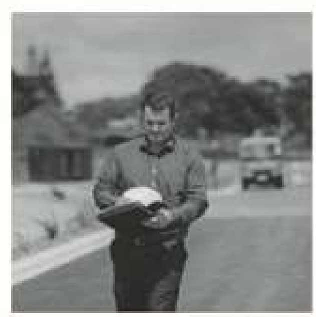
REPORT

Cumulative Effects of Onsite Wastewater Disposal

for West Coast Regional Council

Rev 1 - 28/10/2024



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for West Coast Regional Council

Reviewed

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SUMMARY

Introduction

The Proposed Te Tai o Poutini Plan (TTPP) is the combined District Plan for the Buller, Grey and Westland District Councils replacing the current individual district plans.

During the Rural Hearing for the proposed TTPP, a number of individual rezoning proposals were put before the Hearing Panel by submitters for Rural Lifestyle and Settlement zoning. Most lots, depending on location, are expected to have on-site wastewater disposal systems, due to the lack of sewerage network. The Hearing Panel is unclear as to whether there is the potential for significant adverse effects to occur on a broader basis because of proposed rezonings at Moana and Cape Foulwind in terms of on-site wastewater disposal.

Objective of this Assessment

BTW Company Limited (BTW) have been engaged by the West Coast Regional Council (WCRC) to provide an assessment to investigate the cumulative effects of onsite wastewater disposal for rural properties in Moana and Cape Foulwind. This report provides assessment for the scenarios summarised in Table 1.

For the purposes of this assessment, these developments were split into "Areas" presented in Figures 1 and 2 below, each of which were defined by the Hearing Panel. BTW have applied Area identifiers (A-E) for reference in this assessment.

Table 1: Summary of the scenarios assessed for cumulative effects

Scenario	Moana	Cape Foulwind
Existing	Current predicted wastewater flows for the existing setting under the Operative District Plan, in the identified Areas A-E including the WWTP.	Current predicted on-site wastewater flows for existing dwellings.
Scenario A	Proposed TTPP zoning for Areas A-E, as defined by the Hearing Panel.	Submitters proposed rezoning for Areas A-C as defined by the Hearing Panel, where rural lifestyle = 1 ha.
Scenario B	Changes to the proposed TTPP sought by submitters, as heard through recent plan hearing submissions (predominantly for settlement zoning)	The above Areas A-C, but with reduction of rural lifestyle lots to 4,000 m^2.

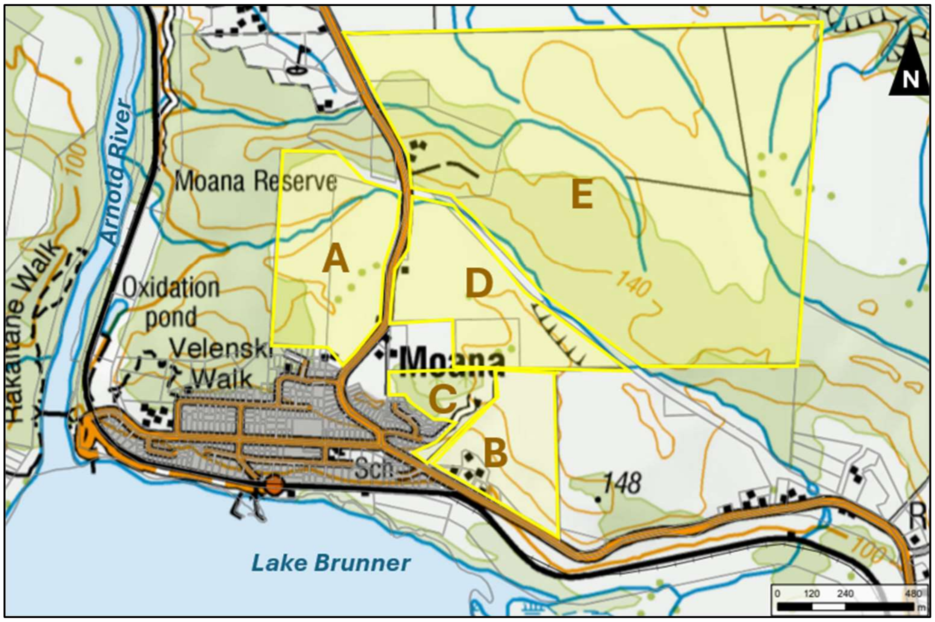

Figure 1: Areas for the assessment of Moana

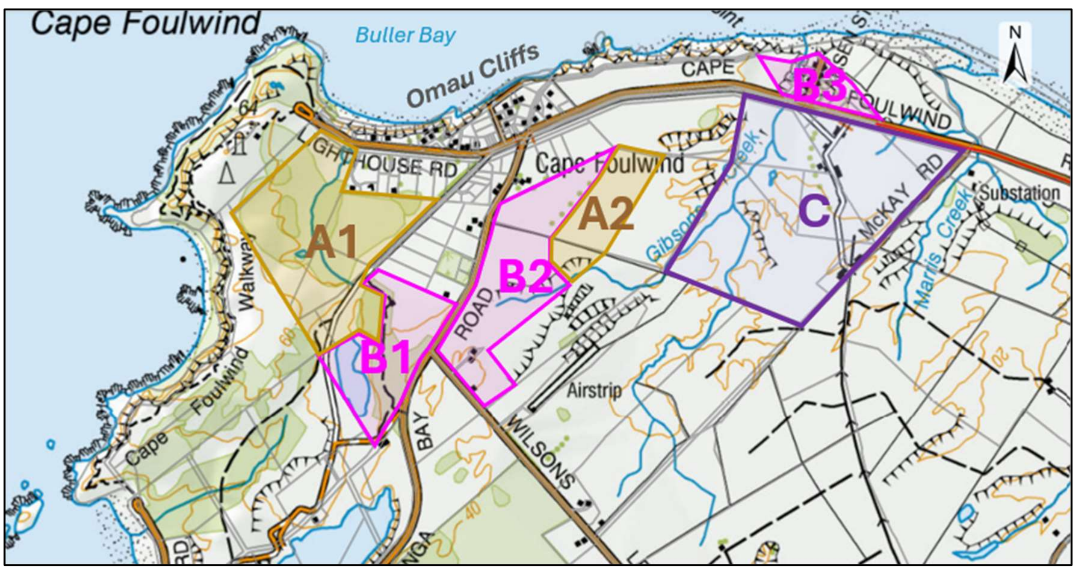

Figure 2: Areas for the assessment of Cape Foulwind

Overview of On-site Wastewater Systems

On-site wastewater disposal, such as that from septic tanks, is the main method of disposing of domestic wastewater in rural parts of the West Coast that do not have access to a sewerage network and wastewater treatment plant (WWTP). The septic discharge is to subsurface soils 'on-site' (within the same property). Wastewater from septic tanks contains high concentrations of nutrients and pathogens (microbial contaminants and viruses). These discharges have the potential to contaminate the receiving environment such as soils, groundwater or nearby wetlands, streams, and lakes.

The level of nutrients present in on-site effluent discharge is dependent on the level of treatment, which ranges from primary treatment (minimal treatment via septic tank and often with an outlet filter), to tertiary treatment (advanced treatment to reduce both nutrients and pathogens).

The primary constraints within the proposed development areas for onsite wastewater treatment and discharge include:

- Setbacks from wetlands, surface water receptors and the coastal environment.
- High/perched water table, notably where hard pan layers are present.

The typical systems installed in Moana are primary treatment septic systems that discharge to land via soak pit; whereas at Cape Foulwind, secondary treatment occurs, via sub surface irrigation.

Key Parameters of Concern

There are many potential parameters of concern for assessment from wastewater discharges. This assessment focusses on:

- Bacteria (*E. coli)*: Considered to representative of the overall presence of pathogens, which are of concern for potable supply and for contact recreation (e.g. bathing, water sports). This is primary concern for swimming at the northern shore of Lake Brunner.
- Excess nutrients (nitrogen, phosphorus). This is a primary issue for localised water systems such as low flow tributaries and wetlands, which are present throughout both Moana and Cape Foulwind. Excess nutrients may cause excessive periphyton growth (nuisance algae). Further, nitrate and nitrite in potable water present issues for human health.

Land Use

The current land use under the Operative District Plan is predominantly General Rural at both locations but is not suitable for extensive pastural grazing in its current state. The Land Use Capability (LUC) is non-arable with moderate to severe limitations for use under perennial vegetation, such as pasture or forest. Some areas are completely undeveloped, with areas of regenerating indigenous vegetation, manuka swamp and pakihi wetlands present (Areas B and C at Moana; and Areas A1, A2, B2 at Cape Foulwind). The options for land development are primarily residential/rural lifestyle as proposed through the TTPP, and dairy farming which is occurring to the north and east of Lake Brunner.

Results of Loading Assessment

Given the undeveloped nature of each location, any change in land use will result in increased nutrient loading to the receiving environment. The estimated nutrient loading to groundwater/surface water resulting from on-site wastewater disposal for each scenario is summarised in Table 2 (TN = total nitrogen; TP = total phosphorus).

Table 2: Summary of estimated increased nutrient loading for Scenarios A and B from the existing condition

	Moana (based on a typical primary treatment system)*	Cape Foulwind (based on a typical secondary treatment system)
Expected loading per person:	4 kg TN/year; 0.1 kg TP/year.	2 kg TN/year; 0.04 kg TP/year.
Scenario A		
TN	1.3 tonnes/year	0.9 tonnes/year
TP	0.1 tonnes/year	0.02 tonnes/year
Scenario B		
TN	6.0 tonnes/year	1.2 tonnes/year
TP	0.3 tonnes/year	0.03 tonnes/year
* Use of secondary treatment systems at Moana would reduce loading to the environment by ~25% for TN ~10% for TP.		

Key Receptors

As the current land use is predominantly undeveloped, BTW considers (until accurate hydrological measurements can be made) there is moderate to high risk of ecological effects to the immediate receiving environment from these discharges, that being the two unnamed tributaries. However, these potential effects will be low risk to the larger waterbodies which they discharge to that being the Arnold River and the Tasman Sea.

The key receptors identified as being sensitive to additional bacterial and nutrient loading are predominantly freshwater ecological receptors and contact recreational, where water sports or bathing occurs, and for drinking water supply. Risks are assessed at a high level below (low – high). In order to quantitatively assess the ecological effects to the tributaries, flow assessments would be required for two key tributaries identified in this assessment.

- **Moana:** Pathogens present a key risk at Moana, where high permeability gravels likely provide insufficient time in the groundwater flow path to allow for full die-off prior to discharging to surface water. This is a particular issue where primary treatment systems are installed, which is common practice at Moana. Nutrients also present a risk to localised water ways. The key receptors are:
  - **Supply bores:** Potential potable supply bore user at the Moana Hotel (high risk if abstraction is from shallow gravels; lower risk if within deeper rock aquifer; no risk if the bore is not installed). Any other bores present under Permitted Activity criteria (not identified in this desktop assessment) are subject to the same assessment.
  - **Local wetlands and waterways:** Including drains and tributaries of Lake Brunner and Arnold River. These tributaries and/or wetlands are expected to have a moderate to high risk of more acute effects of nutrient loading, where flows may not be sufficient to dilute the effects. This may drive the presence of nuisance periphyton and benthic algae, particularly during low rainfall periods. Specifically, there is concern for:
    - In Area A wetlands, if the proposed development remains unsewered to the WWTP.
    - The Unnamed Tributary draining the southern development area of Moana (Areas B and C), which discharges to Molloy Bay of Lake Brunner. Flow information for this tributary is required to provide a more definitive assessment.

- **Molloy Bay of Lake Brunner:** There is potential for low to moderate effects to occur locally from nutrients, where the unnamed tributary discharges into the lake. There is a high to moderate risk to bathing receptors from microbial contaminants.
- **Arnold River:** Whilst loading is expected to be significant, the overall effects to water quality and ecology in the river are expected to be low, due to dilution.

- **Cape Foulwind:** This location has lower permeability soils, which provide for comparably better inground treatment relative to Moana. Contact recreation is less common here also. Key receptors reviewed were:
  - **Supply bores:** No bores were identified. Any bores present under Permitted Activity criteria (not identified in this desktop assessment) are subject to the same assessment as per the Moana bores above.
  - **Local wetlands and tributaries:** Including drains and tributaries of Gibsons Creek. These tributaries and/or wetlands are expected to have a moderate to high risk of more acute effects of nutrient loading, where flows may not be sufficient to dilute the effects. This may drive the presence of nuisance periphyton and benthic algae, particularly during low rainfall periods. Specifically, there is concern for the Unnamed Tributary draining Areas A1 and B1. Flow information for this tributary is required to provide a more definitive assessment.
  - **Gibsons Creek:** A low risk of changes to water quality are expected in the creek, which discharges to the Tasman Sea.
  - **Quarry pit lake in Area B1**. There may be localised effects where seepage initially enters the lake. Overall, the potential risk for effects to this man-made feature is likely low.

Conclusions

The key concluding statements of this assessment are:

- The current land use is general rural but not suitable for extensive pastural grazing in its current state (being non-arable, perennial vegetated land). Some areas are undeveloped, with areas of indigenous vegetation, sphagnum moss, manuka and pakihi wetland present (Areas B and C at Moana; and Areas A1, A2, B2 at Cape Foulwind)
- Any land use will have effects to the receiving environment, and both Scenarios A and B for each location are expected to increase nutrient loading to the local environment (e.g. tributaries, wetlands). To quantitatively assess the ecological effects to the tributaries and provide a higher level of certainty on the cumulative effects of the identified nutrient loading from the two Scenarios, flow assessments are required for the two key tributaries identified in this assessment (the unnamed tributary to Molloy Bay, Lake Brunner, Moana; and the unnamed tributary through Area A1 at Cape Foulwind).
- The effects of this proposed land development must be weighed up against other potential future land use, such as dairy conversions, as is occurring to the norther and east of Lake Brunner.

This assessment finds for all scenarios assessed that there is potential for on-site wastewater discharges to increase nutrients and bacterial counts in smaller waterbodies and waterways such as wetlands and tributaries. These are intermediate receiving environments that receive seepage from the local perched groundwater system beneath each area. Effects to local tributaries and wetlands are expected to report more acute effects of nutrient loading, where flows may not be sufficient to dilute the effects. This may drive the presence of nuisance algae, particularly during low rainfall periods.

Where tributaries discharge into larger waterways, such as the Gibsons Creek or the Arnold River, the total nutrients are expected to be sufficiently diluted so that either: no measurable impact is recorded; or potential minor increases do not change the Attribute Band under the NPS-FM. At Cape Foulwind, the final discharge to the sea (from the identified waterways) is expected to further attenuate the potential effects of nutrients and bacteria.

At Lake Brunner, the large volumes of water present do not necessarily mean that dilution will occur. Due to the physical and chemical characteristics of the lake, including stratification and long residence time, more localised effects may be visible nearest the points of discharge e.g. from the unnamed creek discharging into Molloy Bay. The increase in nutrients discharging to Lake Brunner between the two assessed scenarios is marginal (the proposed TTPP Scenario A; versus submitters rezoning Scenario B). Microbial contaminants are considered to form the primary contaminant of concern at Lake Brunner for contact recreation. Is it possible that increased counts of bacteria will occur at the northern lake shore, which is a popular swimming location. It is considered either zoning options (Scenario A vs. Scenario B in Table 1) would have similar effects on Lake Brunner.

It is expected that localised effects may be measurable from Area B and C in the tributary which drains to Molloy Bay and the Schedule 2 Wetland, for both the considered scenarios A and B. Similarly, at Cape Foulwind, the unnamed Tributary through Area A1 may illicit localised measurable effects, depending on flow rates in the stream.

Based on available literature values for nutrient loss, if these development areas were converted to dairy farming there would be a 5-time increase in predicted onsite loading at Moana, and a 17-times increase at Cape Foulwind. It is assessed that conversion of land at both sites to residential with on-site wastewater systems is expected to produce lower potential adverse effects than if converted to dairy farming. This is because the activity can be better controlled through improved system design mechanisms from the multiple point source discharges compared to the diffuse sources associated to more intensive agricultural practises.

If the Hearing Panel wish to understand the more specific localised effects to the tributaries identified above, accurate water flow information would be required for these tributaries to accurately determine the actual or potential localised effects.

Recommendations

The key recommendations are summarised here. Refer to Section 6.2 for detailed and additional recommendations.

<u>Moana:</u>

- Confirmation if the Moana Hotel supply bore was installed and is in use by its consent holder.
- In the absence of flow data, wastewater disposal at Area A for any development option should be to the WWTP, to protect the receiving unnamed tributary and three natural wetlands present.

- The current method of primary septic treatment and disposal via soak pits at Moana is recommended to cease at for the level of development proposed. This is due to the very high permeability of the soils present, which could transmit perched groundwater to surface water receptors within days to weeks. Secondary treatment as a minimum is recommended, and disposal to land via other methods such as sub-surface irrigation (where possible) or beds/mounds. Where soak pits are deemed the only viable option, and/or minimum setback distances cannot be maintained for any installation, advanced secondary or tertiary treatment for nutrients and bacteria is highly recommended.
- Potential adverse effects to the environment are expected for any land use change scenario. The key effects at Moana likely being to the smaller tributaries to Molloy Bay of Lake Brunner from the development of Areas B and C. This assessment is currently unable to quantify the degree of adverse effects to these tributaries from the current undeveloped scenario. However, the effects between scenarios A and B are expected to be marginal. If the Hearing Panel remain uncertain about the proposed rezonings, stream flow measurements of the tributaries would be required to more accurately determine the actual or potential localised effects.

