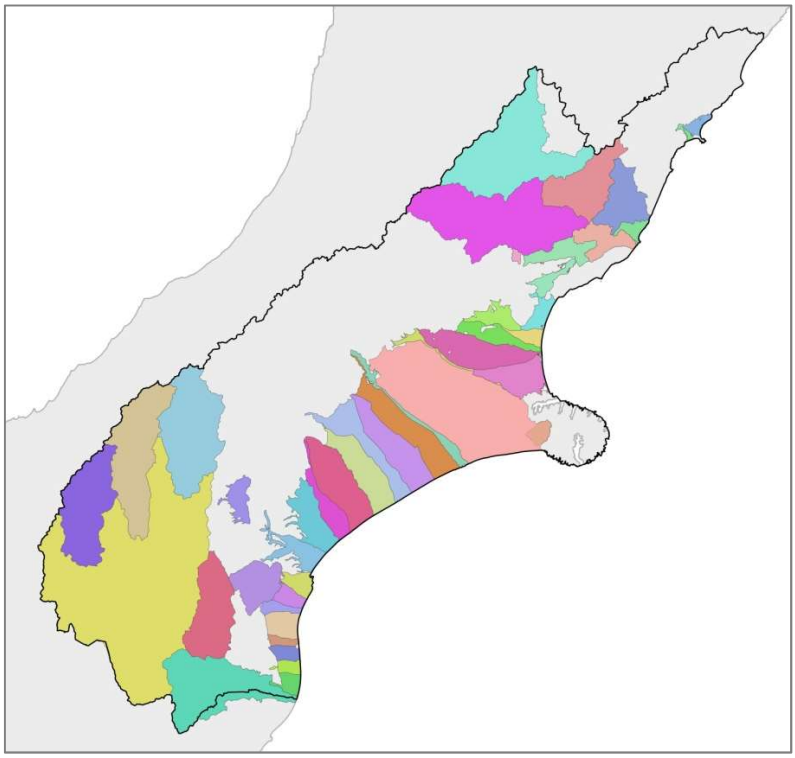

Figure 10. LWRP groundwater allocation zones

3.2.3 Nutrient Allocation Zones

The LWRP specifies a large number of nutrient allocation zones (NAZ) which provide a framework for managing nutrients (specifically N and P) to achieve nominated surface water quality outcomes. The NAZ are typically based on the surface and groundwater quantity management units with modifications to reflect nutrient transport processes (i.e., source to sink relationships) and localised receiving environments of significance (e.g., lakes). Each NAZ is classified using a broad assessment of catchment nutrient status with respect to water quality objectives. The classification assigned to each individual NAZ is then used to apply region-wide nutrient management rules intended to enable relevant freshwater objectives to be achieved (or maintained).

Overall, the NAZ define surface water quality management zones relevant to specific nutrient-related water quality attributes. Depending on the catchment, these attributes may be generalised to all surface water bodies in the NAZ or, as in the case of the Upper Waitaki, specific to nominated water bodies located at the downstream extent of the NAZ

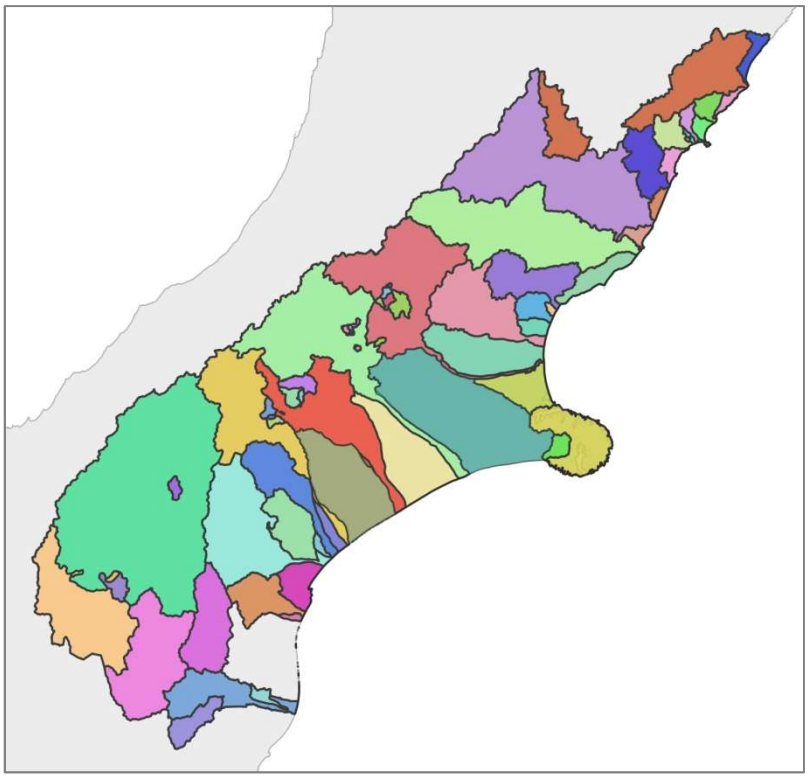

Figure 11. LWRP nutrient allocation zones (NAZ)

3.2.4 Water Quality Management Classes

At a regional-scale the LWRP defines default water quality and water quantity objectives for all water bodies in the region based on bio-physical classification of ten river classes and six lake classes (Figure 12). Table 1a of the LWRP establishes freshwater quality outcomes for each management class in terms of attributes for ecological health, eutrophication, visual quality and microbial quality.

