SOUTHLAND
PHYSIOGRAPHIC ZONES

WATER AND LAND 2020 & BEYOND

OLD MATAURA
Technical information

Physiographic zones are part of the *Water and Land 2020 & Beyond* project that aims to maintain and improve water quality in the Southland region, and to help us as a community achieve our goals for water.

Understanding our water

The Physiographics of Southland project was developed to better understand the evolution of water across Southland. By understanding where water comes from and the processes it undergoes as it moves through drainage networks, we can better understand the reasons for different water quality outcomes across the region.

The findings of the Physiographics of Southland project have been published in two reports, which identify the key drivers of hydrochemistry and water quality variability in Southland (Rissmann *et al*., 2016), and describe a classification system for managing land use effects on water quality (Hughes *et al*., 2016).

Physiographic zones and water quality

Physiographic zones represent areas of the landscape that have a common influence over water quality. The proposed Southland Water and Land Plan identifies nine physiographic zones in Southland that can be used to manage land use effects on water quality.

Physiographic zone technical information

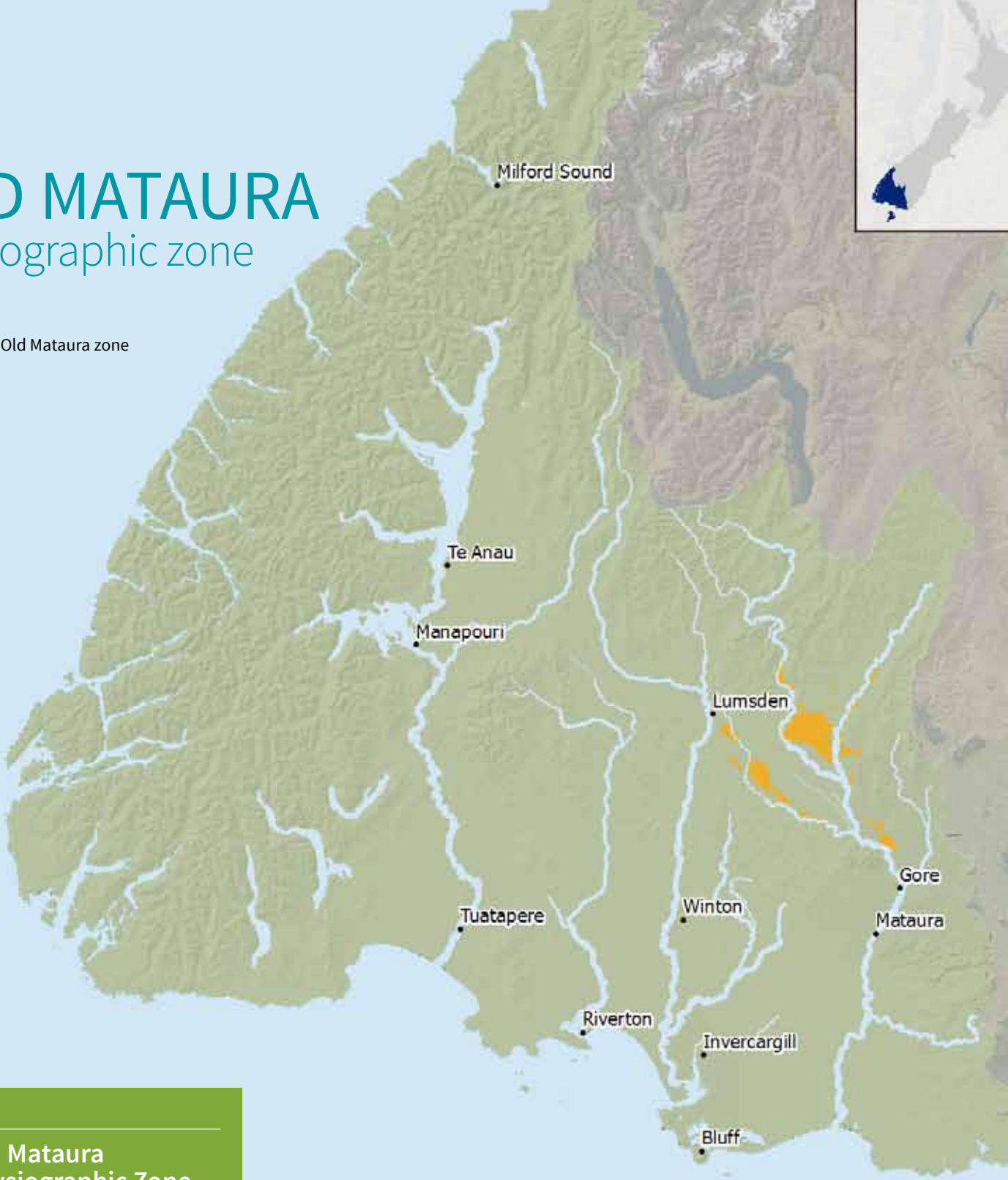
The purpose of this booklet is to describe generalised water quality risks associated with individual physiographic zones. A companion booklet titled *Guide for using the Southland physiographic zones technical information* explains the terms and source data used in this booklet.