Cape Foulwind:

- Secondary treatment, as is current practice, should continue as a minimum. As with Moana, where minimum setback distances cannot be maintained for any installation, either a site-specific assessment of the receiving environment should be undertaken to justify secondary treatment; and/or tertiary treatment be applied to reduce nutrients and bacteria.
- As with the above tributaries into Molloy Bay for Moana, this assessment is currently unable to quantify the degree of actual or potential adverse effects with high certainty to the unnamed tributary in Area A1 at Cape Foulwind from Scenarios A and B. However, initial assessment indicates the effects may be measurable in the water quality values in the immediate receiving environment. Until stream flow data can be obtained to confirm flows are sufficient to dilute the expected wastewater discharges, it's our recommendation not to reduce the rural lifestyle lot sizes to 4,000 m^2 in Areas A1 and B1.

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FIGURES

1 INTRODUCTION

1.1 Purpose of this Report

BTW Company Limited (BTW) have been engaged by the West Coast Regional Council (WCRC) to provide an assessment to investigate the cumulative effects of onsite wastewater disposal for multiple rural properties in Moana and Cape Foulwind. The effects for review relate primarily to nutrient and bacterial impacts on the receiving surface water environment, including ecological receptors and other water users, such as groundwater users.

1.2 Background

The Proposed Te Tai o Poutini Plan (TTPP) is the combined District Plan for the Buller, Grey and Westland District Councils replacing the current individual district plans. It has been prepared in accordance with the Resource Management Act 1991, and controls where activities can be located and how land can be used, developed, and subdivided. It applies to all properties in the three districts.

The proposed TTPP is available online at ttpp.nz, which includes a map of proposed zones and development areas (https://westcoast.isoplan.co.nz/eplan/property/49848/0/78?_t=property), to replace the current operative zones.

BTW understands that during the Rural Hearing for the proposed TTPP, a number of individual rezoning proposals were put before the Hearing Panel by submitters for Rural Lifestyle and Settlement zoning. In addition to the above, several submitters seek to reduce the minimum standard size for subdivisions in the Rural Lifestyle zone to be reduced from one hectare (10,000 m^2) to 4,000 m^2. Most lots, depending on location, are expected to have on-site wastewater disposal systems, due to the lack of sewerage network.

BTW understands that through the hearing and submission process, the Hearing Panel raised concerns on the cumulative effects of onsite wastewater disposal for two areas of the West Coast Region; those being Cape Foulwind in the Buller District and Moana Township in the Grey District.

In accordance with section 41C(4)(a) RMA, the Hearing Panel have requested that WCRC provide a report on the potential cumulative effects of onsite wastewater disposal in relation rezoning proposals contained in the Reporting Officer for the Rural and Settlement zones section 42A reports, along with the potential reduction of the minimum lot site for the Rural Lifestyle zone to 4000 m² in relation to the following two areas[1]:

> i. The Cape Foulwind area - see paragraphs 414 – 438 of the Section 42A Officer's Report on the Rural Zones and the associated evidence and statements of submitters.
>
> ii. The Moana area - see paragraphs 494 – 495 of the Section 42A Officer's Report on the Rural Zones and paragraphs 191 – 193 & 195 – 196 of the Section 42A Officer's Report on the Settlement Zones and the associated evidence and statements of submitters.

Further assessment was requested by the Hearing Panel, to allow for additional areas of development in the assessment[2], being:

[1] Minute 38 – Cumulative Effects of Wastewater Disposal, Hearing of submissions and further submissions on the Proposed Te Tai O Poutini Plan, 9 August 2024

[2] Minute 47 – Further Extension for Cumulative Effects of Wastewater Disposal Reporting, 7 October 2024.

i. The light industrial area, formerly operated as a cement factory (now "Area C" as presented in Section 2)

ii. Rural lifestyle zoning outside the originally indicated area for assessment on Lighthouse Road (now "Area A1").

This report presents an assessment of potential cumulative effects of increased wastewater loading, should the proposed zoning and changes to the minimum lot size for subdivision at these locations be accepted.

1.3 Methodology

The following methodology was undertaken to provide the assessment in Sections 3 – 5.

- Preliminary desktop review, to:
  - Review and assess the proposed zoning changes and associated changes to minimum lot size for subdivision. From there, the total land area and potential wastewater loading to existing infrastructure and/or land was assessed. This is summarised in Section 2.
  - Assessment of wastewater loading, based on population statistics and the land use changes identified above. This method is detailed in Section 3.2.
  - Review available soil, groundwater, environmental information, applicable guidelines, relative to land disposal of treated wastewater. This information is summarised in Sections 4.1 (Moana) and 5.1 (Cape Foulwind).
  - Identify key potential receptors and assess the likely pathways for cumulative effects to those receptors. See Sections 4.5 and 5.5 (respectively).

  Data sources referenced throughout the report are provided in the *References* section at the back of this report.
- Assessment of Potential Cumulative Effects (this report), which includes:
  - A gap analysis, used to inform the final assessment, provided in Section 3.4.
  - An assessment of the potential effects of wastewater contaminants to key freshwater receptors, via groundwater and/or surface water pathways. See Sections 4.5 and 5.5 (respectively).
  - High-level management and/or recommendations for the hearing panel, in Sections 4.6 and 5.6 (respectively).

The draft report was internally reviewed by WCRC planners and water quality specialists in the environmental management team. Their peer review comments have been considered and amendments incorporated to the final report.

1.4 Cumulative Effects

1.4.1 Definition

Given the potential increase in the number of lots and therefore dwellings as a result of the rezoning proposals, a key consideration for the Hearing Panel is the cumulative effects of wastewater loading to land.

The RMA definition of 'meaning of effect' includes 'cumulative effects', which is defined as an effect which arises over time or in combination with other effects, regardless of the scale, intensity, duration and frequency. For example, in the context of wastewater loading to sensitive surface water receptors, this includes the existing effects either positive and/ or negative of the current wastewater loads in each catchment plus all additional effects which may rise from further wastewater inputs.

1.4.2 Key Parameters of Concern

The key parameters of concern from wastewater discharges to land include:

- Microbial contaminants: Bacteria (e.g. *E.coli,* enterococci, campylobacter) and viruses (adenovirus, norovirus, Hepatitis). These are of concern for potable supply and for contact recreation (e.g. bathing, water sports).
- Excess nutrients: Nitrogen (notably in dissolved inorganic form, Ammonia and Nitrate) and phosphorus (notably, dissolved reactive phosphorus (DRP)). This is a primary issue for localised water systems such as low flow tributaries and wetland, and may cause excessive periphyton growth. Further, nitrate and nitrite in potable water present issues for human health.
- Chemical: Household waste, cleaners and pharmaceutical. However, septic systems typically have specifications to avoid non-biodegradable cleaning products. These are more difficult, and quantity are discussed only at a qualitative level in this assessment.

1.4.3 Overview of Potential Receptors

A conceptual schematic of a typical domestic wastewater disposal system is presented in Figure 1.1 below. At a high-level, key receptors and effects are expected to include:

- The first point of contact being to soil, uptake grass/plants (depending on depth of disposal system) and the remaining wastewater flow typically flows downgradient to the local water table.
- Groundwater typically provides pathways to key potential receptors, being bore users and discharge to surface water receptors.
- Wastewater may enter surface water via baseflow from groundwater (e.g. springs) and/or run off from surface breakout and/or daylighting along a restrictive horizon (e.g. shown as seep and run off in Figure 1.1). Receiving surface water bodies may include farm drains, established waterways or wetlands.
- Potential key receptors in these settings include:
  - Waters users: Via potable supply from bores or surface water takes; and contact from recreation/bathing.
  - Aquatic plants: From uptake during contact with contaminated water and may be susceptible to bioaccumulation.
  - Fish: Which may be impacted via gill uptake and ingestion of impacted plants or other fauna, such as excessive nutrients driving nuisance algal growth.
  - Human health: This includes water users noted above, and cumulative effects may also occur via consumption of impacts freshwater plants and/or fish.

A review of all potential receptors has been undertaken, and either assessed in this report, or excluded where appropriate. Potential increases in concentrations in the receiving environment has been assessed against the National Policy Statement for Freshwater Management 2020 (NPS-FM).

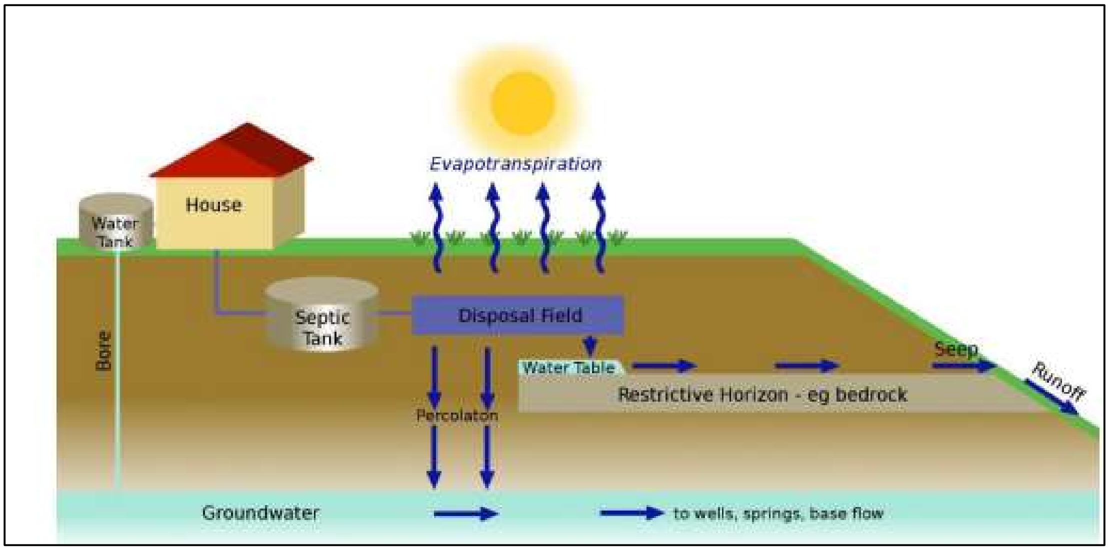

Figure 1.1: Simplistic schematic of a domestic on-site disposal system. Source: Liquid Earth Limited prepared for Environment Southland 2014

1.5 Permitted Activity Rules for On-Site Disposal

The operative Regional Land and Water Plan (LWP) permits on-site wastewater disposal under Rule 79 (listed below). Where any of these conditions are not met, any discharge of contaminants into or onto land is a discretionary activity under Rule 91 of the LWP. This is key to understanding the potential extent of on-site systems installed, as this would form the baseline for the systems that could be installed in the settlement and rural lifestyle zones.

Rule 79. On-site discharge of sewage effluent

The discharge of any sewage effluent into or onto land, other than septage, from on-site sewage treatment and disposal systems is a **permitted activity**, provided that all of the following conditions are met:

(a) The discharge does not exceed:
- i) a maximum of 2000L per day for secondary treatment systems; or
- ii) a maximum of 14,000L per week for other systems; or
- iii) a maximum of 1.3 cubic metres of greywater per day;

(b) The discharge is not within:
- i) 50 metres of any surface water body; or
- ii) 50 metres of the coastal marine area; or
- iii) 100 metres of any bore or well used for potable water supply, where the discharge is from a soak pit and there are no adverse effects on any take of water for human consumption; or
- iv) 50 metres of any bore or well used for potable water supply where the discharge is from other treatment systems; or
- v) 20 metres of any drain; or
- vi) 1 metre of the groundwater table; and

unless the system was installed before 1998 and is not contaminating water.

(c) For systems other than soak pits, the hydraulic design loading rates for a disposal field shall not exceed those recommended for Category 1-3 soils in AS/NZS1547:20~~00~~*12* 'On-site Domestic Waste Water Management', unless the system was installed before 1998 and is not contaminating water; and

(d) The greywater discharge is not within:
- i) 20 metres of any surface water body; or
- ii) 20 metres of any coastal water; or
- iii) 20 meters of any bore or well used for potable water supply, and there are no adverse effects on any take of water for human consumption; or
- iv) 0.6 metres of the groundwater table; and

(e) There is no ponding, runoff, or surface breakout; and

(f) No stormwater enters the system; and

(g) The discharge does not pose a risk to human health, and is not noxious, dangerous, offensive or objectionable to such an extent that it has or is likely to have an adverse effect on the environment; and

(h) For systems which use a disposal field, the system is designed to provide for even distribution of effluent to the entire filtration surface; and

(i) For systems which discharge onto land:
- i) The discharge is not by way of spray irrigation, or otherwise produces any aerosol discharge to air; and
- ii) The effluent is evenly distributed over the entire area of the disposal field; and
- iii) The effluent conforms to the following standard:
  - BOD5 not greater than 20mg/litre;
  - Suspended solids not greater than 30 mg/litre;
  - Faecal coliforms not more than 1000/100 mls.

Notes:
1) The volumes stated in condition (a) are equivalent to the amount of effluent produced by approximately 10 people.
2) For condition (b), the setback depth from the groundwater table should be based on the maximum water table level of the groundwater.
3) The Council will accept as compliance with condition (g) an on-site sewage treatment and disposal system designed, constructed, operated and maintained in accordance with The New Zealand Manual of Alternative Wastewater Treatment and Disposal Systems, Volume II, Part A: On-Site Wastewater Disposal From Households and Institutions Technical Publication No 58, Third Edition (Gunn, 2004), AS/NZS1546 2008, Parts 1, 2 and 3 'On-site Domestic Waste Water Treatment Units', or AS/NZS1547:20~~00~~*12* 'On-site Domestic Waste Water Management'.
4) Condition (h) refers to both gravity-fed and dosed loading systems.
5) When selecting a discharge site, it should be considered whether the site for the system is subject to slippage, subsidence, erosion or inundation from any source.
6) For systems which discharge onto land, the standards required in condition (h) apply to the discharge at the outlet of the treatment plant, prior to discharging onto land.

2 OVERVIEW OF PROPOSED ZONING AND ASSESSMENT APPROACH

The maps below present BTW's understanding of the total areas required for assessment. The legend for the proposed plan maps is provided in Table 2.1:

Table 2.1: Legend of proposed TTPP zoning for the below maps (source: https://ttpp.nz/)

TeTaiOPoutiniPlan Zones	Key
Precincts	
District Plan Zones	
Neighbourhood Centre Zone	
Commercial Zone	
Town Centre Zone	
Mixed Use Zone	
Settlement Zone	
General Residential Zone	
Medium Density Residential Zone	
Large Lot Residential Zone	
Rural Lifestyle Zone	
General Rural Zone	
Light Industrial Zone	
General Industrial Zone	
Open Space Zone	
Sport and Active Recreation Zone	
Natural Open Space Zone	
Waterbody	

2.1 Moana Zoning

Moana is an existing town, with an estimated 300 dwellings; being 45 permanent dwellings and 255 holiday homes, as assessed in the recent wastewater capacity report by Stantec (2024). Moana has an existing wastewater treatment plant (WWTP).

Moana, located in the Grey District, has five identified areas for assessment, presented in Figure 2.1. The development areas labelled A – E are all proposed to be rezoned to Settlement Zones. The scenarios adopted are presented in Table 2.2, based the proposed rezoning to Settlement Zoning for all Areas A – E, and the existing WWTP assessment (Section 3).

The proposed zone changes are summarised in Table 2.3.

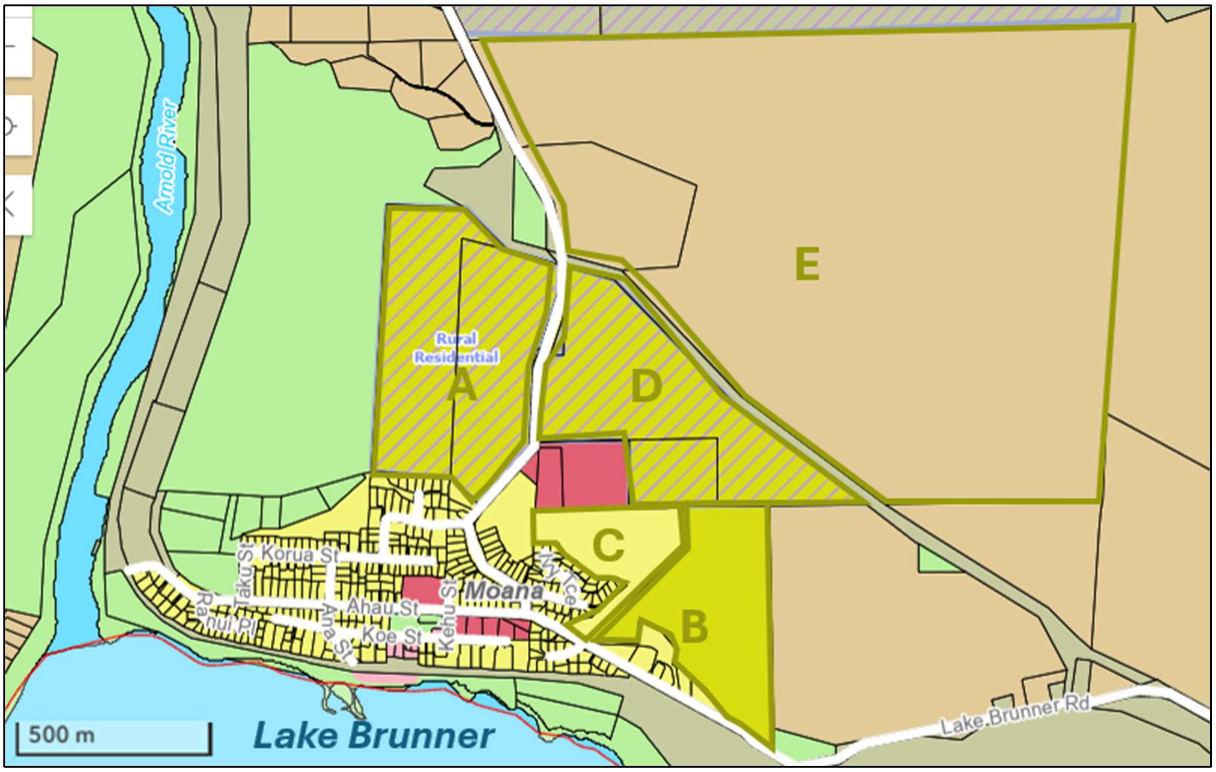

Figure 2.1: Moana sites proposed for rezoning from the current proposed TTPP plan – Proposed changes to Settlement Zones shown in Dark Yellow with Zone identifiers (A-E)*.