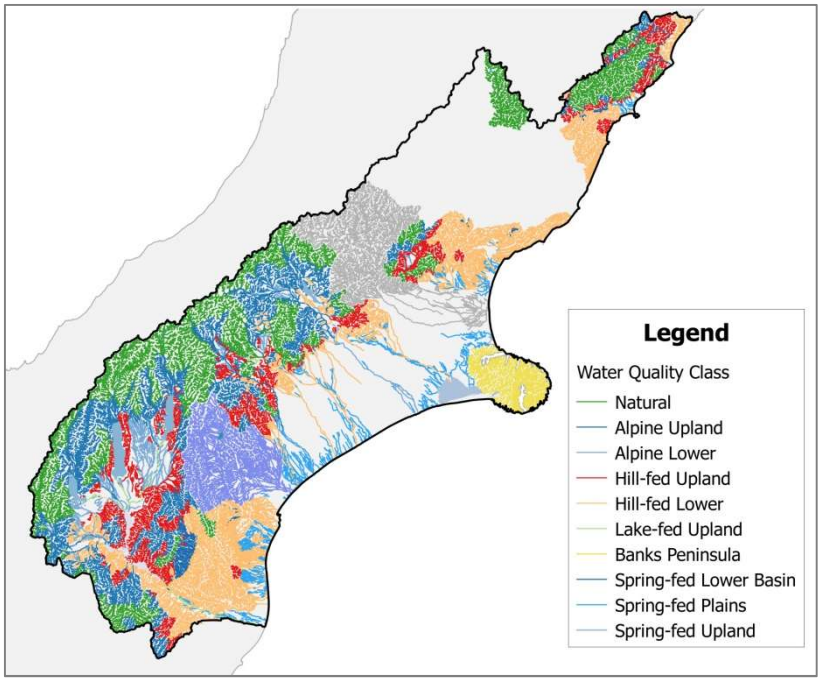

Figure 12. Water quality management classes defined in the LWRP

3.3 FMUs

3.3.1 Waitaki Sub-Region FMUs

Plan Change 5 to the LWRP introduced four surface water quality FMUs[16] for the Waitaki sub-region into the LWRP (Upper Waitaki, Hakataramea, Valley and Tributaries and Northern Fan) to facilitate catchment-specific management of nutrients and associated effects on freshwater values (Figure 13). Delineation of the spatial extent of the FMUs involved consideration of a number of factors including;

- The spatial scale appropriate for setting freshwater objectives and limits and for freshwater accounting and management purposes;
- Receiving environment;
- Communities of interest across the wider catchment;
- The design of a monitoring plan that included representative sites for monitoring freshwater objectives; and
- The design of an accounting system commensurate with water management issues in different parts of the catchment.

Within each FMU modifications were made to existing NAZ defined in the LWRP to reflect technical analysis of catchment hydrology, nutrient losses and resulting effects of land management on water quality objectives. Each of the modified NAZ are subject to a specific

[16] Water quantity is managed separately under the Waitaki Water Allocation Regional Plan

management regime which was developed to reflect existing water quality (with respect to water quality objectives) at specific administrative points within each FMU.

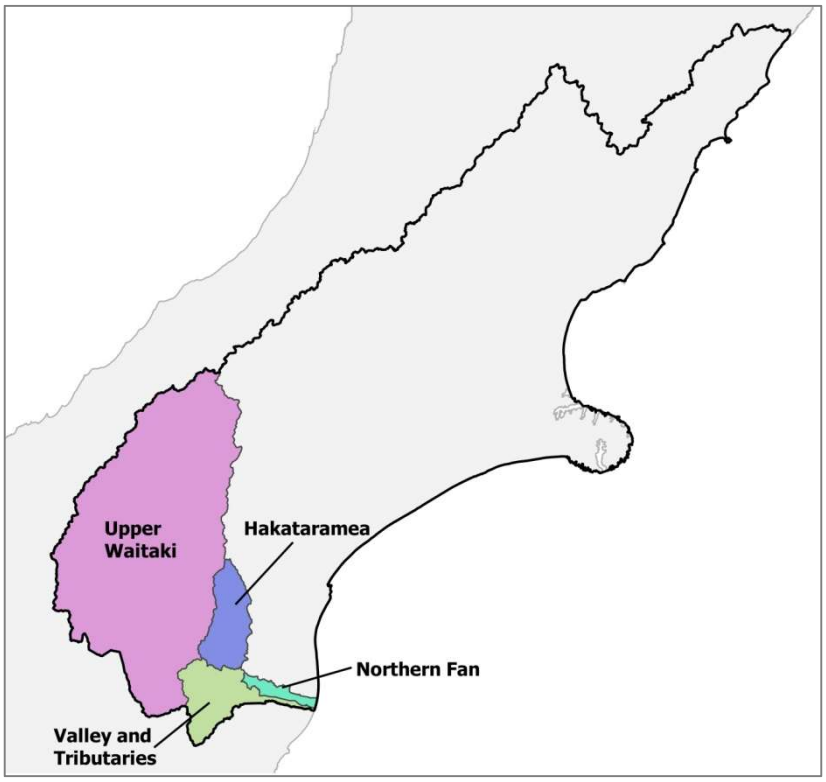

Figure 13. Surface water quality FMUs for the Waitaki catchment

3.3.2 Proposed FMUs for the OTOP zone

The ZIP addendum prepared by the Orari-Temuka-Opihi-Pareora (OTOP) zone committee proposes 6 FMUs (Figure 14). The recommended FMUs include 5 surface water FMUs based on major surface water catchments namely:

- The Orari River and tributaries;
- The Temuka River and tributaries;
- The Opihi River and Tributaries;
- A Timaru FMU comprising urban waterways and the Washdyke Lagoon; and
- The Pareora River and tributaries and adjacent small coastal streams and lagoons.