What's inside

environment SOUTHLAND
REGIONAL COUNCIL
Te Taiao Tonga

OLD MATAURA
physiographic zone

Old Mataura zone



Old Mataura Physiographic Zone

APPROXIMATE AREA

14,970 hectares

GEOGRAPHIC DISTRIBUTION

Along the outer margins of the mid-Mataura valley in the Wendonside, Balfour and Knapdale areas.

MAIN SURFACE WATERWAYS

Small ephemeral streams and Boundary Creek.

Go to our online BEACON mapping service to view the physiographic zones of Southland in more detail.

Overview

The Old Mataura physiographic zone occupies higher, older, highly weathered alluvial terraces in the mid-Mataura catchment. Aquifers in this zone are susceptible to accumulation of nitrate to high levels.

Key features

- Located on older, elevated alluvial terraces in the Mataura catchment (Shotover and Luggate Formations).
- Alluvial materials are highly weathered.
- Recharge of unconfined groundwater resources occurs almost exclusively from infiltration of local precipitation through well-draining soils.
- Few permanent surface water features.
- Soils and aquifers have low denitrification potential.

Water quality implications

- Groundwater in this zone is susceptible to elevated nitrate concentrations.
- Groundwater discharges into springs, streams and aquifers in lower parts of the Mataura catchment, adding to cumulative nutrient inputs.

WATER QUALITY RISK	OLD MATAURA
Contaminant pathways	Deep drainage
Dilution and attenuation processes	Filtration and adsorption
Primary receiving environments	Aquifers
Water quality risk	Nitrogen

Variants and associations

Variants

Variants identify areas within physiographic zones where there is increased water quality risk when soils are wet. Contaminant losses from variants occur along alternate drainage pathways that have lower attenuation potential.

No variants are identified for the Old Mataura physiographic zone.

Associations

There are three physiographic zones commonly associated with the Old Mataura zone (Figure 1).

Bedrock/Hill Country

The Old Mataura zone occurs along the base of the Bedrock/Hill Country zone in the Longridge, Wendonside Terrace and Knapdale areas.

Infiltration of discharge from this zone may make a locally significant contribution to groundwater recharge in the Old Mataura zone in some areas.

Oxidising

The Oxidising zone occupies lower elevation alluvial terraces along the margins of the Mataura River floodplain in the Waipounamu and Knapdale areas.

These areas receive appreciable groundwater throughflow from the Old Mataura zone.

Gleyed

The Gleyed zone occupies lower elevation alluvial terraces surrounding the Old Mataura zone in the Knapdale area and on the Waimea Plains.

These areas receive groundwater throughflow from the Old Mataura zone.