* Basemap: Proposed TTPP Plan, https://ttpp.nz/. See Table 2.1 for basemap legend for current proposed zoning. BTW annotations in red.

Table 2.2: Assessed scenarios for Moana

Scenario	Description
Existing	Current predicted wastewater flows for the existing setting under the Operative District Plan, in the identified Areas A-E including the WWTP (Stantec, 2024).
Scenario A	Proposed TTPP zoning for Areas A-E, as defined by the Hearing Panel.
Scenario B	Changes to the proposed TTPP sought by submitters, as heard through recent plan hearing submissions (predominantly for settlement zoning)

Table 2.3: Summary of Proposed Changes to Zoning and Loading at Moana (colour scheme in footnotes#)

Area ID	Operative District Plan#		Proposed TTPP Plan Zoning#		Submitters Proposed Rezoning (this assessment) #	
	Zone *WW Servicing*	**Lot sizing (m²)**	**Zone** *WW Servicing*	**Lot sizing, (m²)**	**Zone** *WW Servicing*	**Lot sizing, (m²)**
A	Rural; *To Land*	40,000	Settlement - Rural Residential Precinct. *Unsewered (To land)*	4,000	**CHANGE:** Settlement, *Sewered (WWTP)* ***OR*** *Unsewered (to land)* §	1,000 (average)
B	Residential; *Sewered (WWTP)**	500 (average)	Settlement, *Unsewered (To land)*	1,000	Settlement, *Unsewered (To land)*	1,000
C	Residential; *Sewered (WWTP)**	500 (average)	General Residential, *Sewered (WWTP)*	350	**CHANGE:** Settlement, *Unsewered (To land)*	1,000
D	Rural; *To Land*	40,000	Settlement - Rural Residential Precinct. *Unsewered (To land)*	4,000	Settlement - Rural Residential Precinct. *Unsewered (To land)*	4,000
E	Rural; *To Land*	40,000	Rural Lifestyle, *Unsewered (To land)*	10,000	**CHANGE:** Settlement, *Unsewered (To land)*	1,000

* Reticulation not currently active as sites have not been developed, but WWTP capacity for these zones are allowed for in Stantec (2024)

For ease of viewing, colour coding is applied as per the respective issued plans:

- The Grey Operative Plan, https://www.greydc.govt.nz/05our-district/gis-property-mapping
- TTPP Proposed Plan: https://westcoast.isoplan.co.nz/eplan/

§ This scenario assesses loading to the WWTP, but submitters have requested the option to dispose on-site. The loading volume is not assumed to significantly change for unsewered sites, so is not separately calculated. The primary change between the sewered versus unsewered option is the immediate receiving environment (Arnold River vs. shallow groundwater and wetlands in Area A). The effects of on-site disposal is discussed in Section 4.5.3.

2.2 Cape Foulwind Zoning

Cape Foulwind, located in Buller District, has six identified areas for assessment, presented in Figure 2.2. The areas labelled A – C are as requested by the Hearing Panel, which each have variable rezoning proposed. The approach for this assessment differs from Moana, where existing WWTP is not in place, and the areas provided for assessment were guided by the Hearing Panel. The scenarios adopted are summarised in Table 2.4.

The proposed zone changes are summarised in Table 2.5.

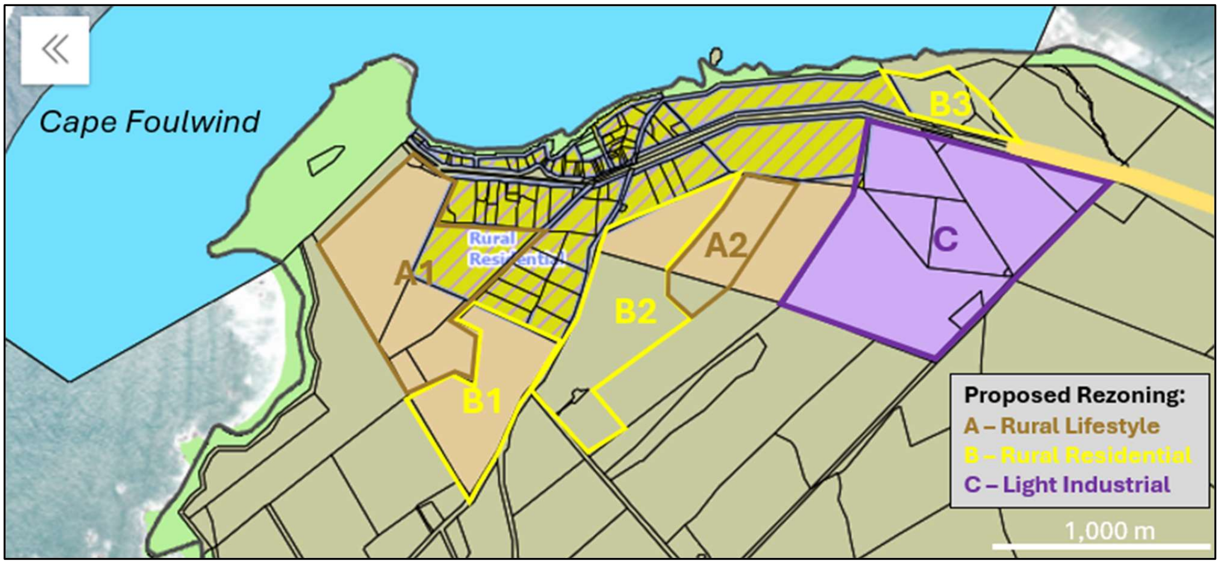

Figure 2.2: Cape Foulwind sites proposed for rezoning from the current proposed TTPP plan – Proposed changes annotated with Zone identifiers (A – C). See Table 2.1 for TTPP basemap legend.

Table 2.4: Assessed scenarios for Cape Foulwind

Scenario	Description
Existing	Current predicted on-site wastewater flows for existing dwellings.
Scenario A	Submitters proposed rezoning for Areas A-C as defined by the Hearing Panel, where rural lifestyle = 1 ha.
Scenario B	The above Areas A-C, but with reduction of rural lifestyle lots to 4,000 m^2.

Table 2.5: Summary of Changes to Zoning at Cape Foulwind (all to land) (colour scheme in footnotes#)

Area ID	Operative Plan#		Submitters Proposed Rezoning# (this assessment)	
	Zone	Number of dwellings with land disposal*	Zone	Lot sizing, m^2
A1	General Rural & Cement Production	0	Rural Lifestyle	10,000** AND CHANGE TO: 4,000
A2	General Rural	0		
B1	Cement Production	0	Settlement Zone – Rural Residential	4,000
B2	General Rural	3		
B3	General Rural	10 houses in B3, currently discharges to C		
C	Cement Production		Light Industrial	15,000

* Lot sizing not provided, as for Moana, as highly variable given the General Rural / Cement Production setting. Dwellings counted from buildings observed on 2023 aerial imagery using Google Earth Pro.
** Rural Lifestyle is currently proposed to be 1 ha, with submissions requesting this be reduced to 4,000 m^2.
# For ease of viewing, colour coding is applied as per the respective issued plans:

- The Buller Operative Plan, found at: https://gis.westcoast.govt.nz/WestMaps/
- TTPP Proposed Plan: https://westcoast.isoplan.co.nz/eplan/

3 METHODOLOGY ASSESSMENT

To enable a cumulative effects assessment, a mass balance approach was adopted. This provides assessment of mass loading (e.g. in kg/day) of key parameters of concern to the receiving environment.

This section outlines the methodology undertaken to assess the following key inputs of a mass balance approach:

- Typical concentrations of wastewater parameters of concern (Section 3.1).
- Wastewater flow volumes expected to occur used to assess additional loading through the proposed zoning changes (Sections 3.2.2 and 3.2.3, respectively).

3.1 Applied Wastewater Quality

There are three stages of treatment available for typical on-site disposal systems, as outlined in TP58 (ARC, 2004), GD06 (Auckland Council, 2021) [3], Horizons (2007) Manual for On-Site Wastewater Design and Management:

- **Primary treatment – septic tank:** The separation of suspended materials by settlement and/or floatation in septic tanks prior to discharge to a land application system or a secondary treatment process. Septic tanks, as primary treatment units, should now always include effluent outlet filters. The design of conventional septic tanks (primary treatment systems) are now also frequently supplemented by siphon and pump dosed systems discharging to the disposal area or followed by a secondary treatment system.
    - There is no significant reduction in nitrogen through this process, estimated to be in the order of 3.5% (TP58), and it is expected that direct discharge of primary treated effluent will have no ammoniacal reduction in the receiving soil (without secondary treatment).
- **Secondary treatment – primary plus aerobic treatment:** Involves aerobic biological treatment, including settling and/or filtering of the primary treated effluent to improve the quality, through biodegradation of the organic contaminants in the wastewater.
    - Secondary treatment quality is expected to be equal to or better than 20 g/m^3 5-day biochemical oxygen demand (BOD_5); 30 g/m^3 suspended solids; and 35 - 40 g/m^3 total nitrogen.
    - Advanced secondary treated effluent is expected to be equal to or better than 15 g/m^3 BOD_5; 15 g/m^3 suspended solids; and 15 – 25 g/m^3 total nitrogen. Methods for advanced treatment include additional filters (intermittent sand filter; recirculating sand filter; recirculating textile filter; recirculating sand filter with N reduction), and/or membrane bioreactor units.
- **Tertiary treatment – disinfection and/or further nutrient reduction:** This is not particularly common for on-site disposal systems, where the secondary effluent is treated to further remove remaining organic and physical contaminants. This can be achieved by:
    - Reducing nutrient levels (including nitrogen) by modifications to the flow regimes and aeration within the system;
    - Further filtration to remove remaining suspended material and pathogens (e.g. further sand filtration, membrane filtration); and/or,

[3] GD06 is currently in draft form, and when finalised is expected to supersede the current TP58 guidance document currently referenced in the WCRC LWP for on-site disposal.

— Disinfection to destroy or reduce pathogen levels by practices such as chemical treatment (e.g. chlorination, ozone) or radiation (ultraviolet light). Sludge requires more frequent removal management, which is dependent on system loading, design and the influent characteristics.

From there, wastewater is disposed of, on-site, to land via several methods, including:

- Shallow irrigation systems: Pressure compensating drip irrigation (PCDI) systems, and other low pressure irrigation systems (low-pressure pipe (LPP) and low-pressure effluent distribution (LPED)).
- Conventional land application systems: Trenches, beds, mounds.
- Combined treatment systems: Bottomless sand filters with specified sand media < 1.0 mm in size.

Additional uptake of nutrients can be provided by vegetation planted on the disposal field soil surface. Nitrate concentrations in wastewater discharged from the disposal field may be significantly reduced due to a combination of volatilization and denitrification. In some cases uptake by overlying vegetation (where the discharge is shallow and/or vegetation sufficiently deep rooted) can also aid reduction in nitrate concentration.

The installed on-site systems depend on site constraints, such as local soil acceptance rates, geological restrictions (such as hard pan layers), and groundwater (perched groundwater or high water table). Of particular concern to this assessment is the addition of bacteria (*E.coli*) and additional nutrient loading from nitrogen and phosphorus. Raw and treated wastewater quality is expected to comprise the ranges presented in Table 3.1, where the key parameters of concern are total nitrogen (TN), total phosphorus (TP) and bacteria (*E.coli* and faecal coliforms).

The adopted effluent quality values for this assessment are presented in Table 3.2.

Table 3.1: Typical range of on-site influent and effluent quality (MfE, 2020)

Parameter (mg/l), (cfu/100ml)	Raw domestic wastewater (influent)	Septic tank effluent	Advanced system effluent (e.g. Aerated WWP)
BOD	210 – 400	120 – 180	15 – 50
SS	220 – 350	60 – 80	10 – 80
TN	45 – 100	45 – 60	20 – 45
NH_4	42 – 90	40 – 50	6 – 40
NO_3	0.5 – 2	0.5 – 20	10 – 35
TP	4 – 18	4 – 12	6 – 10
FC	$10^7 – 10^9$	$10^5 – 10^7$	$10^4 – 10^6$
E coli	$10^6 – 10^7$	$10^4 – 10^6$	$10^3 – 10^5$

Data source: (Treblico, et al., 2012)

Table 3.2: Adopted parameters for cumulative effects analysis

Treatment Level	TN (g/m^3)	TP (g/m^3)	Soil Attenuation	Source / Rationale
Moana WWTP	22.5	6	None	TN: Stantec (2024), based on median ammoniacal-N 0.9 g/m^3 present as an assumed 60% proportion of TN. TP: Advanced treatment system above, at lower end allowing for dilution from I&I within a reticulated system. No attenuation as direct to water.
Moana Primary Septic	60	12	TN: 10% TP 85%	As per Table 3.1 (conservatively the maximum values presented). Attenuation based on values provided by TP58 and USEPA (2002) assuming lower end of the literature values (TN 10 – 30% and TP85 – 95%) based on soil categories 1-2. **Primary septic scenario considered, as the current preferred method at Moana (refer to Appendix A.5).**
Moana Secondary Septic	45	8		
Cape Foulwind Secondary Septic	45	8	TN: 20% TP 90%	As per Table 3.1, with increased attenuation rates nominally adopted at the midpoint ranges above, for soil categories 3-4. **Secondary septic scenario considered, as the current preferred method at Cape Foulwind (refer to Appendix B.5).**

3.2 Volumes Assessment

3.2.1 Population Assessment and Assumptions

In estimating population and wastewater discharge volumes for both the Moana and Cape Foulwind areas, and respective development scenarios, the following key assumptions have been made:

- One dwelling per lot is assumed.
- As no local specifications were available, the Waikato Regional Technical Specifications (RITS) recommendations were used as a guide which stipulates an infiltration allowance of 1.5 m^3/Ha/day & inflow 2.25 m^3/Ha/day for the reticulated Wastewater Scenario. In this case, in Moana, the proposed lot sizes are much larger, resulting in less reticulation than in a typical urban development, hence reduced rates of infiltration allowance of 0.6 & 1 m^3/Ha/day for scenarios A and B respectively & stormwater inflow of 0.8 & 1.6 m^3/Ha/day for scenarios A & B respectively were adopted).
- The current (2024) number of dwellings has been estimated from a visual inspection of the 2023 aerial imagery of both areas.
- For all population estimates in Moana it has been assumed that 15% of the residential homes will be permanently occupied dwellings. This is based on the average split between permanently occupied dwellings and holiday homes observed in the 2006-2018 census data (Stantec report, Moana WWTP Capacity Assessment, May 2024). This assumption was applied both for the scenarios, A and B. Moana Existing scenario dwellings have been assessed as all permanently occupied.
- Persons per dwelling data used, permanently occupied dwellings, 1.6 persons per dwelling (based on Stats NZ data), and 4 persons per holiday home (based on past project experience). A summary of the adopted inputs are provided in Table 3.3.
- Wastewater discharge per person assessed as: onsite (roof water collection etc) at 180 litres per person; and reticulated water supply at 200 litres per person.

Table 3.3: Moana population assessment to support wastewater volumes calculations

Moana Areas A to E	Existing Scenario (Permanently occupied Existing dwellings)	Scenario A (Permanently occupied dwellings)	Scenario A (Holiday Homes)	Scenario B (Permanently occupied dwellings)	Scenario B (Holiday Homes)
Total Dwellings	8	78	443	255	1444
Maximum Population	13	125	439	408	1429

3.2.2 Moana Township Volumes

The following scenarios were considered in calculating the predicted daily volumes of wastewater:

- Existing: Existing current dwellings based on 2023 aerial imagery
- Scenario A: Maximum potential development for the proposed TTPP for each of:
    - Permanently Occupied dwellings; and
    - Holiday homes.
- Scenario B: Maximum potential development for the submitters proposed rezoning:
    - Permanently Occupied dwellings; and
    - Holiday homes.

Moana's annual resident population fluctuates significantly, with visitors visiting during the holiday season. For this reason, it was necessary to split scenario A and B into occupied and holiday homes to better estimate resident population and wastewater discharge.

Arnold River Catchment comprises discharges from Areas A, D and E; Lake Brunner includes discharges from Areas B and C.