A single groundwater FMU is also proposed that encompasses the entire OTOP zone and includes seven sub-zones corresponding to existing LWRP groundwater allocation zones within the geographic area.

Delineation of the surface FMUs largely reflects historical water management arrangements (including existing catchment-based regional plans). The recommended FMUs were considered to strike a balance between the specificity possible in management provisions

applying across large spatial management units and the additional administrative and monitoring requirements associated with a larger number of discrete management units[17]. Adoption of a single groundwater FMU comprising the entire OTOP zone reflects the occurrence of groundwater across the entire zone (only some of which is within LWRP groundwater allocations zones) and the poor alignment between surface water catchments and groundwater recharge areas in the north of the OTOP zone.

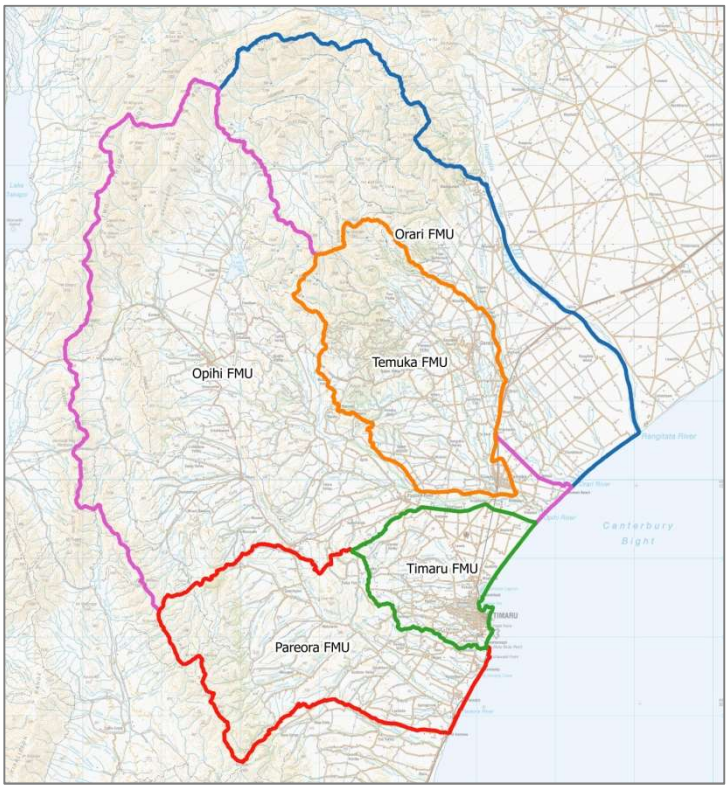

Figure 14. Proposed FMUs for the OTOP zone (note the proposed groundwater FMU includes the maximum geographic extent of the individual surface water FMUs)

3.3.3 Proposed FMUs for the Waimakariri zone

The Waimakariri zone committee have adopted a recommended approach to defining FMUs for the Waimakariri zone (Figure 15). The approach comprises three surface water FMUs (effectively equivalent to the spatial extent of the corresponding NAZ in the LWRP):

- Ashley River FMU;
- Saltwater Creek FMU; and
- North Waimakariri Tributaries FMU

The three proposed surface water FMUs are identified as being broadly consistent with the different communities of interest in the zone and at a scale appropriate for community

[17] Minutes from the Orari-Temuka-Opihi-Pareora Water Zone Management Committee meeting, Monday 30 January 2017

outcomes. Within each surface water FMU, sub-units are identified based on surface water catchments to enable variations in water quality and water quantity objectives and limits for different water bodies, and to enable application of different methods (e.g. policies and rules) to achieve them.

A single groundwater FMU is proposed encompassing the whole Waimakariri zone. This FMU is sub-divided into 5 sub-zones based on existing groundwater allocation zones defined in the LWRP. These sub-zones will form the basis for applying water quantity limits and accounting, while the sub-regional-scale FMU is considered appropriate for groundwater quality.

The overall approach adopted for defining FMUs in this zone was for fewer rather than many FMUs to ensure catchments such as the Ashley River/Rakahuri are managed as a whole from source to sea, to minimise unnecessary complexity and reduce potential administrative burden and costs associated with a larger number of FMUS.

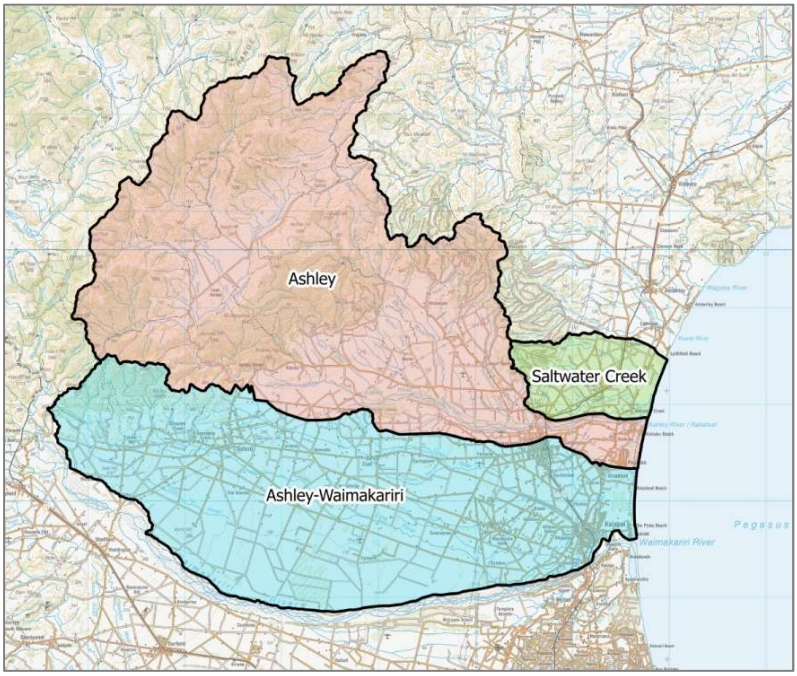

Figure 15. Proposed FMUs for the Waimakariri zone (note the proposed groundwater FMU includes the maximum geographic extent of the individual surface water FMUs)