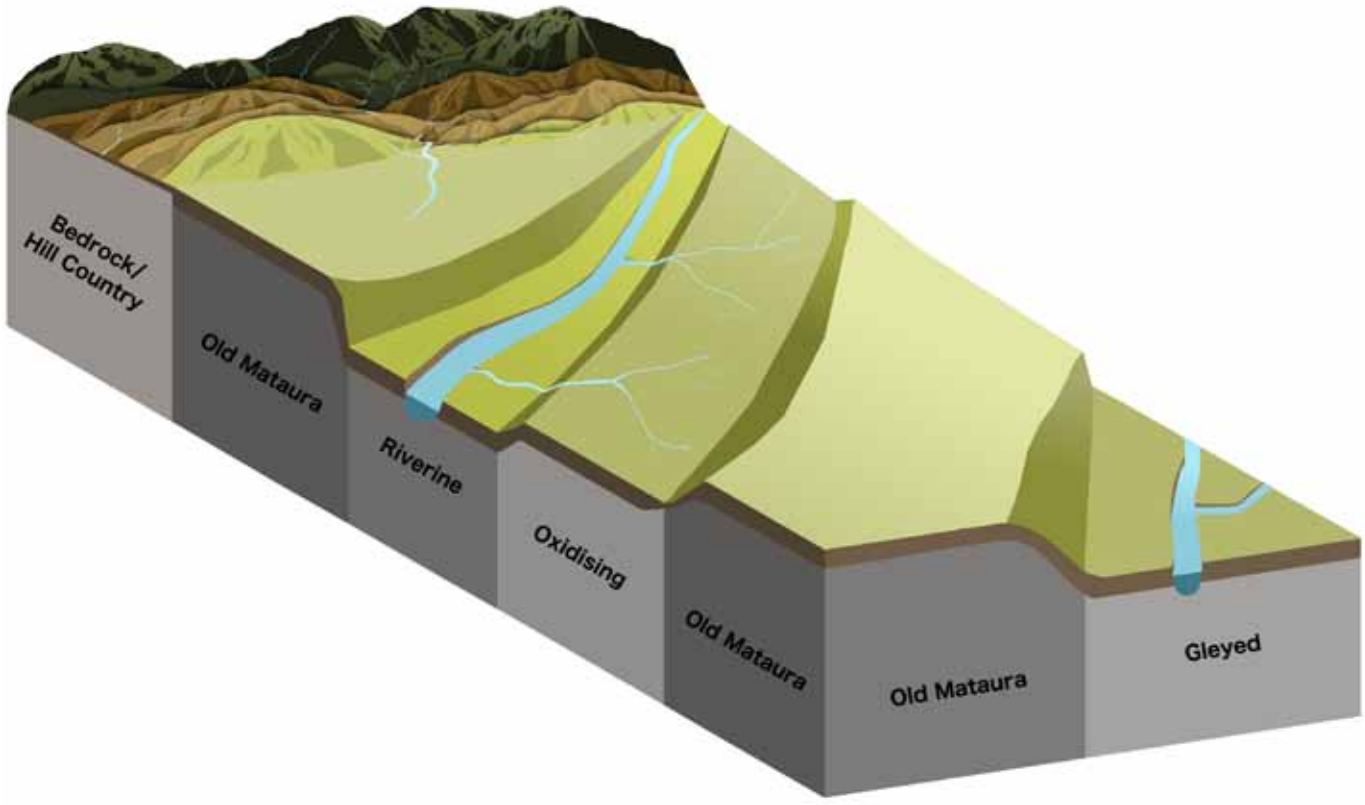


Figure 1: Landscape context image showing neighbouring zones. The Old Mataura zone occupies alluvial terraces that are elevated above major river channels. A majority of this zone has flat slopes, well drained, fertile soils. Very few permanent surface waterways occur in this zone.

Dominant characteristics that affect water quality

Landscape characteristics

Surface zone characteristics

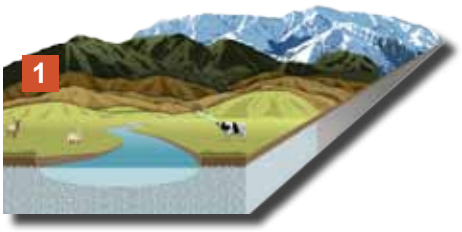
Soil zone characteristics

Saturated zone characteristics

Water quality implications

1 Landscape characteristics

The Old Mataura zone is located on the older and higher alluvial terraces in the Wendonside, Balfour and Knapdale areas.



Topography

Elevation

Most of this zone occurs between 140 and 220 metres elevation relative to sea level (m RSL).

Slope

Most of the Old Mataura zone is flat to gently undulating (≤3° slope) with only a minor component occurring on undulating to rolling land (4-15° slope).

Geology

This zone is comprised of remnants of old (Q6 to Q8) alluvial terraces and terrace gravels of the Shotover and Luggate Formations. These deposits consist of weathered greywacke-schist alluvium in a silty, sandy matrix, overlain by loess.

The predominance of fine-grained sediment in the gravel matrix reflects limited reworking of these materials combined with extensive weathering since deposition.