The calculated volumes adopted for the assessment are provided in Table 3.4:

Table 3.4: Calculated volumes for discharge to the receiving environment at Moana

Scenario	Catchment	No. of Dwellings (max)	Sewered (WWTP) m^3/d	Unsewered (to land) m^3/d
Existing (Operative Plan) (WWTP only + Area A-E onsite)	Arnold River	6	75*	2
	Lake Brunner	2	0	1
Scenario A + Existing (Proposed TTPP)	Arnold River	251	75	49
	Lake Brunner	271	32	24
Scenario B + Existing (Submitters proposed Rezoning)	Arnold River	1521	124	252
	Lake Brunner	179	0	35
* Stantec report, Moana WWTP Capacity Assessment, May 2024				

3.2.3 Cape Foulwind Volumes

The following scenarios were considered in calculating the predicted daily volumes of wastewater:

- Existing: Existing current dwellings based on 2023 aerial imagery.
- Scenario A: Maximum potential development for submitters proposed TTPP Rezoning (all Rural Lifestyle blocks as 1 ha).
- Scenario B: Maximum potential development for submitters proposed TTPP Rezoning (Rural Lifestyle lot sizes reduced to 4,000 m^2).

The catchments were assessed as follows:

- Gibsons Creek: Areas A2, B2, B3 and C
- Quarry Pit Lake: Southern portion of B1.
- A1 Unnamed Tributary: Area A1 and B1 north.

It is assumed that the future population comprises all permanent dwellings. As no WWTP exists at Cape Foulwind, all of the proposed developments areas will require wastewater discharges to be disposed to land. The calculated volumes adopted for the assessment are provided in Table 3.5:

Table 3.5: Calculated volumes for discharge to the receiving environment at Cape Foulwind

Scenario	Catchment (Areas)	No. of Dwellings (max)	Unsewered (to land) m^3/d
Existing	Gibsons Creek	13	4
	Quarry pit lake	0	0
	A1 Unnamed Tributary	1	0.3
Scenario A (Submitters proposed rezoning, rural lifestyle = 1 ha)	Gibsons Creek	146	42
	Quarry pit lake	25	7
	A1 Unnamed Tributary	77	22
Scenario B (Submitters proposed rezoning, rural lifestyle = 4,000 m^2)	Gibsons Creek	175	50
	Quarry pit lake	No change from Scenario A	No change from Scenario A
	A1 Unnamed Tributary	155	45

3.3 Cumulative Effects Approach

The total loading to each identified catchment was assessed as mass loading in kg/year, and average discharge concentrations assessed in g/m^3 for review against existing surface water flows (where known). In addition to the above inputs, the following assumptions were made in assessing the cumulative effects presented in Sections 4.5 and 5.5, respectively.

3.3.1 Moana

- The loading to Lake Brunner is from all of Area B, the southern portion of Area C and the southwest corner of Area E, via unnamed tributaries. Refer to topographic plan in Section 4.1.
- The loading from the remaining areas (A, D, Area C north, majority of Area E) is to the Arnold River Catchment via unnamed tributaries.
- For existing discharges:
  - Only the existing average daily WWTP discharge to the Arnold River was considered, and
  - On-site discharge from existing dwellings only within Areas A-E were considered in the analysis.
- The wastewater volumes applied were in m^3/day for average annual estimates, as per Table 3.4. The results are therefore for an average daily condition
- Effluent quality is applied as per Table 3.2. Soil attenuation is allowed for, at conservative rates. No allowance is made for uptake by vegetation e.g. wetlands; or from dilution in groundwater prior to discharge.

3.3.2 Cape Foulwind

- The majority of discharge is to the Gibsons Creek and the unnamed tributary through area A1. Marris Creek is not separately assessed, as it is considered that the relocation of the current discharge of the 10 houses in Area B3 to on-site disposal will offset the majority of future proposed development in Areas B3 and C.
- Area C is a former cement factory, which is approximately 25% developed following site decommissioning. This area has been adopted for loading assessment.
- Half of the potential discharge from Area B1 is assumed south to the quarry pit lake, which is assumed to remain as a water feature.

3.4 Data Gaps

The following considerations are acknowledged in the assessment of the noted receptors and their associated cumulative effects discussed, along with the assumptions provided above, as of the time of this report's preparation:

- WCRC advised that there was no available bore depth or source aquifer information for the bores recorded in the WCRC database. Further, as bore installation and reasonable domestic takes are a permitted activity, the location of any actual bores are unknown.
- No wetland delineation as per the Ministry for the Environment. 2022. Wetland delineation protocols has been undertaken for either location and or shallow groundwater investigations which may indicate hydrological connections between potentially impacted groundwater and wetlands.
- No flow or water quality information is available for individual minor tributaries of the identified Arnold River and Lake Brunner catchments (Section 3.3.1).
- Detailed flow and water quality data was not available for Gibsons Creek, the unnamed tributary in A1, or any other smaller tributary in the development area for Cape Foulwind.

3.5 Assessment of Risk

This report references risk as being low, moderate or high / acute.

These are high-level qualitative assessments only, based on what has been reviewed as part of this desktop only assessment, and potential risks. These are defined as follows for the purposes of this assessment:

- Low:
  - Unlikely to cause measurable changes to water quality; and/or
  - Not likely to influence a change to the NPS-FM attribute band; and/or
  - Unlikely to have effects for potable to contact recreation.
- Moderate:
  - Likely to cause a minor change in water quality; and/or
  - May influence a change in the NPS-FM attribute band; and/or
  - May have effects for drinking water or contact recreational users e.g. require monitoring to assess for safety/treatment requirements.
- High:
  - Likely to cause a notable change in water quality; and/or
  - Likely to influence a change in the NPS-FM attribute band; and/or
  - Likely to affect drinking water supplies or contact recreational users requiring treatment or avoidance of use/contact.

4 ASSESSMENT OF MOANA CUMULATIVE EFFECTS

4.1 General Catchment Setting

Moana is a small town on the northern edge of Lake Brunner, located 37 km inland from Greymouth, in the Grey District. It currently has an estimate 30-40 permanently occupied dwellings and up to 280 holiday homes (Stantec, 2024). It currently has a small residential area surrounded by general rural zoned land. Rainfall locally is in the order of 4,700 mm/year (NIWA, 2024a). As such, the majority of residential dwellings are on rainfall supply, and connected to the wastewater network that is treated at the Moana WWTP. The WWTP discharge treated wastewater to the Arnold River at the location shown on Figure 4.2.

Lake Brunner (41 km^2 in area) lies within a glacial basin is at an elevation of approximately 110 m above mean sea level (m asl). Its maximum depth is 109 m, and is fed by two main rivers, the Eastern Hohonu River entering the lake to the west, and Crooked River from the east (at Howitt Point), and from the Inchbonnie catchment via the Bruce Creek to the south. Water leaves the lake via the Arnold River, flowing northwest and discharging to the Grey River ~20 km downstream. From that confluence, the Grey River discharges to the Tasman Sea at Greymouth ~13 km away.

The areas proposed for development from their nearest boundaries are 200 m from Lake Brunner (Area B) and 500 m from the Arnold River (Area A). The development area is generally flat across Area E, becoming steeper as the land ascends towards these water features (Figure 4.2). The lower properties are terraced, e.g. Area A, which itself is made up of flat to gentle (0° to 5°) terraces of differing elevations. Numerous steep gullies are present throughout the development area, indicating water flow paths generally toward the river (Areas A, D and E) and the lake (Areas C and D).

The use of land for farming in the subject area is currently minimal, with low density livestock grazing. This is due to the Land Use Capability, being of category 6-7, which is typically non-arable due to limitations of perennial vegetation. It is noted however that land northeast of (and external to) Area E, has been recently developed for more intensive dairy farming activities.

Figure 4.1: Map of Lake Brunner discharge catchment Basemap source: LINZ Topo250 map series)

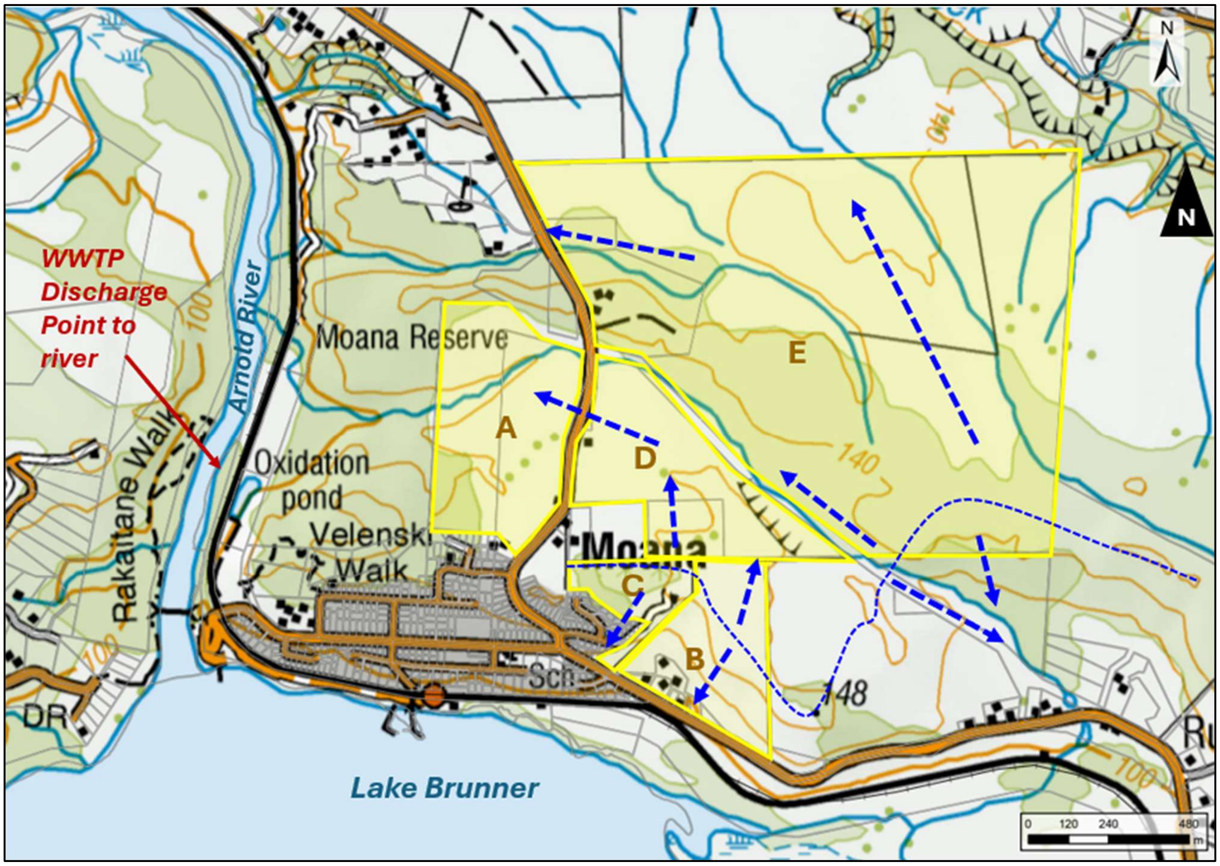

Figure 4.2: Topographic map showing sites for rezoning (Zones A-E), interpreted catchment divide (blue dotted line) and general shallow water flow direction toward final receiving environments (blue arrows) (Basemap source: LINZ Topo50 map series)

4.2 Subsurface Conditions

A detailed review of subsurface conditions are presented in Appendix A. A summary is provided here:

- The surface soils present are predominantly glacial til, comprising high permeability sands and gravels, consistent with AS NZS 1547:2012 soil categories 1-2. A hardpan layer is present at some locations, as was the presence of cobble and boulders.
- On-site septic systems are predominantly primary treatment systems with a filter on the effluent outlet to soak pits. This information is key to this cumulative effects assessment. Soak pits can be installed in the West Coast Regional Land and Water Plan (LWP), either as a permitted activity (subject to conditions of Rule 79 being met), or as a discretionary activity under Rule 91. However, in many regions in New Zealand, wastewater disposal via soak pits is no longer permitted due to failure and/or the potential risk of groundwater contamination to occur in such free draining soils (Water NZ, 2019). There is consensus within the wastewater industry that soak pits are an outdated method, notably since the reform of New Zealand's management of three waters.

- A local continuous groundwater table was not identified in any of the reviewed data. It is expected that any regional water table would be present in the hard rocks that form the local basement. This would potentially be hydraulically separate from the shallow soils and likely discharge to sea to the west.
- Groundwater, if encountered, during site specific investigations was inferred to be perched. It is expected that perched groundwater is discharged to local wetlands and local water ways (drains, tributaries of Lake Brunner and Arnold River).
- It is interpreted that the majority of Lake Brunner Source water is from surface water run-off and tributary/stream inputs, rather than a significant hydrogeological input.

4.3 Groundwater Receptors

There is only one registered bore within 3 km of Moana as shown in Figure 4.3 below. WCRC has confirmed that Bore No. 476 in Moana, drilled in 2004, is associated with water take RC04142 for the Moana Hotel water supply. The bore use is listed as daily use for drinking, at a take rate of 3 L/s, equivalent to up to 260 m^3/day. A bore log is required as a condition of consent and none has been submitted to WCRC. It is therefore possible this bore was not drilled. However, further review would be required to assess, as if screened within the shallow water table, as risk of contamination to the supply are high. If within the deeper rock units, some protection is likely to be naturally in place and risk is likely low. If the bore does not exist (was not drilled), there is no risk.

It is noted that installation of bores is a permitted activity, and therefore not all bores may be registered with the regional authority. Any bores are subject to the same risk assessment as for the Moana Hotel supply bore. However, given the high rainfall in this catchment, it is expected that roof collection is the primary on-site water source for the majority of the township.

Figure 4.3: Extract of WCRC registered bores map for Moana

4.4 Surface Water Receptors

4.4.1 Lake Brunner – Flows and Water Quality

NIWA (2009) assessed the lake as having a total water volume of 2.3 x 10^9 m^3, with residence time of 1.14 years, and an outflow rate of 61.5 m^3/s.

NIWA (2009) reports that the water quality of Lake Brunner is high and is valued for trout fishing. At the time of the 2009 report, there was concern that development of dairy farms in the catchment (20% of the catchment) would lead to water quality will decline. WCRC and NIWA have undertaken long-term water quality sampling for nutrients since 1992 (WCRC, 2022).

Some groundwater contribution of farming nutrients was interpreted to occur from the Inchbonnie catchment to south (near Bruce Creek shown on Figure 4.1) (WCRC, 2024b). However, impacts of nutrients (nitrogen and phosphorus) are most evidence from run-off and surface water flows in the lake bays that directly receive stream/river flows from farming catchments e.g. Cashmere Bay (WCRC, 2024a), at the head of Iveagh Bay (Figure 4.4). It is noted that the mixing of elevated nutrients in Cashmere Bay does not affect the rest of the lake, possibly owing to Cashmere Bay's inherently different suite of physical characteristics (including physical-chemical parameters and lake stratification).

Lake Brunner is also a very popular bathing area with the lake shore containing multiple bathing areas, including adjacent Moana Marina. Pathogens are of primary concern for this location. The WCRC collects water samples weekly for bacterial contamination from the site from November to March each year[4] for comparison with the NPS-FM. Samples from the last five years (121 samples) indicate a grade of 'good' to 'fair' which mean bathing is suitable 95% of the time (*E. coli* <260 CFU/100mL) caution is advised 4% of the time (260 – 540 CFU/100mL) and bathing is deemed unsuitable 1% of the time (below the national bottom line of 540 CFU/100mL).

[4] Land, Air, Water Aotearoa (LAWA) - Lake Brunner @ Moana: https://www.lawa.org.nz/explore-data/west-coast-region/swimming/lake-brunner-moana/swimsite

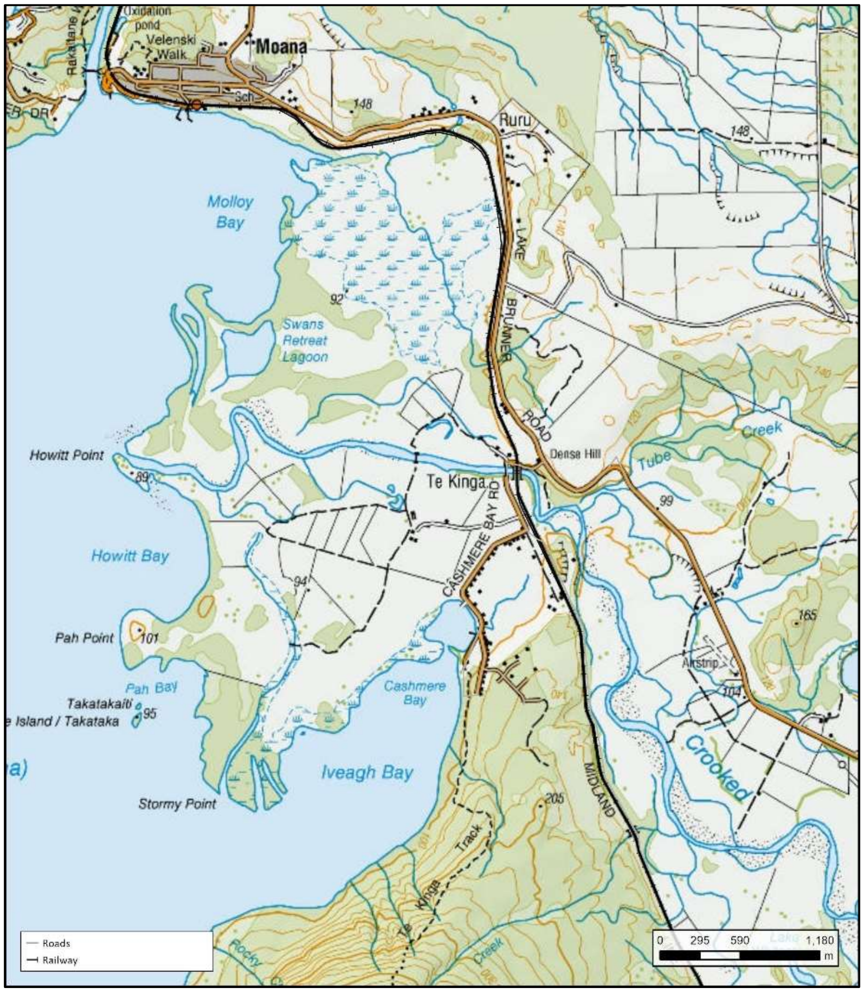

Figure 4.4: Location of Cashmere Bay, with localised nutrient impacts from dairy farm runoff

4.4.2 Arnold River - Surface Water Flows and Quality

WCRC data indicates the median flows of the Arnold River at Moana range from 37.4 – 65.3 m^3/s (Table 4.1).