4 Recommendations for the Development of FMUs

As described in the previous section, the LWRP currently defines:

- Water quality management classes (and associated objectives) for rivers and lakes;
- Management zones (and in some cases administrative points) for surface water quantity, groundwater quantity and nutrient allocation; and
- Default rules for allocation of surface water and groundwater.

We consider these provisions provide a good basis for defining FMUs for the Canterbury Region in a manner that is consistent with our recommended approach (Section 2.5),

including default FMUs would apply where location-specific FMUs are not defined in sub-regional chapters of the LWRP. The following sections provide an outline of our suggestions to assist development of FMUs for the Canterbury Region.

4.1 Surface Water Quality

As described in Section 3.2.4 above, the LWRP defines default water quality and water quantity objectives for all water bodies in the region based on bio-physical classifications comprising ten river classes and six lake classes. These classifications form the basis for management of surface water quality but may be further developed and refined for specific water bodies through LWRP sub-regional processes.

While the existing LWRP water quality classifications provide a starting point, we consider that development of surface water quality FMUs requires Council to consider the following:

- Delineating areas that drain to each management class. These spatial areas would become management zones (i.e., as described in Section 2.5.3 above) for individual water quality classes to provide a spatial framework for application of management actions (limits, policies and rules) to achieve the nominated water quality objectives for each management class;
- Identification of appropriate locations at a sub-catchment or catchment scale to be utilised as administrative points for accounting and reporting purposes[18]. Initial administrative points may be based on the existing NAZ but could be further refined where more local-scale approaches to nutrient management are appropriate, or to manage water quality attributes other than nutrients; and
- Ensuring the environmental monitoring network provides adequate representation for individual management classes.

It is also recommended that Council evaluate existing and proposed provisions of the LWRP (and catchment-based resource management plans) with regard to the management zones delineated for the default water quality classification. This assessment would seek to ensure that management actions (e.g. limits, policies and rules) specified in the LWRP:

- Can achieve water quality objectives identified in Table 1a for each of the individual management classes (i.e., to ensure management actions specified for individual management zones are sufficient to achieve water quality objectives for the relevant water quality class); and
- Ensure that management actions applied to individual management zones are consistent with the achievement of water quality objectives in all downstream water bodies.

The Upper Waitaki FMU defined in Plan Change 5 (PC5) to the LWRP provides examples of the requirement to achieve both local and downstream water quality objectives. This FMU comprises five nutrient allocation zones[19] (NAZ) upstream of the Waitaki Dam that essentially form management zones for selected water quality objectives (nutrient

[18] So effectively the NAZ can be considered to be larger-scale management zones that incorporate multiple management zones associated with the various water quality classes they contain.

[19] Including the lake zone

concentrations). Specific management regimes comprising limits, policies and rules relating to nutrient management are specified for each zone to meet relevant downstream water quality objectives.

In the case of the Ahuriri zone, while the contributing catchment is comprised of rivers and streams of varying water quality classes (each with differing objectives specified in Table 1a of the LWRP), the overall regime is determined by downstream water quality objectives (in this case maintenance of water quality in an oligotrophic state in the Ahuriri arm of Lake Benmore). To achieve this objective, policies and rules are established to avoid any increase in nitrogen loss in the Ahuriri zone. Thus, the most constraining downstream objective is to maintain the current tropic status of Lake Benmore and this requires a conservative management regime that will presumably also achieve the water quality objectives in all the specific management classes within the NAZ.

In contrast, PC5 identifies some “headroom” for nutrient increases in the Haldon zone. This headroom is provided for by a management regime that allows some intensification of land use (within specified constraints). While the management regime is determined by the downstream objective (maintenance of oligotrophic state in the Haldon arm of Lake Benmore), it also needs to ensure that objectives are also achieved in all management classes within the NAZ. In this case Council has to be satisfied that the management regime applying to the Haldon zone to achieve water quality objectives in the Haldon Arm, also achieves the objectives for the individual management classes within the NAZ (Figure 16). A similar situation arises in other FMUs within the Waitaki catchment (such as the Hakataramea FMU) where multiple management classes occur within a NAZ for which a single management regime is specified.