Climate

Average annual rainfall in this zone varies spatially between 790 mm in the Balfour area to around 1,050mm north of Waikaia.

This zone has much lower average annual rainfall (of 860 mm) compared to other physiographic zones. This is due to this zone occurring in low elevation inland areas near ranges that sometimes provide a rainshadow effect.

Old Mataura LANDSCAPE zone characteristics

ELEVATION
80 – 340 m RSL

SLOPE
Flat to gently undulating

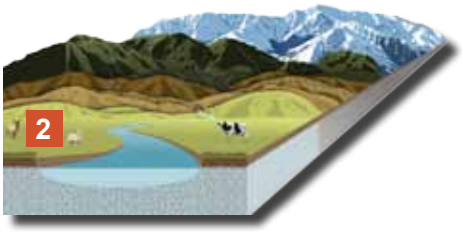
GEOLOGY
Quaternary sediments

LANDFORM AGE
Q7–Q9

AVERAGE ANNUAL RAINFALL
860 mm per year

2 Surface zone characteristics

Recharge to the Old Mataura physiographic zone occurs almost exclusively via local precipitation infiltrating through the soil matrix. Infiltration of runoff from adjacent higher elevation areas may make a minor recharge contribution.



Dilution

This zone is predominately recharged via land surface recharge (matrix flow). There is limited potential for dilution of contaminant concentrations associated with this recharge mechanism.

Surface waterways

The surface water network is largely restricted to small ephemeral streams (e.g. Boundary Creek). During significant precipitation events, these streams carry discharge from laterally connected, higher elevation areas.

Overland flow

Overland flow is not a significant pathway for this zone. Localised ponding may occur in response to extreme or sustained precipitation. However, ponding is usually of short duration and does not result in significant overland flow due to the flat topography.

Old Mataura SURFACE zone characteristics

DILUTION POTENTIAL
Low recharge flux

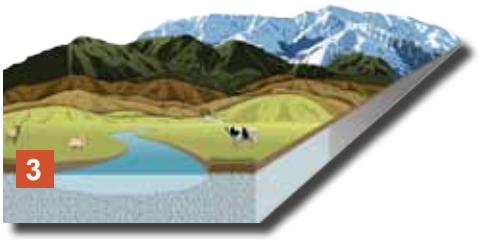
DRAINAGE DENSITY
Low

STREAM ORDER
Mixed

OVERLAND FLOW POTENTIAL
Very low

3 Soil zone characteristics

Soils in this physiographic zone are typically well drained, fine textured and prone to seasonal water deficits during summer droughts. Many soils in the zone are stony (particularly in the subsoil) or are formed in silty loess deposits.



Soils

Brown soils are the most common soil type in this zone. These soils are generally rapidly permeable silt loams with low to moderate water holding capacity.

Reduction potential

Due to their good/high internal drainage, soils in this zone have low reduction potential (i.e. limited potential for denitrification to occur).

Artificial drainage

This zone has low likelihood for artificial drainage due to good soil drainage and flat topography.

Lateral drainage

Lateral drainage through the soil profile is restricted to localised areas where soils have lower subsoil permeability.

Old Mataura SOIL zone characteristics

SOIL ORDER
Brown

PROFILE DRAINAGE
Well drained

PERMEABILITY
Rapid over rapid

ANION STORAGE CAPACITY
Moderate

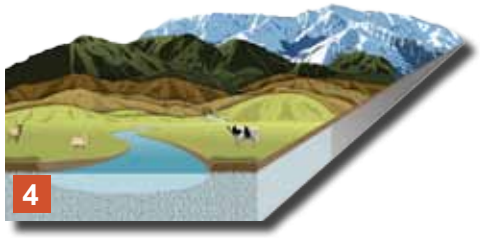
REDUCTION POTENTIAL
Low

ARTIFICIAL DRAINAGE DENSITY
None to low

LATERAL DRAINAGE POTENTIAL
Localised

4 Saturated zone characteristics

The Old Mataura physiographic zone is characterised by an extensive groundwater resource that is hosted in old alluvial sediments. Aquifers in this zone tend to exhibit low to moderate permeability due to their fluvioglacial origin combined with extensive weathering of the alluvial materials.