WCRC collect water quality data from the Arnold River at the Kotuku Fishing Access. Table 4.2 below summarises the last 5 years of monitoring data. This sampling site is 2.2 km downstream of the WWTP discharge point but available water quality data indicates the Arnold River has very good water quality, with all measured parameters either in the best 25 % or 50% of all sites in the Country, and in the NPS-FM Attribute band A for all the parameters monitoring. However, the incoming tributaries of the Arnold River near the Kotuku record partially degraded water quality with respect to contaminants associated to diffuse runoff from agricultural activities. Molloy Creek and Deep Creek in the Arnold Valley are rated in the worst 25% and 50% of all similar waterways in the country for E. coli, Total Nitrogen, Total Oxidised Nitrogen and Nitrate Nitrogen, respectively.

Table 4.1: WCRC Statistics for River Flows at Arnold River, Moana*

Statistic	Data (m^3/sec)
Median Flow Range (long-term median)	37.4 – 65.3
Minimum Flow (March long-term average)	28.6
Maximum Flow (July long-term average)	263.6
* Source: https://envirodata.wcrc.govt.nz/dashboards/riverlevels/ArnoldatMoana	

Table 4.2: Summary of 5-year median of monitoring data for Arnold River at the Kotuku Fishing Access (LAWA, 2024)

Parameter	State	Trend	NPS-FM* Attribute Band	Median Value
E. coli	In the best 25% of all sites	Improving	A	7.5 n/100 mL
Total nitrogen	In the best 25% of all sites	Improving	A	0.19 mg/L
Total Oxidised Nitrogen	In the best 50% of all sites	Improving	A	0.098 mg/L
Ammoniacal Nitrogen	In the best 50% of all sites	Improving	A	0.006 mg/L
Nitrate Nitrogen	In the best 50% of all sites	Improving	A	0.097 mg/L
Dissolved Reactive Phosphorus (DRP)	In the best 25% of all sites	Improving	A	0.002 mg/L
Suspended Fine Sediment	In the best 25% of all sites	Degrading	A	3.98 m
* National Policy Statement for Freshwater Management 2020				

4.4.3 Discussion of Surface Water Receptors

The general surface water receptors for the development areas include a range of unmodified watercourses, drainage channels and multiple wetland features, such as meandering watercourse with riparian vegetation, Pakihi and Manuka flood plain wetlands. The sensitive surface water receptors for each development and the downstream receiving environment are described below.

- Area A: If the discharge is to the WWTP, the main receptor will be the Arnold receiving via direct discharge. Where to land, the receptors will be perched groundwater, small tributaries and receiving wetlands.
- Area D: Is upgradient of Area A, but any shallow perched groundwater will again be subdued by topography and the various meandering channels and tributaries heading north and then directed toward the drainage channel adjacent Arnold Valley Road to discharge to the tributary which then flows back to the west through the Moana Scenic Reserve as per the tributary in Area A.
- Lake Brunner Catchment:
  - The small southern area of Area E draining to Lake Brunner flows southeast into an un-channelised tributary which flows downhill to two wetland ponds adjacent Lake Brunner Road, prior to discharging under the road and to two Schedule 1 and Schedule 2 ‘Te Kinga Ruru’ wetlands.
  - The main development areas (B, C) contain shallow groundwater driven downslope toward the various surface water drainage channels which drain toward the east side of Moana township prior to discharging to the lake under both Lake Brunner Road and the Rail line. The ultimate receiving environment adjacent Lake Brunner is also a regional

significant wetland (Schedule 2 Te Kinga Ruru) and lies in the Lake Brunner Special Management Area identified by WCRC (insert map).

— The unnamed tributary discharges to the large area of wetland and lake Brunner approximately 380 metres from the nearest lake front beach, making Lake Brunner bathing water quality a key receptor to potential discharges from these developments.

- Area E: Is split into three sub catchments draining to Lake Brunner to the southeast (discussed above); the remainder to the Arnold River to the west and Molloy Creek to the north. The larger Northern section of Area E contains large areas of unmodified sphagnum moss, pakihi and manuka wetlands, ephemeral flow channels and a range of tributaries which drain towards the northwest and discharge both to the Arnold River to the west and north to the Molly Creek. None of the potential wetlands are identified as either Schedule 1 or 2 significant wetlands per the WCRC management plans.

4.4.4 Freshwater Fish and Stream Biology

The Arnold River and the surrounding tributary including the Molloy Creek contain a diverse range of freshwater fish assemblages including multiple ‘at risk and declining’ species, such as the kanakana (*Geotria australis*), giant kokopu (*Galaxiid argenteus)* and the dwarf Galaxis (*G. divergens*). Both catchments are also well renowned sport fisheries for brown trout (*Salmo trutta*) and rainbow trout (*Oncorhynchus mykiss*). However, the influence the Arnold River power schemes has on the freshwater fish assemblage also requires further investigation, as mortality events have been recorded in the catchment. The various sphagnum moss, Pakihi and Manuka wetlands and ponded surface water around Moana, including within Areas A, D and E, will hold excellent habitat for the ‘at risk declining; Brown Mudfish (*Neochanna apoda*).

Due the lack of suitable habitat, WCRC does not monitor stream invertebrates (MCI/SQMCI) in the Arnold River adjacent Moana and Areas A, D and E. However, it’s noted that due to Arnold River flow being regulated by the Lake Level, the stabilised flow regime favours abundant algal growth which suits macroinvertebrate taxa less sensitive to pollution.

The nearest stream invertebrate monitoring is undertaken in the Molloy Creek. Macroinvertebrate community scores indicate the site is recording degrading trends in the last 10 years of data.

4.5 Results of Cumulative Effects Assessment

The estimated nutrient loading to groundwater/surface water resulting from on-site wastewater disposal is equivalent to:

- 4 kg TN/person/year.
- 0.1 kg TP /person/year.

This is generally consistent with the ranges reported elsewhere for similar cumulative effects assessment (e.g. Environment Southland; Liquid Earth, 2017), being at the upper end of the ranges due to primary treatment methods in soils of category 1-2 at Moana.

The mass loading expected to reach the primary surface water receptors is presented in Table 4.3. The resulting averaged concentrations of the final discharge are presented in Table 4.4, which are variable for each scenario due to the variable application methods between each zone, including to the WWTP, and consideration of secondary treatment options.

For the various scenarios presented, including treatment through the existing WWTP, the following maximum increases in loading are predicted for the proposed submitters settlement rezoning (Scenario B), assuming primary septic treatment (rounded due to uncertainty where ~ denoted):

- Arnold River: Approximately 5 – 7 tonnes TN/year and ~0.4 tonnes TP/year.
- Lake Brunner: Approximately 0.5 – 0.7 tonnes TN/year and ~0.02 tonnes TP/year.

Under the proposed TTPP (Scenario A), these are:

- Lower for the Arnold River: Approximately 1 – 2 tonnes TN/year and ~0.2 tonnes TP/year.
- Only marginally lower for Lake Brunner: Approximately 0.4 – 0.5 tonnes TN/year, and 0.01 – 0.02 tonnes TP/year.

The Arnold River catchment is expected to be the largest receiving water body for the proposed on-site disposal field discharges from the development areas, receiving 70-90% of the total proposed loading (depending on the scenario assessed).

The potential effects of each scenario and recommendations are provided below.

Table 4.3: Predicted mass loading of nutrients to receiving water bodies

	Existing (Operative Plan)	Scenario A (proposed TTPP)		Scenario B (submitters proposed rezoning)	
	Primary septic disposal and WWTP discharge (excludes on-site systems outside of Areas A-E)	Primary Treatment only (current accepted method)	Secondary Treatment	Primary Treatment only (current accepted method)	Secondary Treatment
Arnold River: Areas A, D, E (including WWTP)					
Sum of WW flow (m^3/d)	77	124		365	
TN (kg/year)	650	1578	1337	5978	4738
TP (kg/year)	165	265	260	437	410
Lake Brunner: Area B, C					
Sum of WW flow (m^3/d)	1	49		35	
TN (kg/year)	11	476	357	685	514
TP (kg/year)	0.4	16	13	23	19

Table 4.4: Predicted average discharge concentrations of nutrients to receiving water bodies

	Existing for Areas A-E	Scenario A (proposed plan)		Scenario B (proposed rezoning)	
	Primary septic disposal and WWTP discharge (excludes on-site systems outside of Areas A-E)	Primary Treatment only (current accepted method)	Secondary Treatment	Primary Treatment only (current accepted method)	Secondary Treatment
Arnold River: Areas A, D, E (including WWTP)					
TN (g/m^3)	23	41	35	44	35
TP (g/m^3)	6	6	6	3	3
Lake Brunner: Area B, C					
TN (g/m^3)	54	36	30	54	41
TP (g/m^3)	2	1	1	2	2

4.5.1 Arnold River – Nutrients

For the Arnold River, the differences in results between the scenarios are as follows for primary treated effluent for areas A-E (including the WWTP discharge):

- ***Scenario A*** (current proposed plan) from the ***existing scenario*** presents a 240% total annual mass loading increase of TN to Arnold River, and 120% increase of TP.
- A further increase in annual mass loading of 370% for TN and 210% for TP is predicted to result from ***Scenario B*** (compared with ***Scenario A***) for the proposed rezoning, including settlement zones.
- The total increase of ***Scenario B*** from the ***existing scenario*** to Arnold River is in the order of 9x the current annual loading for TN and 2.5x that of TP.
- Of the above maximum values, the predicted long-term increases in concentrations[5] in the Arnold River (under average/median conditions) for TN are:
  - 0.004 g/m^3 increase for TN for primary septic treatment under the proposed settlement rezoning (Scenario B).
  - These values will be subject to variable weather conditions and difficult to identify after mixing within the current measured ranges of 0.1 - 0.8 g/m^3 (LAWA, 2024).
  - These increases are not considered to lower the current NPS-FM Attribute Band of A for nitrate for the Arnold River. However, during summer, where periphyton effects are already notable, this may locally exacerbate the extent of algal cover due to the stable flow regime.
- Similarly, for TP:
  - 0.001 g/m^3 increase under the proposed settlement rezoning (Scenario B) for both primary and secondary treatment.
  - It is expected this will be difficult to identify within the reported river range of 0.006 - 0.098 g/m^3.
  - DRP would remain within NPS-FM Attribute Bands B and A, for an average flow condition.

It is noted however that these results apply an *average discharge quality* to the Arnold River after mixing. This presents a low risk in terms of effects to the overall water quality of the river.

Pathways via tributaries are not individually assessed, due multiple present of varying sizes, for which flow and quality data is not available for. It also excludes summer flow periods where potential effects may be elevated. For long-term wide-spread on-site septic installations, individual tributaries and ponded water such as in wetlands are expected to have a moderate to high risk of impacts from nutrients driving primary production indicators, such as nuisance algae. For this reason, primary effluent discharge via soak pits is not recommended. Secondary treatment as a minimum is recommended, with discharge via trenches, subsurface irrigation or beds/mounds where possible.

4.5.2 Arnold River – Bacteria

Mixing calculations were not undertaken for bacteria, where pathogens die-off rates are dependent on the source count and pathway length, which includes hydraulic gradients to drive contaminant

[5] Based on mass balance calculation of Concentration (g/m^3) x V Volume (m^3/day) = Mass Flux (g/day); as assessed for the average predicted discharge volumes against the calculated mass loading.

water to downgradient receptors, where a longer pathway results in additional time to allow for die-off. Where seeps daylight to tributaries or other waterways (e.g. wetlands), the bacteria may not have sufficient time to die off, particular within high permeability sandy gravels. Setback distances are set for this purpose (50 m as per Rule 79 of the LWP), but under high permeability conditions apparent at Moana, these setback distances may not be sufficient to mitigate the cumulative effect of wide-scale on-site installations in surface water. Secondary treatment is recommended as above. The primary receptors to bacteria are typically potable and recreational water users, such as bathers in summer in the Lake. In the absence of these receptors within proximity to Area A, D and E, the risk is low, where for area B and C it represents a moderate to high risk as multiple bathing beaches are available within one kilometres of the stream outlet.

Development of a pathogenic fate and transport model was outside the scope of this assessment, but it is our assessment that the tributary draining Area B and C to Lake Brunner represents the single largest risk to pathogens from onsite wastewater systems from the development to freshwater bathers. This is addressed in Section 4.5.5.

4.5.3 Area A Wetlands

For Area A (Brunner Builders), indicated through the submission process that onsite waste disposal is requested, a review of the closing statement of the consultant planner (dated September 09, 2024) was completed alongside the development area plan (DAP drawing SK006 Rev P1). The scheme plan indicated the internal road layout, former land fill, no-build areas, forest residential development area across the proposed settlement zone. Based on the indicative layout, the internal road transverses through multiple wetland units which have been identified in the ecological assessments by the applicant, as containing three natural inland wetlands, as per the NPS-FM, whist another three units are not deemed natural inland wetlands.

The various wetland units are connected via a series of modified farm drains, presumably dug to facilitate agriculture to the adjacent semi-permanent and ephemeral unnamed tributaries. Wetlands 1, 2 and 3 all drain to the unmanned tributary in the north of the site whereas wetlands 4, 5 and 6 all drain to the second unnamed ephemeral tributary in the south of the site. The semi-permanent unnamed tributary in the north of the site is fed from the large sphagnum moss wetland on the eastern side of Arnold Valley Road and will encompass the discharges from Area D and A and the western side of Area E. Whereas the ephemeral unnamed tributary in the south of the site collected water from wetlands 5 and 6 and the land area west of Arnold Valley Road.

The position of wetlands indicates the topography is flat and in contact with shallow groundwater receptors, so that discharge of wastewater contaminants to these surface water units will have a slower travel time to the larger water body of the Arnold River, compared to the steeper catchment draining Area B and C as the hydraulic gradient is flatter. However, as the flow regime and current ecological condition of the unnamed tributary's is currently not known, determining the impact from both the development in Area A and then the cumulative waste loading from Area D and E is not possible from a desktop assessment.

Furthermore, removal or modification of the wetland units are per the submitters DAP also requires further investigation as wetlands are well documented nutrient and pathogenic retention and treatment devices. Until such time as the flow regimes in both the tributary's traversing Area A can be put context of the nutrient loads in this report, it is recommended all sites are sewered and disposed of to the WWTP.

4.5.4 Lake Brunner – Nutrients

The total increase of ***Scenario B*** from the ***existing scenario*** to Arnold River is in the order of:

- 60x the current annual loading for both TN and TP for primary treated systems;
- And under secondary treatment, reducing to 45x TN and 50 x TP for the current scenario.

The assessment approach for water quality for Lake Brunner differs from the above, where the lake has notably different physical characteristics, including physical chemical parameters and lake stratification. This can result in localised areas of nutrient loading that do not rapidly mix with the wider Lake for dilution. An example of this has been previously reported at Cashmere Bay (Section 4.4).

The increase in nutrients resulting in the change in zoning from the proposed TTPP (Scenario A) to as presented by the submitters (Scenario B) is marginal, and it is considered either zoning options would have similar effects.

Moderate potential risk of changes to water quality is predicted for the tributary form Areas B and C in the which drains to Molloy Bay (Figure 4.4) and the Schedule 2 Wetland. If the Hearing Panel wish to understand the more specific localised effects to the tributaries, accurate water flow information would be required for this tributary to accurately determine the potential or actual localised effects.

4.5.5 Lake Brunner – Bacteria

The lake is particularly susceptible to pathogens from the proposed on-site wastewater disposal. The expected removal timeframes to <1 CFU/100 mL of bacteria in groundwater[6] are:

- 5-6 months for primary treatment.
- 2-3 months for advanced treatment.

Due to the relatively permeable sandy gravels present it is possible that the groundwater travel times are as low as days to weeks to local surface discharge points. As such, this is not be long enough to allow for all bacteria to die-off prior to discharge to the identified tributaries that feed Lake Brunner. As such, elevated bacterial counts are considered a moderate to high risk to bathers in the area near Molloy Bay from development of Areas B, C and southern Area E.

Advanced septic treatment is recommended for an on-site disposal.

4.5.6 Additional Commentary – Dairy Farming

Dairy farming currently occurs north of the development area, and east of Lake Brunner near Cashmere Bay, where effects to Lake Brunner have been observed from the latter. A review of nutrient loading from farming was compared to the current proposal for residential zoning with on-site wastewater disposal.