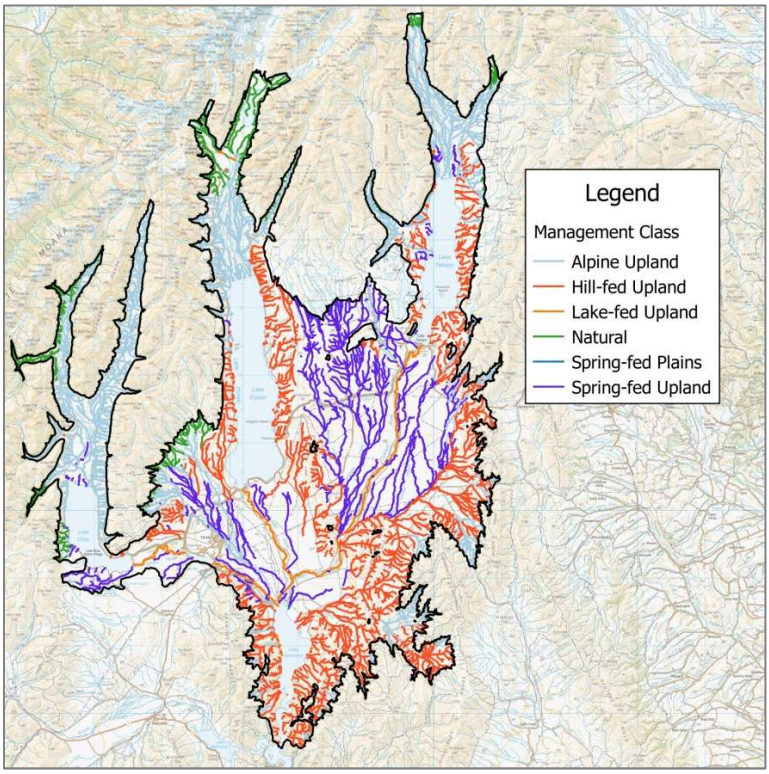

Figure 14. *Water quality management classes in the Haldon Zone (denoted by the black line) within the Upper Waitaki FMU*

It is recommended that Council undertake a similar exercise as part of the future development of surface water quality FMUs to ensure that management actions assigned to individual management zones are adequate to achieve both local and downstream water quality objectives. This process provides a mechanism that identifies any additional plan provisions that may be required to ensure that water quality objectives are achieved in all surface water bodies.

In combination with management zones defined for individual water quality classes, the NAZ defined in the LWRP potentially provide an additional layer of spatial attributes that can be utilised to define default water quality FMUs. For example, the NAZ provide catchment or sub-catchment scale management zones for specific waterbodies (e.g., lakes or individual sub-catchments or river reaches) and/or administrative points (e.g., for the specification of nutrient load limits) for nutrient management and selected sub-catchments. Management actions within each NAZ required to achieve water quality limits or objectives can then be established for management zones associated with individual water quality classes within these larger spatial units in a similar method to that outlined in Section 2.5.7 above (i.e., consistent with our recommended approach to defining FMUs).

While the LWRP NAZ may be sufficient for managing water quality effects associated with nutrients, Council also needs to ensure that management zones used to define default FMUs are also appropriate for the management of other water quality objectives. These may include attributes relevant to NPS-FM compulsory values (such as *E.coli*) as well as other freshwater objectives listed in Table 1a of the LWRP that may require management at spatial scales different to nutrients.

4.2 Surface Water Quantity

A surface water allocation regime sets a minimum flow and total allocation (the total allowable sum of consumptive takes) for a river. These thresholds set limits that define the level of protection for instream values and the reliability of supply for water users (e.g., to achieve objectives set to maintain values attributed to surface waterbodies as per Figure 1). Ideally, and generally in practice, minimum flows and total allocation are set by assessing how these limits interact with the hydrological regime to influence the residual flow that supports instream values and the reliability of supply to water users. There is significant variation across the region in several bio-physical characteristics of rivers and streams that are relevant to defining the allocation regime limits including: hydrological regimes, ecological communities and relationships between flow and hydraulic conditions (water depth, width and velocity). This means that, to be justifiable, water allocation regimes should vary spatially in association with variation in the bio-physical characteristics of streams and rivers.

Surface water allocation zones defined in the LWRP provide a framework of management zones and associated administrative points that provide a spatial structure of surface water quantity FMUs. The LWRP framework comprises minimum flows and flow allocation for specific catchments or sub-catchments specified in the various sub-regional chapters (and other catchment-specific resource management plans). Many of these surface water allocation zones reflect historical development and/or management of surface water resources, and each of these has accounted for the specific instream values and hydrological characteristics of that zone. Where no location-specific provisions are specified, minimum flow and flow allocation are established under a single “default” rule specified in Chapter 5 (Rule 5.123).

As an example, numerous surface water allocation zones are defined for sub-catchments on the lower plains between the Ashley and Waimakariri rivers[20]. These allocation zones typically encompass a restricted geographic area and comprise a water bodies of a single management class (i.e. spring-fed plains streams). These allocation zones establish specific flow allocation and minimum flows at a relatively high spatial resolution and also define a relatively detailed network of administrative points. The implication of this this is that the spatial framework of allocation zones is sufficient to resolve differences in instream values and hydrological regimes at a relatively fine-scale, which in turn helps to justify the specific limits (i.e., the minimum flow and flow allocation) that are defined for each zone.

In contrast, the nearby Ashley River/Rakahuri allocation zone comprises a relatively extensive area for which a single set of minimum flow and flow allocation limits apply at a single administrative point (LWRP, Table 7). As shown on Figure 14, this catchment comprises water bodies of varying management classes from natural state to spring-fed plains. These water bodies vary in terms of their hydrological regime, size and character and support differing values. There a two potential issues with this large allocation zone. First, it is in strong contrast to relatively finely resolved allocation zones in the neighbouring Waimakariri zone. This contrast may be viewed as inconsistent and either advantageous or disadvantageous to different parties. Second, the lack of resolution of variation in hydrological regimes and values makes it difficult to justify a uniform management regime across the entire allocation zone. A similar situation occurs in other large surface water allocation zones, or in locations where no location-specific management regime has been established.