Groundwater

Groundwater levels

Water table depth varies spatially across this zone, from:

- < 5m below ground near Balfour and Knapdale
- >20m below ground across central areas of the Wendonside Terrace

Groundwater levels can vary significantly between years due to aquifer permeability, which allows gradual accumulation or dissipation of aquifer storage depending on the volume of recharge occurring in any given year.

Groundwater levels typically peak in spring. This reflects the accumulation of deep drainage occurring through soils that have been at or near field capacity during winter months.

During summer and autumn, groundwater levels exhibit an almost linear decline. This is due to the progressive depletion of aquifer storage via groundwater discharge.

Groundwater discharge

Groundwater discharge from this zone occurs via a combination of:

- Baseflow to streams along the down-gradient (terrace) margins, including the Garvie Burn, Okapua Creek and Waimea Stream.
- Throughflow to unconfined aquifer systems underlying lower elevation alluvial terraces.

Reduction potential

Aquifers within this zone have low reduction potential due to their low organic carbon content. As a result, there is low potential for denitrification to occur within the aquifer.

Deep drainage

Deep drainage to groundwater is the main drainage mechanism in this zone due to the predominantly flat-lying topography and well-drained, rapidly permeable soils.

Deep drainage is typically seasonal. Most recharge occurs when soil moisture is at or near field capacity, generally between late autumn and spring.

However, drainage to the water table can occur at any time of the year in response to heavy or sustained precipitation.

Old Mataura SATURATED zone characteristics

WATER TABLE DEPTH
Moderate to deep

AQUIFER PERMEABILITY
Moderate

ACTIVE GROUNDWATER STORAGE
Moderate

REDUCTION POTENTIAL
Low

DEEP DRAINAGE POTENTIAL
Moderate

5 Water quality implications

The main water quality issue for the Old Mataura physiographic zone is the leaching of excess soil zone nitrate from late autumn to early spring, and subsequent elevated nitrate levels in groundwater.

Influencing factors

Due to significant weathering, soils and underlying alluvial materials in this zone are relatively inert. Therefore, recharge passing through the soil profile to underlying groundwater is not significantly altered in composition.

Water quality issues

Groundwater

With intensive land use, nitrate concentrations in groundwater can become elevated. In many places, current concentrations exceed the New Zealand Drinking Water Standard.

The following conditions facilitate the occurrence of high nitrate levels:

- the low reduction potential of soils and groundwater
- the low assimilative capacity of aquifers
- the low dilution potential reflecting recharge almost exclusively derived from infiltration of rainfall through the soil zone

Groundwater discharge from this zone has the potential to add high nitrate inputs to waterbodies in lower parts of the Mataura catchment (Figure 2). Discharge from this zone:

- Comprises a significant component of the water balance in lower-lying unconfined aquifer systems, putting them at risk from increased nitrate loads.
- Contributes to baseflow in adjacent rivers and streams. These rivers and streams are also at risk from increased nitrate loads and concentrations.

Surface waters

Surface waterways are limited to small ephemeral streams. These streams only flow during heavy precipitation events, generally as a result of runoff from upstream zones.

Key HYDROCHEMICAL features

- Alkalinity values are low likely due to lower soil and unsaturated zone pH and the absence of carbonate lithologies
- This zone is characterised by very low sulphate (SO_4) concentrations, which likely reflects the preferential removal of SO_4 by aluminium and iron oxides (oxy hydroxides) within the soil and unsaturated zones. As a result, subsoil concentrations of SO_4 are significantly elevated

What affects water quality in the Old Mataura zone?

WHERE	KEY CHARACTERISTICS	CONTAMINANT PATHWAYS	ATTENUATION PROCESSES	WATER QUALITY RISK
All areas	Well-drained soils Predominately flat topography Highly weathered sediments Predominately land surface recharge Few, if any permanent surface waterways	Lateral flow through the soil matrix when soils are wet	Filtration and adsorption of particulate contaminants	Low water quality risk
		Deep drainage	Filtration and adsorption of particulate contaminants. Limited denitrification	Nitrogen High potential for nitrate losses to groundwater
		Artificial drainage or overland flow in response to significant precipitation events	Limited attenuation potential	Low water quality risk due to infrequent occurrence and limited spatial extent

CONTAMINANT PATHWAY	MITIGATION OBJECTIVES
Deep drainage	Reduce the accumulation of surplus nitrogen in the soil, particularly during autumn and winter