The conversion of land to residential is expected to have significantly less impact than if the land were converted for dairy farm use. This is concluded from the typical nitrogen excreted from a single cow is about 5.4 kg TN/year (WRC, 1995). Guidance suggests that the maximum loading of soils in New Zealand should be 150 kg N/Ha/year (Manaaki Whenua Landcare Research, 2022). This equates to 33 Tonnes TN/year to the same assessed catchment for the settlement zone. Conversion of land to residential with on-site systems presents less potential effects to the receiving environment.

[6] Excludes removal via soil filtration. These timeframes are based on conservative die-off rate of 0.1/day (Pang et al., 2003); and *E.coli* in Table 3.1 and data factsheets for AES advanced secondary treatment systems for bacteria to 2,260 CFU/100mL.

4.6 Recommendations

4.6.1 Domestic water supply

Not all installed bores are required to be registered with regional council, as a permitted activity. Localised contamination of groundwater through poor well-head protection, and through excessive effluent loading to ground, presents a high risk to shallow groundwater quality. The risk is likely lower for deeper groundwater (e.g. in the basement rock). Where all supplies are roof-sourced, there is no risk from on-site loading.

Should the developments proceed, public notification may be required to:

- Advise that roof collection is the most appropriate supply for local domestic use for new on-site supplies. If groundwater supply is sought, this should be from deeper rock; however the yield of the aquifer is not known and requires exploration. Based on the cost of this exercise, and high rainfall in the area, roof supply is most likely to be feasible for the majority of new dwellings.
- Notify residents with existing bores to regularly check and test their bore supply to ensure they are free from contamination (nutrients such as nitrate and bacteria). Further, additional treatment should be implemented, such as UV disinfection for protection against bacterial contamination.

As a minimum, an assessment of whether the supply bore at the Moana Hotel exists, where the consent is recorded as being owned by one of the Brunner Buildings submitters for rezoning.

4.6.2 Septic Treatment

Whilst allowable under Rule 79 of the LWP, primary effluent discharge via soak pits is not recommended to continue to occur at Moana for wide-spread land development on-site disposal systems.

This is due to the high soakage rates of the gravels present, preventing in-ground attenuation, and potential evapotranspiration uptake by overlying suitable vegetation.

As noted with the nearby development at Cashmere Bay Road, David Ogilvie (2024) notes that '*on-site management would see individual lot owners install, operate and maintain individual secondary or tertiary wastewater treatment and discharge systems. The treatment systems are likely to take the form of proprietary filtration and treatment systems with advanced Nitrogen and pathogen reduction capabilities before discharge via evapotranspiration and infiltration beds.'*

This assessment reaches the same conclusion for the Moana township.

The sensitive nature of the surrounding environment, including Lake Brunner, will need to be taken into account when deciding on the appropriate nature for specific lot wastewater management systems. Secondary treatment, as a minimum is recommended, with discharge via trenches, subsurface irrigation, or beds/mounds where possible, with appropriate grasses/ vegetation planted to increase nutrient uptake. For systems closer to Lake Brunner's sensitive receptors (e.g. Areas B and C and the downstream bathing receptors), advanced secondary or tertiary treatment is required.

If soak pits are to be installed, 100 m setback distances are unlikely to mitigate bacteria die-off at Moana. Tertiary treatment is recommended for any soak pit system, to mitigate the nutrient and bacteria loading to either receiving catchment. However, it is noted that these recommendations may necessitate a change at the regional LWP level.

Regular maintenance of these systems is required, and will be specified by the system manufacturer, Generally, septic tanks should be inspected once a year and pumped out every 3-5 years (or more often if necessary), by a certified contractor.

Alternative considerations to the above include upgrading the existing WWTP to treat increased influent volumes; and/or maintaining the currently proposed TTPP densities of 4,000 m^2 for rural residential zoning.

5 CAPE FOULWIND

5.1 General Catchment Setting

Cape Foulwind is approximately 8.5 km west of Westport, in the Buller District. It is a predominantly undeveloped rural area, located on a raised and gently sloping coastal terrace, lowering toward the coast. Contours are shown on Figure 5.1, where slope gradients are typically <10º (GWE, 2022; GWE 2024). Large cliffs are present (Omau cliffs), with steep slopes (near vertical) up 64 m asl at its highest elevation.

Locally, a series of natural watercourses with steep sides and invert levels of up to 4 m on the terrace are draining the terrace and discharging over the cliff at positions of coves, which suggests a correlation between high erosion rates and discharge of surface water (WSP, 2021b). Examples of this are the Gibson and Marris Creeks within the eastern portion of the proposed rezoning area.

Shallow water flow paths are generally indicated on Figure 5.1 to be:

- Predominantly towards Gibson Creek (Areas A2, B2, C, B3) which discharges to the Tasman Sea, with only a small portion toward the lower Marris Creek from Areas B3 and C, also to the sea.
- The remaining flow paths are toward an unnamed tributary flowing through Area A2. The receiving catchment from Area B1 is a combination of the A2 unnamed tributary, and likely the quarry pit lake.

Land is currently generally unsuitable for intensive livestock grazing, as reflected by the land use capability category 6 (NZ LRI, 2024).

Rainfall locally is in the order of 2,100 mm/year (NIWA, 2024b).

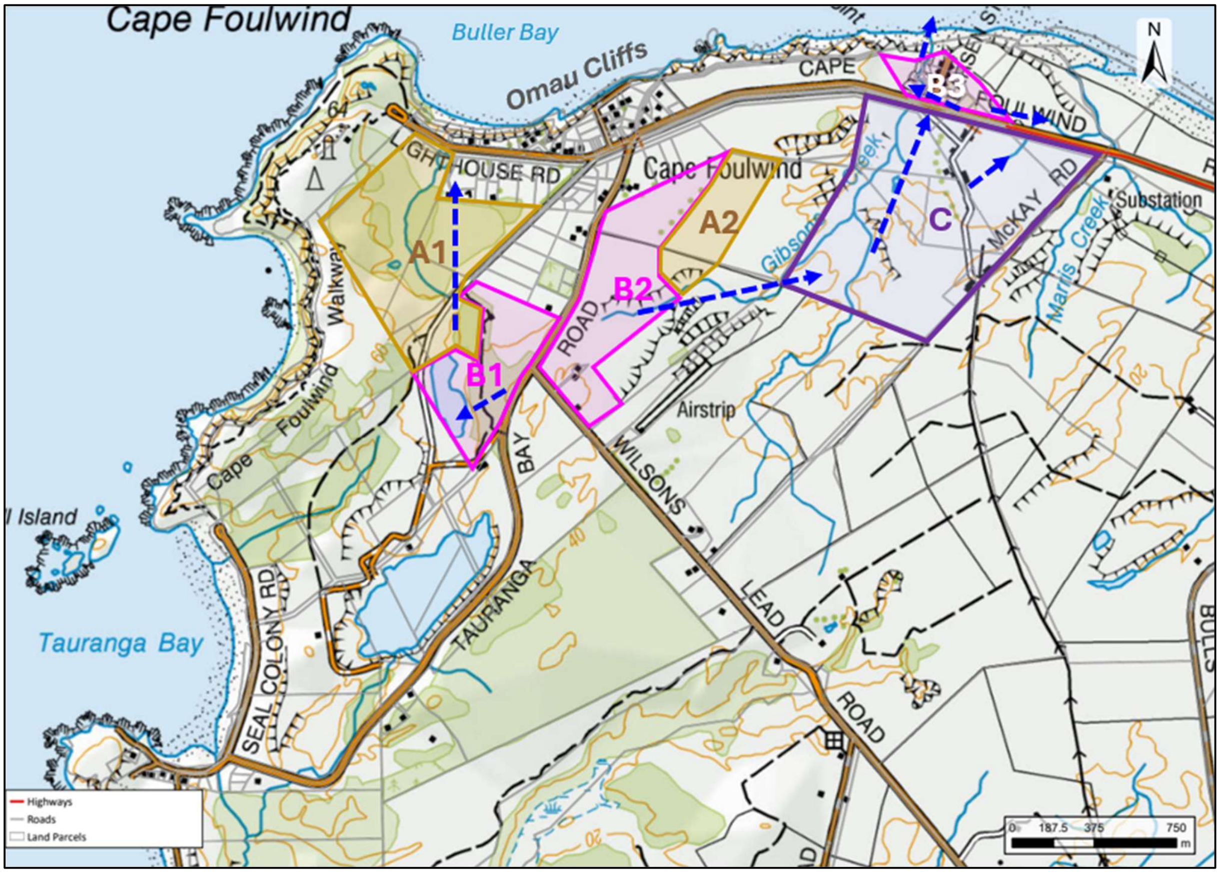

Figure 5.1: Topographic Map of Cape Foulwind areas for rezoning. General shallow water flow direction toward final receiving environments (blue arrows) (Basemap source: LINZ Topo50 map series)

5.2 Subsurface Conditions

A detailed review of subsurface conditions are presented in Appendix B. A summary is provided here:

- The surface soils present are predominantly marine sand and gravel, comprising moderately permeable soils ranging from AS NZS soil categories 1-4. A hard pan layer is present across the development area, varying from 0.3 to up to 2.7 m depth.
- A local continuous groundwater table was not identified in any of the reviewed data. It is expected that any regional water table would be present in the hard rocks that form the local basement. This would potentially be hydraulically separate from the shallow soils and likely discharge to sea to the west.
- Groundwater, if encountered, during site specific investigations was inferred to be perched. It is expected that perched groundwater is discharged to local wetlands and local water ways (drains, quarry pit lakes, tributaries of Gibson's Creek and the Area 2 unnamed tributary).
- On-site septic systems are predominantly secondary treatment systems via shallow irrigation fields. Flipping of soils is generally required to break the hard pan layer, which presents a site constraint for on-site disposal at Cape Foulwind.

5.3 Groundwater Receptors

There are no registered local groundwater users within 1 km of the site. The closest water supply bore is indicated to be approximately 1,900 m the east (cross-gradient) of the site (WCRC Bore No. 374, dairy use). No information is available for this bore or the source aquifer.

There are no Buller District Council reticulated water supplies available to the majority of development areas. A water line labelled “PVC rural” is present, running a total length of 8 km from approximately 76 Bulls Road to the corner of Tauranga Bay Road and Wilsons Lead Road. No other information is available regarding water reticulation infrastructure. Based on the reports available for review, and the lack of local groundwater and surface water sources, it is expected that water supply will predominantly be from roof water collected in water tanks.

Based on WCRC information there are currently no groundwater users considered as direct potential receptors for the potential cumulative wastewater loading. Future groundwater users (if they occur) would likely seek potable water sourced from the deeper regional groundwater aquifer, which will require exploration first to assess if a viable water supply source.

It is noted that installation of bores is a permitted activity, and therefore not all bores may be registered with the regional authority. However, given the high rainfall in this catchment, it is expected that roof collection is the primary on-site water source for the majority of the township.

5.4 Surface Water Receptors

The risks from the onsite discharge of wastewater at Cape Foulwind is contamination of perched groundwater, receiving surface water and the coastal marine area.

5.4.1 Water Flows and Quality

The connection of perched groundwater to other water bodies is likely to be:

- Primarily horizontal, flowing toward local surface water bodies (streams, wetlands) with along the top of the hardpan layer, or along the contact surface with the underlying Neogene rock units:
    - Gibsons Creek naturally incises approximately 8.0 m through the natural ground, exposing a near vertical slope with varying vegetation density near the discharge point.
    - Surface water is regularly observed in the area to pond within topographical lows.
    - To Quarry Lakes/Ponds e.g. within Areas A1 including the small channelised unnamed tributary and B1 (Figure 5.1).
- Minor vertical drainage to the regional water table may occur but is expected to be minimal. Water within a regional deeper aquifer will likely be sourced from upgradient of the site as aquifer through-flow.

There is only one consented water user within the development area, being for water supply for the now defunct Holcim cement factory in Area C (AUTH-RCN97202-2). The supply was taken from a dam on the Gibson Creek; the location of this is unknown and inferred as shown on Figure 5.2. There is also one stormwater discharge permit to the Gibson creek (AUTH-RCN97202-3), being a discharge permit to discharge up to 2,800,000 litres per day of stormwater from the site and water used at the factory into Gibson Creek, from the same factory.

Surface water flows in Gibson Creek are stated in the 1997 consent application (Milburn Cement, 1997a and 1997b) as ‘*Observation records has always been a minimum flow. Over the last six* *months lowest flow was 30 L/sec. Average flow has been 100 L/sec'*. The current consent (transferred to Cape Foulwind Staple 1 Ltd.) requires that the permanent flow in the creek shall not be reduce below 20 L/sec as a result of the take. Further indication of flow is presented in the photo in Figure 5.3, which appears to show a reasonable flow volume in the creek near its discharge point to sea.

The only available water quality data at the time of preparing this assessment was from the 1997 AEE, which indicated the catchment at that time had generally neutral pH (6.9), typical freshwater conductivity (160 µS/cm) and had detected concentrations of ammoniacal-nitrogen (0.04 g/m^3), and elevated concentrations of iron (0.59 g/m^3).

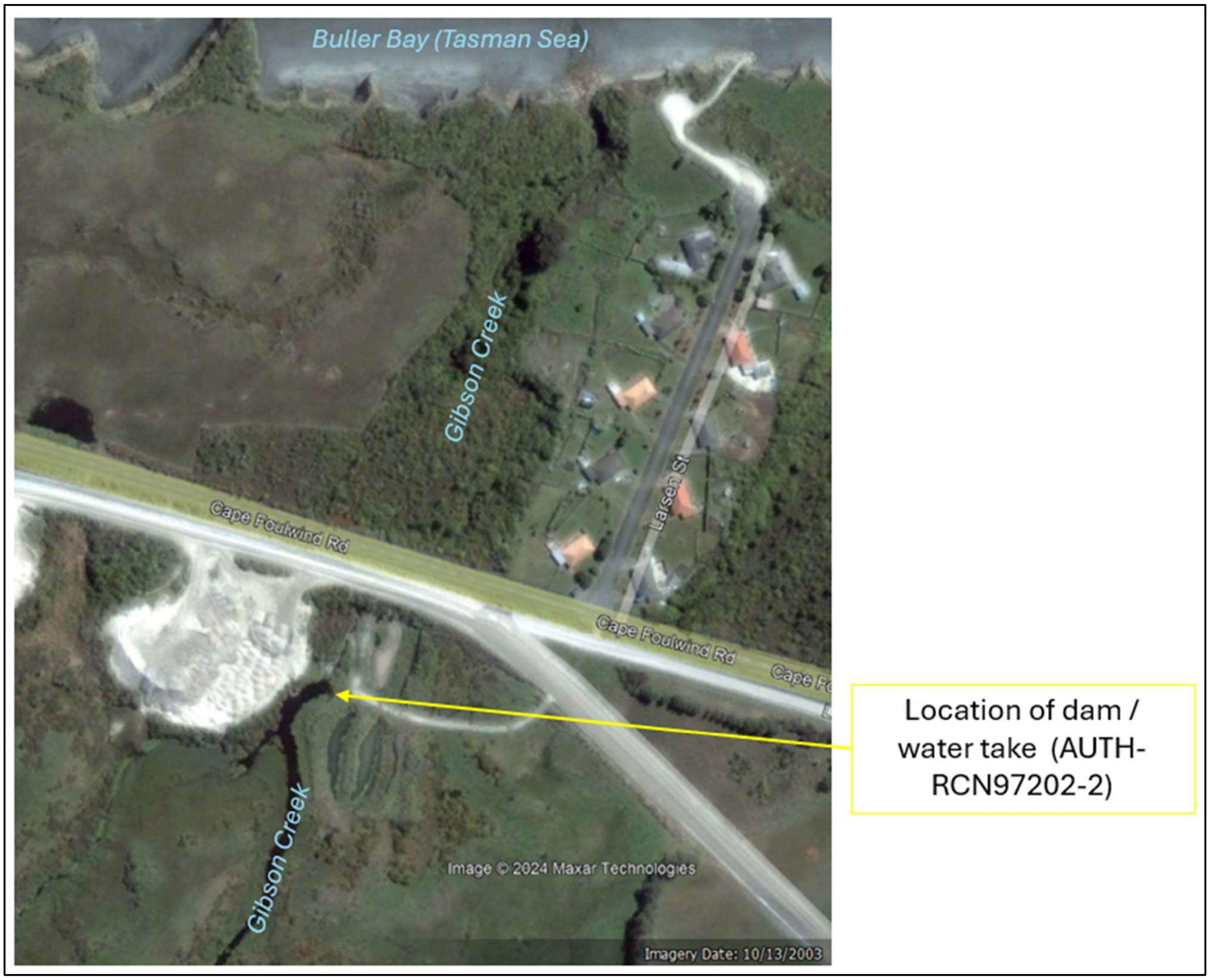

Figure 5.2: Gibson Creek, with inferred dam and consented water take location (basemap source: Google Earth Pro)

Figure 5.3: Gibson Creek, facing north. (Source: Davis Ogilvie, 2023)

5.4.2 Overview of Surface Water and Ecological Receptors

The main receptors are surface water bodies, including:

- Gibsons Creek and Marris Creek, at the eastern and of the proposed development area (Area B2, A2, B3 and C). Both creeks discharge to Buller Bay at the base of the Omau cliffs. The Marris Creek is inferred to receive only a small portion of the overall on-site disposal catchment.
- Quarry lakes and ponds, present in the western portion of the development area, including the Quarry lake in B1, and a unnamed tributary leading to a pond in Area A1 as shown on Figure 5.1
- Wetlands – None of the Development Areas A1, A2, B1, B2, B3 and C contain either Schedule 1 and 2 Wetlands under the West Coast Management Plan, however, based on aerial imagery, topography there appears to be multiple land surface depressions across all the development area which hold wetland vegetation and wetland hydrological indicators.