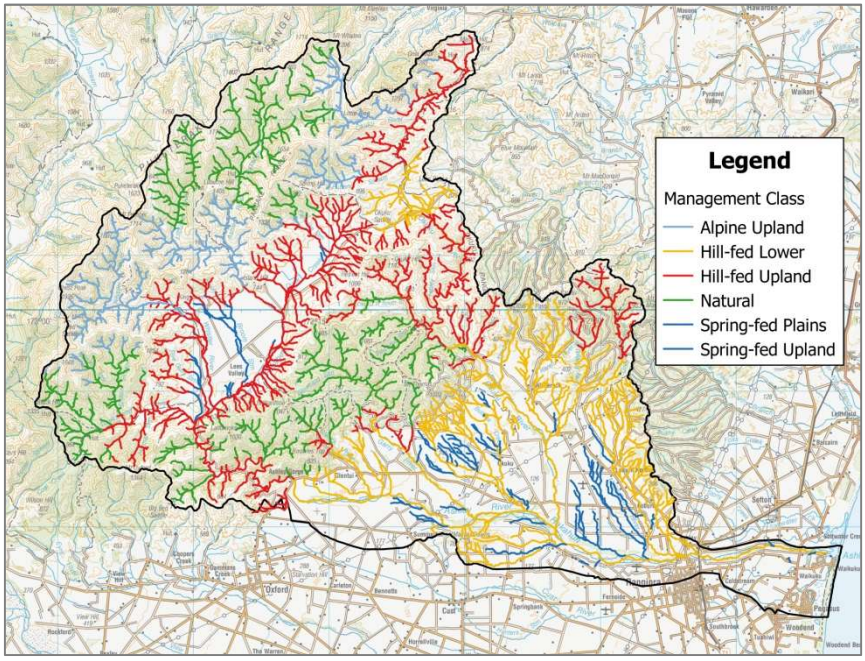

Figure 14. *Surface water management classes in the Ashley River/Rakahuri catchment*

The River Environment Classification (REC) was used to define the water quality management classes specified in the LWRP. The REC classification can also be used to

[20] In the Waimakariri River Regional Plan

define water allocation management regimes (e.g. Snelder et al., 2010[21], Snelder and Kerr, 2016[22]). It is therefore recommended that Council consider refining the existing 'default' water allocation regime specified in Chapter 5 of the LWRP based on the existing water quality management classes to reflect:

- The different minimum flow and flow allocation regimes required to support values in different management classes; and
- The difference in the susceptibility to effects of abstraction for streams of different size (defined by average flow statistic) within individual management classes.

Using the existing water quality management classification (or some refinement thereof) would enable better resolution of the spatial variation in bio-physical characteristics in rivers and streams. In turn this would provide for definition of more specific and justifiable management regimes and would allow the LWRP to be more specific about anticipated outcomes in terms of level of protection for instream values and the reliability of supply for water users.

4.3 Groundwater

The LWRP definition of groundwater refers to:

> *all water beneath the surface of the earth contained within the saturated zone, but excludes the water chemically combined in minerals.*

Groundwater allocation zones defined in the LWRP are spatial units established to manage groundwater quantity, based on a sub-division of the main water-bearing deposits. Each groundwater allocation zone has a volumetric allocation limit established to maintain values associated with the resource itself (e.g., reliability of supply for users) as well as objectives for downstream water bodies (i.e., baseflow in spring-fed streams). However, groundwater also occurs (albeit typically in reduced quantities) outside the spatial extent of the LWRP groundwater allocation zone boundaries. Groundwater allocation in these areas is managed according to region-wide policies and rules specified in Chapters 4 and 5.

As outlined in Section 2.3.3, we consider that management zones comprise land areas that drain to a specific water body (or class of waterbody). Given the relatively ubiquitous nature of groundwater throughout the Canterbury Region it follows that a large proportion of the region may, to some extent contribute to recharge of groundwater in underlying geological materials that may, or may not, occur within a specific groundwater allocation zone defined in the LWRP. Certainly, the potential recharge zones for groundwater allocation zones defined in the LWRP extend over a significantly larger area than the currently defined zone boundaries. Therefore, the groundwater allocation zones defined in the LWRP are generally identifying specific waterbodies, rather than the extent of the areas that drain to them. The existing LWRP groundwater allocation zones are consistent therefore with the management classification of water bodies as outlined in our conceptualisation of FMUs (Section 2.5 above).

The definition of groundwater FMUs for the OTOP and Waimakariri zones has recognised that the area that is relevant to the management of regional groundwater resources is larger

[21] Snelder, T., Biggs, B., Weatherhead, M., 2010; New Zealand River Environment Classification User Guide. Report prepared for the Ministry for the Environment, Wellington.

[22] Snelder, T., Kerr, T., 2016; Defining a biophysical framework for Freshwater Management Units of the Te Awarua-o-Porirua Whaitua. Report prepared for Greater Wellington Regional Council, November 2016.

than the immediate extent of the main water-bearing deposits. These proposed FMUs define the entire spatial area of the respective CWMS zones as a single groundwater FMU (for both quantity and quality), with specific sub-units for the purpose of groundwater allocation corresponding to the existing LWRP groundwater allocation zones.

We consider this framework is consistent with our conceptual approach to defining FMUs. The LWRP groundwater allocation zones (i.e., the main water-bearing deposits) are specific management classes to which defined limits (i.e., allocation volumes) apply. Areas outside the defined extent of the LWRP groundwater allocation zones are a separate management class to which default provisions apply. If appropriate, specific management actions (i.e., policies and rules) could also be developed for separately defined management zones comprising the recharge areas for individual LWRP groundwater allocation zones (or equivalent units defined for groundwater quality) to achieve groundwater objectives that may be influenced by the quality or quantity of aquifer recharge.