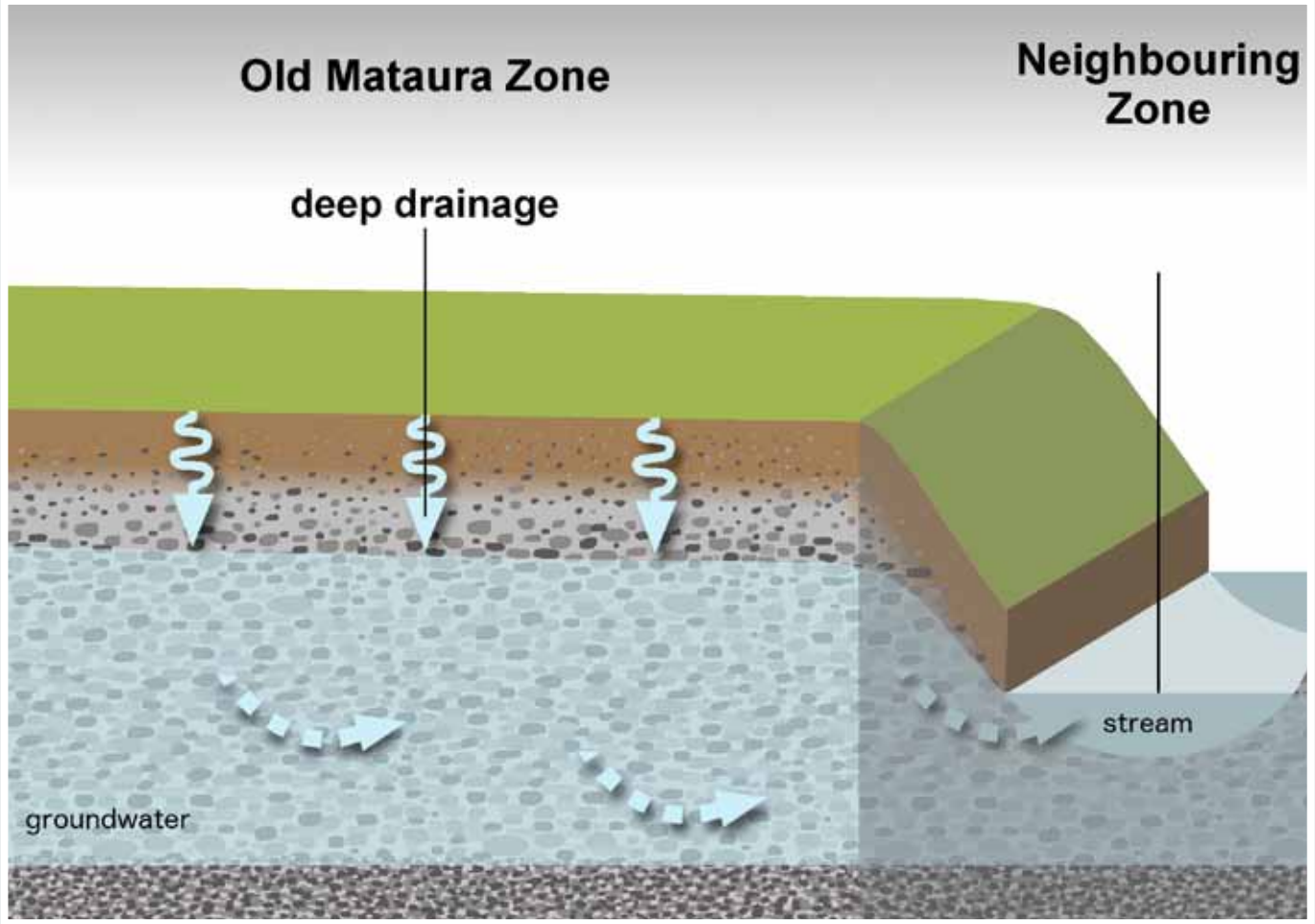


Figure 2: Water quality in the Old Mataura zone is susceptible to nitrate leaching and becoming elevated in groundwater due to the predominately flat topography, well drained soils and low denitrification potential. Nitrate accumulates in the soil between summer and early autumn, and is leached to underlying groundwater during the drainage season (normally between autumn and spring).