Whilst there is a current take consent at the Gibson Creek Dam, this is unlikely to be active as the cement production ceased in 2016 and the plant was subsequently decommissioned. It is considered that this could form a potential water source in future.

Gibsons Creek is therefore one of the key receiving surface water bodies for this this study area, which originates in Area B2 and flows through A2 and Area C and B3. This creek is considered to be fed by the largest catchment for this assessment. This creek is 3 – 4 m wide, naturally incises approximately 8.0 m through the natural ground, exposing a near vertical slope with varying vegetation density near the discharge point (Davis Ogilvye, 2023). It discharges to the Tasman Sea, at Buller Bay at the base of the cliffs near Area B3 (Figure 5.4).

Figure 5.4: Oblique aerial view showing cliff edge overlooking the Tasman Sea (Buller Bay) and Gibson creek Outlet. Photo sourced from Davis Ogilvie (2023) and annotated by BTW

5.4.3 Gibson Creek Ecology Receptors

The WCRC does not collect macroinvertebrate samples in the area around Cape Foulwind. However, a 1992 study by Kingett Mitchell undertaken as part of the Assessment of Environmental Effects for the Milburn Cement Factory collected stream invertebrates in the water courses around the site. The stream survey indicated the macroinvertebrate assemblage was of low diversity with benthic species dominated by pollution tolerant species, such as oligochaetes, chironomid, and snails. It was deemed this was related to the sandy stream bed sediment and the lack of available habitat, such as boulders with hard stream bed habitats.

Two further ecological survey of the Gibson and Maris Creeks was completed by SKM in 1998 and 2006, and again both surveys indicated the streams were dominated by pollution tolerant taxa and indicated an over enrichment of nutrients and were degraded as they were unfenced farm drains.

No New Zealand Freshwater Database records exist for either the Gibbson and Marins Creek, however, there are several eDNA records in the Cape Foulwind area. The small tributary which drains the Cement Work quarry to the southwest of Area B1 contained multiple freshwater fish including both species of tuna (*Anguilla dieffenbachia and A australis*), redfinned bully (*Gobiomorphus huttoni*), commons bully (*G. cotidianus*), banded kokopu (*Galaxias fasciatus*) and Koura. Its then expected the lower reaches of the Gibbson Creek would contain a similar fish assemblage where connectivity to the Tasman Sea exists.

5.5 Assessment of Potential Cumulative Effects

The estimated nutrient loading to groundwater/surface water resulting from on-site wastewater disposal is equivalent to:

- 2 kg TN/person/year.
- 0.04 kg TP /person/year.

This is generally consistent with the ranges reported for the Environment Southland assessment of cumulative effects (Liquid Earth, 2017), being at the lower end of the ranges due to secondary treatment methods at Cape Foulwind in soils of category 3-4.

The mass loading expected to reach the primary surface water receptors are presented in Table 4.3. For the various scenarios presented, including treatment through the existing WWTP, the following maximum increases in loading are predicted for the proposed rural lifestyle rezoning to 4,000 m^2, assuming secondary septic treatment (rounded due to uncertainty where ~ denoted):

- Gibsons Creek: ~700 kg TN/year and ~20 kg TP/year.
- Quarry Pit Lake in Area B1: ~90 kg TN/year and ~3 kg TP/year.
- A1 Unnamed tributary: ~600 kg TN/year and ~20 kg TP/year
- Marris Creek: no significant increases predicted on the basis that removal of the existing B3 Larsen Street housing development will offset new developments within the small catchment reporting to the creek.

The resulting averaged concentrations of the final discharge for secondary effluent treatment to land across the area is 36 g/m^3 for TN, and 1 g/m^3 for TP.

The Gibsons Creek catchment is expected to be the largest receiving water body of the proposed on-site disposal field discharges. No flow or water quality data is available for the A1 tributary, which is expected to have less flow than Gibsons Creek based on the smaller catchment size. Both tributary's discharge to the Tasman Sea and have short catchments (nlike the Arnold River and Grey Catchment) and which will mitigate a significant amount of the wastewater loading as travels times to the coast is in hours and not days. Additionally, the wastewater loading will be further attenuation in the coastal marine area.

The changes between the proposed rezoning of rural lifestyle to 4,000 m^2 is more pronounced for the A1 unnamed tributary, with on-site discharges expected to approximately double in volume from the 1 ha scenario (A).

The potential effects to the local surface water environment and recommendations are provided below.

Table 5.1: Predicted mass loading of nutrients to receiving water bodies

	Existing for all areas	Scenario A (Proposed rezoning, RL* = 1 ha)	Scenario B (Proposed rezoning, RL* = 4,000 m2)
Gibsons Creek: A2, B2, B3, C			
Sum of WW flow (m^3/d)	4	42	50
TN (kg/year)	49	553	660
TP (kg/year)	1	15	18
Quarry pit lake: B1 (south)			
Sum of WW flow (m^3/d)	0	7	
TN (kg/year)	0	93	
TP (kg/year)	0	2.6	
A1 Unnamed Tributary: A1, B1 (north)			
Sum of WW flow (m^3/d)	0.3	22	45
TN (kg/year)	4	291	588
TP (kg/year)	0.1	8	16
* RL = rural lifestyle			

5.5.1 Gibsons Creek – Nutrients

- ***Scenario A*** (current proposed rezoning) from the ***existing scenario*** presents an 11-fold increase in annual TN and TP mass loading to the Gibson Creek.
- A further increase in annual mass loading of 1.2-fold for TN and TP is predicted to result from ***Scenario B*** (compared with ***Scenario A***) for the proposed resizing of rural lifestyle to 4,000 m^2 lots.
- The total increase of ***Scenario B*** from the ***existing scenario*** to the creek is in the order of 13x the current annual loading for TN and TP.
- Of the above maximum values, the predicted long-term increases in concentrations in Gibsons Creek River (under average/median conditions) are:
  - ~0.2 g/m^3 increase for TN for both Scenarios A and B from the existing scenario. This is a potentially measurable increase, but no existing water quality data is available to compare, and not flow data is available as to determine a TN load post mixing.
  - ~0.01 g/m^3 increase for TP, which is unlikely to be measurable after mixing.

As with the Moana assessment (Section 4.5.1), these results apply an *average discharge quality* to the freshwater creeks after mixing.

This includes pathways via tributaries, which are not individually assessed, due multiple surface water receptors being present of varying sizes, for which flow and quality data is not readily available. For long-term wide-spread on-site septic installations, individual tributaries and ponded water such as in wetlands may expected to present a moderate to high risk of measurable impacts of nutrients driving primary production indicators, such as nuisance algae. No less than secondary treatment is recommended for on-site disposal.

5.5.2 Unnamed Tributary A1 – Nutrients

This water body is expected to be measurably impacted by the proposed rezoning of rural lifestyle to 4,000 m^2, indicated by the 200% increase in loading predicted in Table 5.1 between scenario A and B. Assuming half the average flows of Gibsons Creek (based on the catchment area being approximately ¼ the size), water quality increases after mixing may be in the order of 0.7 g/m^3 TN and 0.02 g/m^3 TP for Scenario B for rural lifestyle to 4,000 m^2. For scenario A, where 1 ha is maintained, this reduces to 0.4 g/m^3 TN and 0.01 g/m^3 TP.

The magnitude of the Scenario B increases has the potential to lower the existing attribute bands under the NPS-FM.

It is noted that the flows for this tributary are unknown, and could be greater where quarry pit lake in Area B1 contributes to additional flow. Until stream flow data can be obtained to confirm flows are sufficient to dilute the expected wastewater discharges, it's our recommendation not to reduce the rural lifestyle lot sizes to 4,000 m^2 in Areas A1 and B1.

5.5.3 Quarry Lake B3 – Nutrients

An average estimated flow of 7 m^3/day is predicted to enter the quarry lake from up to 25 additional dwellings within the pit lake catchment. It is estimated this equates to ~90 kg TN/year and ~3 kg TP/year. The lake is 35 ha in size, and assumed to be greater than 2 m deep, has >70,000 m^3 of water for mixing. This may result in a minor effect due to the reducing mixing and circulation. However, as with Lake Brunner (Section 4.5.4), mixing may not be uniform due to lake physical characteristics. There may be localised effects where seepage initially enters the lake, but effects are expected to be low overall. There is no change between Scenario's A and B, where no change in rural residential lot sizes are proposed.

5.5.4 Bacteria

The lower permeability soils at Cape Foulwind (relative to Moana) offer longer flow paths for pathogen die off. Where set back distances are maintained (50 m as per Rule 79 of the LWP) from shallow water ways, pathogen die off is expected to be 99.9%, which is consistent with USEPA (2002) estimates.

5.5.5 Additional Commentary – Dairy Farming

For consistency with the Moana assessment, conversion of the land use to intensive diary farming would result in 17x more nutrient loading when compared with the proposed residential lots (4,000 m^2) at Cape Foulwind.

5.6 Recommendations

5.6.1 Domestic Water Supply

The recommendation as provided for Moana is applicable to Cape Foulwind; refer to Section 4.6.1.

5.6.2 Septic Treatment

In general, at least secondary treatment should be required for Cape Foulwind developments, as is the current local practice. Tertiary treatment should be implemented where setback distances to waterways cannot be achieved, such as dwellings upgradient of surface water receptors.

With secondary treatment, appropriate vegetation planted above the disposal fields, shallow drip systems and mounds are a good option (as opposed to deeper trench systems) for uptake by grass/evapotranspiration, to reduce the nutrients loading to perched groundwater. Flipping is a viable disposal method to enable installation of shallow irrigation systems where hardpan layers are present close to the land surface.

Soakage or deeper trench systems should be avoided where possible. Shallow systems are preferable to assist with nutrient uptake by plants, which further mitigates nutrient loading. The latter appears to already be the preferred method at Cape Foulwind.

The LWP provides a minimum setback distance of 50 m from surface water bodies for onsite wastewater discharge as a permitted activity.

In order to conclusively assess the effects to Gibsons Creek, water quality sampling and flow gauging is required. The unnamed tributary in Area A1 may be notably adversely affected by the proposal to reduce rural lifestyle lot sizes to 4,000 m^2. Until stream flow data can be obtained to confirm flows are sufficient to dilute the expected wastewater discharges, it's our recommendation not to reduce the rural lifestyle lot sizes to 4,000 m^2 in Areas A1 and B1.

6 SUMMARY AND RECOMMENDATIONS

6.1 Conclusions

The Hearing Panel is unclear as to whether there is the potential for significant adverse effects to occur on a broader basis because of proposed rezonings at Moana and Cape Foulwind in terms of on-site wastewater disposal.

Overall, adverse effects are to be expected to occur in the receiving environment for any land use change. This assessment finds that there is potential for on-site wastewater discharges to increase nutrients and bacterial counts in smaller waterbodies and waterways such as wetlands and tributaries. These are the intermediate receiving environments that receive seepage from the local perched groundwater system beneath each area. Effects to local tributaries and waterways are expected to report more acute effects of nutrient loading, where flows may not be sufficient to dilute the effects. This may drive the presence of nuisance algae, particularly during low rainfall periods and low flows over summer.

Where tributaries discharge into larger waterways, such as the Gibsons Creek or the Arnold River, the total nutrients are expected to be sufficiently diluted so that the risk is low, where either: no measurable impact is recorded; or potential minor increases do not change the Attribute Band under the NPS-FM. At Cape Foulwind, the final discharge to the sea (from the identified waterways such as the Gibson Creek) is expected to further attenuate the potential effects of nutrients and bacteria.

At Lake Brunner, the large volumes of water present in the lake do not necessarily mean that dilution will occur:

- Due to the physical and chemical characteristics of the lake, including stratification and long residence time, more localised effects may be visible nearest the points of discharge e.g. from the unnamed creek discharging into Molloy Bay.
- Pathogens present a risk for contact recreation at the northeastern shore of Lake Brunner, where sub-surface transport times (in permeable gravels) are likely insufficient to allow for full die-off before reaching the lake.
- There is potential for low to moderate effects to occur locally where the unnamed tributary discharges into the lake. The increase in nutrients discharging to Lake Brunner between the two assessed scenarios is marginal (the proposed TTPP Scenario A; versus submitters rezoning Scenario B). It is considered either zoning options would have similar effects on Lake Brunner.

Similarly, at Cape Foulwind, the unnamed Tributary through Area A1 may have localised measurable effects (considered also to be moderate to high), depending on flow rates in the stream, which have not been currently determined. If the Hearing Panel wish to understand the more specific localised effects to the tributaries identified above, accurate water flow information would be required for this tributary to accurately determine the potential or actual localised effects.

Based on available literature values for nutrient loss, if these development areas were converted to dairy farming there would be a 5-time increase in predicted onsite loading at Moana, and a 17-times increase at Cape Foulwind. It is assessed that conversion of land at both sites to residential with on-site wastewater systems is expected to produce lower potential adverse effects than if converted to dairy farming. This is because the activity can be better controlled through improved system design mechanisms from the multiple point source discharges compared to the diffuse sources associated to more intensive agricultural practises.

6.2 Recommendations

The key recommendations for Moana are:

- Confirmation if the Moana Hotel supply bore was installed and is in use by its consent holder.
- The current method of primary septic treatment and disposal via soak pits is recommended to cease at Moana for the level of development proposed. This is a typically outdated method in other regions, notably since the central government water reforms have occurred.
- Adverse effects to the environment are expected for any land development scenario
  - The key human health effects are to contact recreation users, from bacterial loading. Monitoring of the northern lake shores is recommended for swimming and water sports safety.
  - The key ecological effects at Moana being the smaller tributaries to Molloy Bay of Lake Brunner from the development of Areas B and C. If acceptance of rezoning is uncertain by the Hearing Panel based on the conclusions above, stream flow measurements for the unnamed tributary at Molloy Bay would be required to accurately determine the potential or actual localised effects.
- Secondary treatment as a minimum is recommended, and disposal to land via other methods such as sub-surface irrigation (where possible) or beds/mounds. Where soak pits are deemed the only viable option, advanced secondary or tertiary treatment for nutrients and bacteria is highly recommended. The method of treatment should be assessed on a site-by-site basis.

The key recommendations for Cape Foulwind are:

- Secondary treatment (as is the current local practice) as a minimum is recommended, and disposal to land via other methods such as sub-surface irrigation (where possible) or beds/mounds. Flipping of soils can assist the installation of the shallow irrigation systems. Where minimum setback distances cannot be maintained, tertiary treatment for nutrients and bacteria is highly recommended. The method of treatment should be assessed on a site-by-site basis.
- As with the above tributary into Molloy Bay for Moana, this assessment is currently unable to quantify the degree of adverse effects to the unnamed tributary in Area A1 at Cape Foulwind. Until stream flow data can be obtained to confirm flows are sufficient to dilute the expected wastewater discharges, it's our recommendation not to reduce the rural lifestyle lot sizes to 4,000 m^2 in Areas A1 and B1.

Additional Recommendations

- Additional sampling: If stream flow assessments of the two unnamed tributaries above are undertaken, it is recommended that additional water quality samples are collected at the same locations, and at Gibsons Creek.
- Long-term water quality monitoring: Should be undertaken (by the appropriate authority) to monitor parameters for safe contact recreation at Molloy Bay at Moana, and at the creek ocean discharges at Cape Foulwind.

- Other existing permitted activity bore supplies: Notification for residents with existing bores is recommended to check their bore depth. The greatest risk is in bores screened in the shallow sediments. Where screened in the deeper rock, risk is likely reduced. A bore survey could be undertaken to identify all bore users. Any identified bore users are recommended to check and test their bore supply to ensure they are free from contamination (nutrients such as nitrate and bacteria). Further, additional treatment should be implemented, such as UV disinfection for protection against bacterial contamination, given the significant number of on-site disposal systems proposed for the town.
- Future on-site supply sources: Should ideally be roof sourced, given the high rainfall in the area and extent of proposed on-site loading.

LIMITATIONS

This report has been prepared by BTW for West Coast Regional Council to satisfy the objectives outlined within the report. BTW accepts no liability if the report is used for a different purpose or is relied upon by any person(s) other than the client. Any such use or reliance will be solely at their own risk.

This report is representative of all the information available to the authors, and the conclusions and recommendations made in this report are derived from that information which was available at the time the report was written.

BTW accepts no liability for any detail not included within the report arising from additional information about the development area, scenarios, sites and environmental information discovered after the report's date of delivery.

The services of this project are in accordance with current and known professional standards for environmental and site assessments at the time of investigation. BTW reserves the right to update this report if any additional information is made available.

This report has been prepared based on the proposed development areas as determined by West Coast Regional Council for the various land use scenarios, if these scenarios or development areas change, this report and its assessment and recommendations will require updating.

The passage of time, unexpected variations in ground and surface and water conditions, or the impact of future events (including (without limitation) changes in policy, legislation, guidelines, scientific knowledge; and changes in interpretation of policy by statutory authorities); may require further investigation or subsequent re-evaluation of the Conclusions by BTW Company.

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APPENDIX A MOANA DATA REVIEW – DETAILED SITE SETTING

A.1 Land Use Capability

Land at Moana is a mix of Land Use Capability Categories (NZ LRI, 2024):

- 6) Non-arable with moderate limitation for use under perennial vegetation such as pasture or forest.
- 7) Non-arable with severe limitations to use under perennial vegetation such as pasture or forest (NZ LRI, 2024).