Given the hydraulic connection between surface and groundwater in many parts of the region, management of groundwater quantity and quality also needs to consider objectives established for surface water bodies.

5 Discussion

Our recommended approach to defining FMUs for Canterbury Region comprises three components:

1. The water bodies that are designated to be managed for a particular purpose (i.e., freshwater objective), termed the *management classification* in this report;
2. The land area (catchment or sub-catchment) that drains to an individual management class, termed the *management zone*, and
3. The points in the hydrological network where the *management zone* changes, which are termed *administrative points*.

Our approach recognises that water bodies vary in their environmental and biophysical characteristics, associated values and their capacity for resource use. This variation can be efficiently accounted for by appropriate classification of water bodies into management classes. It follows therefore that management zones are the areas that drain to water bodies belonging to specific classes. FMUs are then defined by layering and merging *management zones* in an order that allows the definition of policies and limits that achieve the most restrictive downstream objectives. The details of this layering and merging of management zones must be undertaken as part of the policy development process with the overall aim being the production of a simple and clear set of justifiable plan provisions.

Location-specific *special management zones* may be defined to reflect the unique values associated with individual water bodies, and for which specific plan provisions (limits, objectives, policies and rules) would apply to their upstream catchments. However, it is recommended that criteria used to define the management classes should be sufficiently broad to avoid the proliferation of special management zones that would create many ad-hoc exceptions to the management provisions applied to general management classes.

FMUs are being developed for the 10 CWMS zones that encompass the Canterbury Region as part of zone implementation programmes (ZIP) being prepared by each individual Zone Committee. While these sub-regional processes are currently at varying stages, it is

intended that their outcomes (including delineation of FMUs) will ultimately be incorporated into the LWRP. The following section outlines our key recommendations for development of FMUs either through these sub-regional processes or via default LWRP provisions to meet the requirement for the NPS-FM to be fully implemented by 2025.

We recommend that FMUs should be developed with the primary objectives of being comprehensive so that all waterbodies are included within either a location-specific or default FMU, and spatially-specific so the management regime appropriately reflects geographical variation in values, bio-physical characteristics and ecological function of water bodies. This is likely to require delineation of separate FMUs of differing spatial scales to effectively manage surface water quality, surface water quantity, groundwater quality and groundwater quantity. It may also require definition of 'default' FMUs that apply where location-specific FMUs have not been defined in sub-regional chapters of the LWRP.

The LWRP already establishes a spatial framework for managing freshwater resources in the Canterbury Region. This framework includes:

- Management zones (and in some cases administrative points) for surface water quantity, groundwater quantity and nutrient management;
- Default water quality management classes (and associated objectives) for rivers and lakes;
- Default provisions (policies and rules) controlling land use within individual NAZ
- Default rules for allocation of surface water and groundwater outside of management zones defined in individual sub-regional chapters.

We consider these provisions provide an ideal base to assist definition of FMUs for the Canterbury Region. However, in order to ensure that FMUs and associated management actions (limits, policies and rules) are developed and applied in a justifiable manner that reflects the bio-physical context of all water bodies and their catchments, we suggest that Council give consideration to further development of some aspects of the existing LWRP provisions. The following section outlines our recommendations for the delineation of FMUs for surface water quality, groundwater quality, surface water allocation and groundwater allocation.

5.1 Key Recommendations for Delineation of FMUs

5.1.1 Surface Water Quality FMUS

The existing water quality classes specified in the LWRP define a management classification and associated freshwater objectives for water quality management of surface waterways across the Canterbury Region. In order to utilise this spatial framework to develop and implement surface water quality FMUs it is recommended Council undertake the following steps:

- Delineate management zones associated with each management class in the water quality management classification. Management zones provide a framework for application of management actions (limits, policies and rules) to specific land areas to achieve nominated water quality objectives for each water quality class;
- Identify appropriate locations at a sub-catchment or catchment scale to be utilised as administrative points for accounting and reporting purposes. Initial administrative

points may be based on the existing LWRP NAZ with additional refinement where more local-scale approaches to the management of water quality attributes are appropriate. In addition, Council may also need to consider if the existing NAZ are also appropriate for the management of water quality objectives other than those relating to nutrients;

- Review the current environmental monitoring network to ensure that individual management classes are adequately represented. Adequate monitoring data is required within individual management classes in order to characterise water quality state and identify confirm that management actions are sufficient to ensure water quality objectives are met;
- Ensure that existing and proposed management actions (limits, policies and rules) specified for individual management zones are adequate to:
  - achieve water quality objectives for the relevant water quality class, and
  - achieve the *most constraining* downstream water quality objective within a given hydrological system.

5.1.2 Surface Water Quantity FMUs

Surface water allocation zones defined in the existing LWRP provide a framework of management zones and associated administrative points that can be used to provide the basic structure for surface water quantity FMUs. The existing LWRP framework comprises limits (minimum flows and flow allocation) specified at administrative points within specific catchments or sub-catchments. Many of these limits (and administrative points) reflect historical development and/or management of surface water resources. Where no location-specific provisions are specified, surface water quantity limits are currently established under a single "default" rule specified in LWRP Chapter 5.

In order to ensure that freshwater quantity objectives are achieved we recommend that the default management regime should be refined and applied in a manner that appropriately reflects spatial variation in bio-physical characteristics of all rivers and streams. To achieve this we suggest Council consider further refinement of the existing default surface water allocation regime using the water quality management classes specified in the LWRP[23] to recognise:

- The different minimum flow and flow allocation regimes required to support values associated with different management classes; and
- The difference in the susceptibility to effects of abstraction for streams of different size (defined by their estimated mean flow, or similar, statistics) within individual management classes.

Limits (e.g., minimum flows and flow allocation) developed for each management class can then be utilised to manage surface water allocation for individual stream reaches. These management classes could then be combined with management zones and administrative points defined by the existing LWRP surface water allocation zones to manage cumulative allocation (including that associated with abstraction of hydraulically connected groundwater) at a sub-catchment or catchment scale. This would provide a management framework

[23] These classes are derived from the River Environment Classification which also has utility for defining water allocation management regimes (e.g., Snelder et al., 2010)

comprising a reach-specific management classification along with management zones and administrative points defined at a sub-catchment scale that collectively define surface water quantity FMUs at a larger catchment scale.

5.1.3 Groundwater Quantity and Quality FMUs

Given the relatively ubiquitous nature of groundwater throughout the Canterbury Region it is logical to assume that a large proportion of the region may, to some extent, contribute to recharge of groundwater in underlying geological materials. Some of this groundwater will occur within the geographic extent of existing groundwater allocation zones defined in the LWRP and be subjected to specific limits specified in sub-regional chapters. However, groundwater also occurs (albeit typically in reduced quantities) outside the spatial extent of the LWRP groundwater allocation zone boundaries. Groundwater allocation in these areas is managed according to region-wide policies and rules specified in Chapters 4 and 5. We therefore suggest that groundwater quantity FMUs may be best defined at a sub-regional scale[24].

The definition of groundwater FMUs for the OTOP and Waimakariri zones has recognised that the area that is relevant to the management of regional groundwater resources (i.e. the *management zone*) is larger than the immediate extent of the primary water-bearing deposits (i.e. individual waterbodies which effectively comprise *management classes*). These proposed FMUs define the entire spatial area of the respective CWMS zones as a single groundwater FMU (for both quantity and quality), with specific allocation limits specified for the existing LWRP groundwater allocation zones (i.e., individual management classes).

We consider this approach is consistent with our conceptualisation of FMUs, and may be utilised to develop future groundwater quality and quantity FMUs. This approach would involve specific limits (i.e., allocation volumes) that apply to individual management classes (i.e., groundwater allocation zones). If appropriate, specific management actions (i.e., policies and rules) could also be developed for separately defined management zones comprising the recharge areas for individual LWRP groundwater allocation zones (or equivalent units defined for groundwater quality) to achieve groundwater objectives that may be influenced by the quality or quantity of aquifer recharge[25].

It is important to note that due to the hydraulic connection between groundwater and surface water, the most constraining downstream objectives for individual groundwater quality or quantity management zones may be those assigned to hydraulically connected surface water bodies (e.g., discharge or water quality in spring-fed streams). It is also noted that defining FMUs for groundwater quality would require definition of groundwater quality objectives in the LWRP.

5.2 Summary

We recommend that FMUs be developed with the primary aims of being (1) comprehensive (so that the entire region, including its waterbodies and land is included within FMUs), and (2) spatially-specific (so the management regime appropriately reflects geographical variation in values, bio-physical characteristics and ecological function of water bodies). This will require delineation of separate FMUs of differing spatial scales to manage surface water quality, surface water quantity, groundwater quality and groundwater quantity. It may

[24] i.e., at the CWMS zone scale as currently proposed for the OTOP and Waimakariri sub-regions

[25] Such influences could include land use effects on the quantity or quality of aquifer recharge

also require definition of ‘default’ FMUs that apply where location-specific FMUs have not been defined in sub-regional chapters of the LWRP.

The underlying logic of our recommended approach is that freshwater objectives apply to individual water bodies, while management actions (e.g., limits, policies and rules) apply to catchments draining to those water bodies. This recognises that limits need to be set and management actions applied to specific land areas to achieve the most constraining downstream objective in any given hydrological system.

We suggest that use of classification systems to define FMUs for surface water (quantity and quality) provides an appropriate approach to resolving variation in values and bio-physical characteristics of waterways that are relevant to management. In contrast, due to the more ubiquitous nature of groundwater throughout the Canterbury Region, FMUs for groundwater (quality and quantity) may be best defined at a sub-regional scale, with limits (i.e., allocation volumes) that applying to individual management classes (i.e., groundwater allocation zones). If appropriate, specific management actions could also be developed for management zones comprising the recharge areas for individual groundwater allocation zones (or equivalent units defined for groundwater quality) to achieve groundwater quality objectives that may be influenced by the quality of aquifer recharge.

While further work is likely to be required to define both location-specific and/or default FMUs for the Canterbury Region, it is recommended that plan change processes occurring in the short-term should consider introducing general policies that establish the framework for delineation of FMUs going forward. For example, with regard to maintaining or improving water quality, policies could be introduced to require that land use is managed to achieve water quality objectives (defined in Table 1a) through:

- Delineation of management zones that encompass land areas that drain to waterbodies in each management class;
- Development and application of management actions for specific management zones to ensure water quality objectives are met in all downstream management classes; and

Similarly, policies relating to surface water abstraction could be established to require recognition of the variable values and bio-physical characteristics in streams and rivers to provide an appropriate level of protection for instream values and reliability of supply for water users. It is also suggested that the delineation of groundwater FMUs would be assisted by clearer specification of objectives for groundwater quantity and quality.