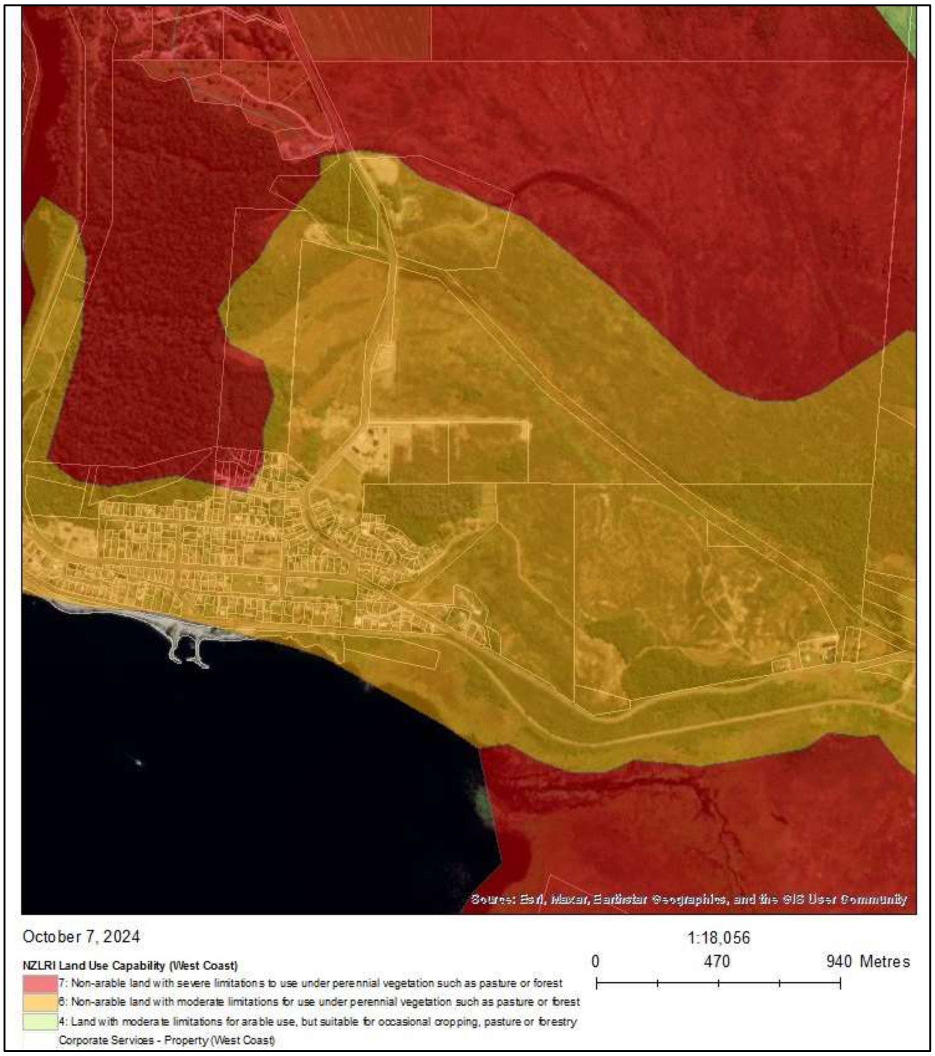

Figure A 1: Land Use Capability, Moana (NZ LRI, 2024)

A.2 Local Geology

An excerpt of the Geological Map of New Zealand, (GNS, 2024) 1:250,000 is provided in Figure A 2. The following units are present at the site:

- The majority of the Moana area for assessment has mapped quaternary surficial deposits:
  - Areas A-D and part of E: Late Pleistocene glacial deposits described as '*till; gravel with sand and silt (Q2.tilgvl)*'.
  - North eastern section of Area E: Late Pleistocene river deposits described as '*gravel with sand and silt'* (Q2.alvgvl).
- Local basement rocks comprising the Neogene sandstones and mudstones of the O'Keefe Formation, which is part of the Blue Bottom Group that outcrops at Cape Foulwind.

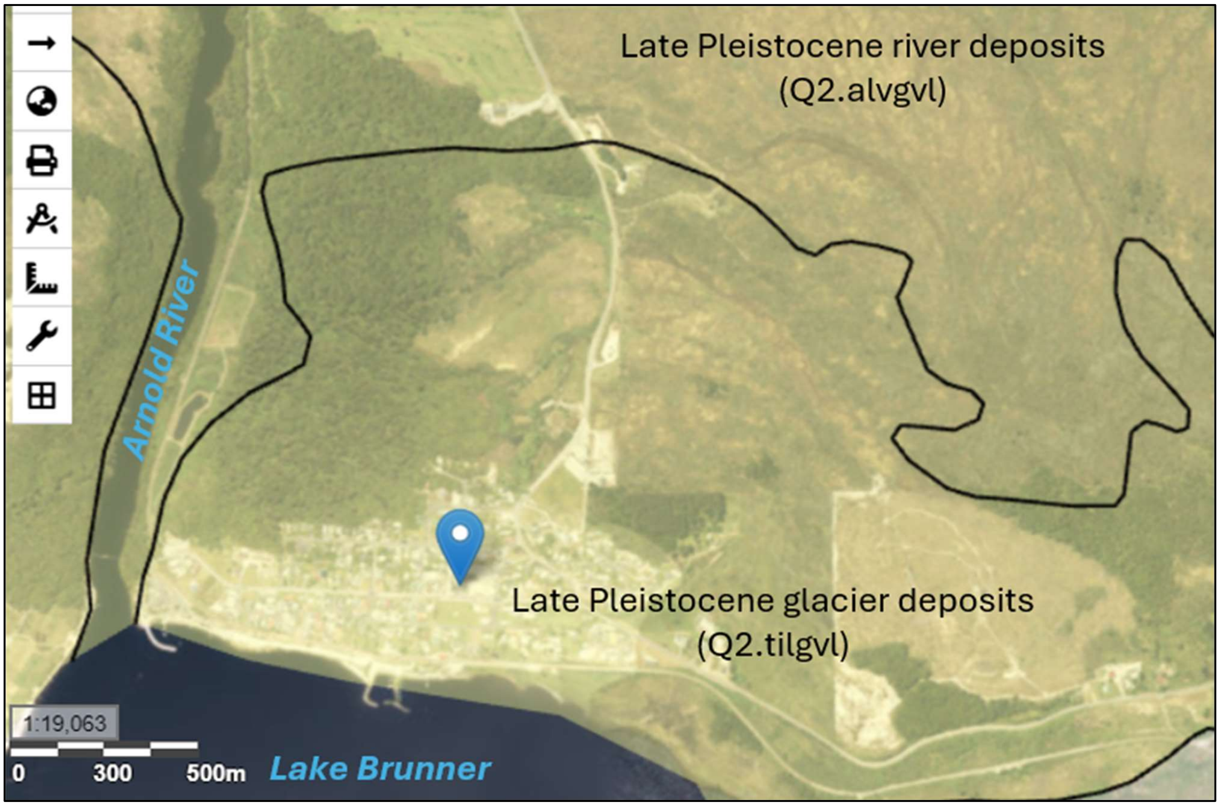

Figure A 2: GNS Geological Map 1:250K of Moana (Basemap source: https://data.gns.cri.nz/geology/)

A.3 Soils

Logs from available reports (Wiley Geotechnical, 2020; Landtech Consulting, 2019; Scimac Ltd, 2024; Scimac Ltd, 2023; and consent applications) indicate highly variable soils present across the proposed rezoning area, Where fill was not encountered on pre-developed sites, the local soil profile up to 2.5 m depth generally comprised:

- A soft surface organic topsoil layer (or fill, if present) up to 0.6 m thick.
- Three test locations of 29 total across all reports reviewed reported a hardpan layer, comprising dense gravels up to 0.3 m thick immediately under the soft organic layer. These were present in Area A or north of the lake, adjacent to Arnold River. Yellow-orange mottles reported indicate the potential for poorly drained soils, such as hydric soils.
- Where the hardpan layer was not present at all other locations, medium-dense gravels are present. These ranged from sandy fine gravels to boulder gravels at short distances (i.e. within the same subject site).

- Beneath this, glacial till was encountered from between 0.6 m bgl, comprising grey, dry, gravels sand with cobbles and boulders.

The presence of groundwater was similarly variable, due to terracing, presence of hardpan layers and drainage channels. A continuous local water table not encountered in the investigations reviewed. Groundwater seepage was observed in several test pits, by Landtech Consulting (2019) through permeable soils layers between 0.3 and 1.7 m at one site. The seepage was considered to be sourced from interflow, as surface runoff which has locally infiltrated the soils. Standing perched groundwater was encountered by Wiley Geotechnical (2020) in four out of 18 test pits between 1.3 and 1.7 m bgl.

As the Arnold River flows northwest it is contained in gently undulating floodplains surrounded by shallow stone Gley and Recent soil in LUC 4.

A.4 Percolation/Soil Acceptance Capacity

The soil categories reported below a topsoil and any hardpan layer are soil category 1-2 comprising rapid draining gravels, at some locations with perched groundwater. A couple of locations nearer to Arnold River reported higher soil categories of 3-4, which are typically slower draining. However, the dominant lithology across the development area is category 1-2 free draining sands and gravels.

Only one percolation test was available, in Area A, which reported a soakage rate of 0.56 L/sec (SciMac, 2023). This was based on 1,000 L of water draining from a soak pit 2m W x 3.8 m L x 0.9 m deep over a 30-minute period.

A.5 Typical septic systems

Several wastewater consents[7] in the study area and associated application documents were supplied by WCRC and reviewed to inform this section. This included supplied permitted activity approval letters[8]. Disposal methods are influenced by the reported soil categories, typically being 1-2.

The following disposal methods are consented or exist as permitted activities at Moana:

- At one location reviewed (west of Area E, closer to the river), a commercial discharge was consented in slower draining soils (category 4). This included a secondary treatment system and sub-surface dripper irrigation was installed.
- At another location, at the western edge of Area E, discharge of primary treated effluent was via "field drains" comprising slotted discharge pipe, 100 m in total length, at 2 m spacings, 100 mm below the soil surface, placed within a wooded area and covered with vegetation.
- All other disposal systems reviewed were in gravelly soils, with primary treated effluent discharged to land via soak pits. A typical soak-pit design at Moana is presented in Figure A 3 , which includes:
  - Multichambered septic tanks (two or three separate chambers) with a filter on the outlet pipe.
  - Minimum size of 3m x 3 m x 3m, filled with gravel aggregate.
  - Filter cloth around the aggregate (AP20/40) in poorer draining soils.
  - Discharge to the soak pits is predominantly via trickle feed.

[7] Resource Consent Numbers: RCN99148, RC00350, R09186, RC-2014-0155, RC-2023-0056.

[8] PA-2015-9026, PA-2019-9037, PA-2021-9017.

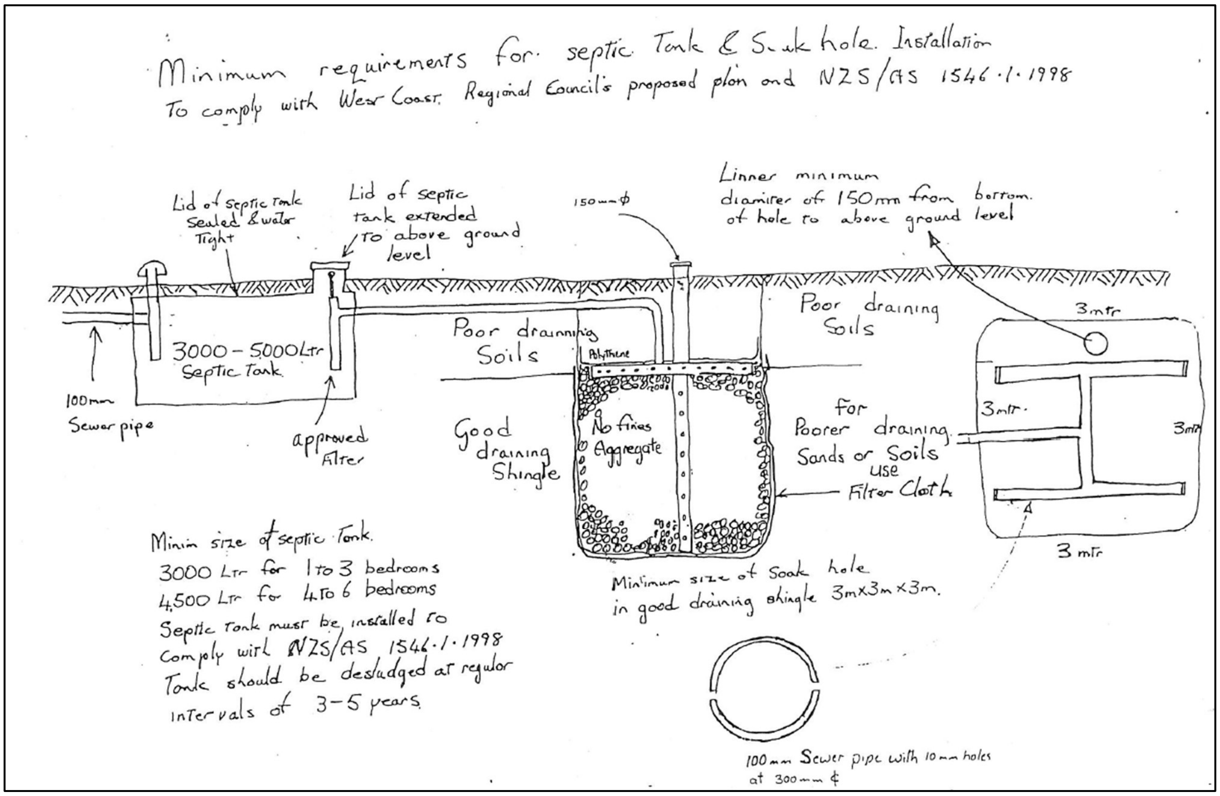

Figure A 3: Diagram illustrating typical minimum installation requirements of on-site septic systems at Moana

A.6 Groundwater and Connection to Surface Water

Information on the Lake Brunner source water is limited. NIWA (2009) reports that a significant volume of inflow is sourced from tributaries into the lake, with no information of groundwater provided. Limited local bore information is available to inform the presence of aquifers.

No consistent local groundwater table was identified during this review. Based on review of the wider geological setting (including for Cape Foulwind in Section 5.1) and lack of groundwater sources locally, it is inferred that a perched water table is present, that feeds into local waterways and wetlands. Where water is not held in wetlands, it is expected to drain laterally towards the nearest main surface water body.

A regional groundwater table is likely present at depth, but this depth is unknown. Based on the same underlying geology for Cape Foulwind (Section B.6) there is likely a significant vertical separation distance between the perched groundwater and the continuous water table at this area of proposed development. Between these two features, the soils are expected to be unsaturated, creating a hydraulic separation between the perched groundwater and regional water table.

It is therefore assumed that the majority of Lake Brunner Source water is from surface water run-off and tributary/stream inputs based on the following:

- The lake is within a glacial basin, with the slopes formed by moraines;
- The Lake is underlain by low permeability rocks of the Blue Bottom Group;
- Is within an area of high rainfall, inducing high runoff; and

- No hydrogeological assessment is publicly available, and is stated by WCRC that '*little is known about the associated groundwater pathway*'[9].

Connection via direct groundwater seepage occurs (including from the southern Inchbonnie Catchment, via Bruce Creek) but is likely to be minimal, compared with surface water and rainfall sources.

Locally, at the proposed development area, it is expected that perched groundwater is discharged to:

- Wetlands, where some nutrients are possibly up-taken by evapotranspiration;
- Local water ways (drains and tributaries), with lateral flow eventually to either the following as indicated in Figure 4.2:
  - Lake Brunner (Area C, and the southern portions of Areas B and E).
  - To the Arnold River (remaining northern areas of Area A, D and E).

As it is difficult at a high-level to provide assessment of the direct effects on smaller tributaries (in the absence of specific site information), the overall focus for the key receptors in this report are the ultimate end receiving environment water bodies, being Lake Brunner and Arnold River.

[9] https://www.wcrc.govt.nz/environment/water/groundwater/inchbonnie-catchment

APPENDIX B CAPE FOULWIND DATA REVIEW – DETAILED SITE SETTING

B.1 Land Use Capability

All land at the proposed Cape Foulwind development is considered to be Land Use Capability Category 6, being *Non-arable with moderate limitation for use under perennial vegetation such as pasture or forest* (NZ LRI, 2024).

B.2 Local Geology

An excerpt of the Geological Map of New Zealand, (GNS, 2024) 1:250,000 is provided in Figure B 1 and a photograph of the Oamu cliffs near the Larsen Street development (Area B3) is provided in Figure B 2. The following units are present at the site:

- The majority of the Cape Foulwind area for assessment has mapped surficial deposits of Late Pleistocene shoreline/ocean beach sediments described as '*marine sand and gravel'* (Q5.bch).
- Local basement rocks comprising:
  - O'Keefe Formation (Blue Bottom Group) (Mi.sst1): Neogene sandstone sedimentary rocks described as '*blue-grey; micaceous muddy sandstone'* are mapped to the north of the areas proposed for rezoning, including the Omau Cliffs. This unit is expected to underlie the wider area of assessment.
  - Other local basements rocks present to the west of the subject area include paleogene sedimentary rocks (mudstones, limestones), and the regional basement granites.

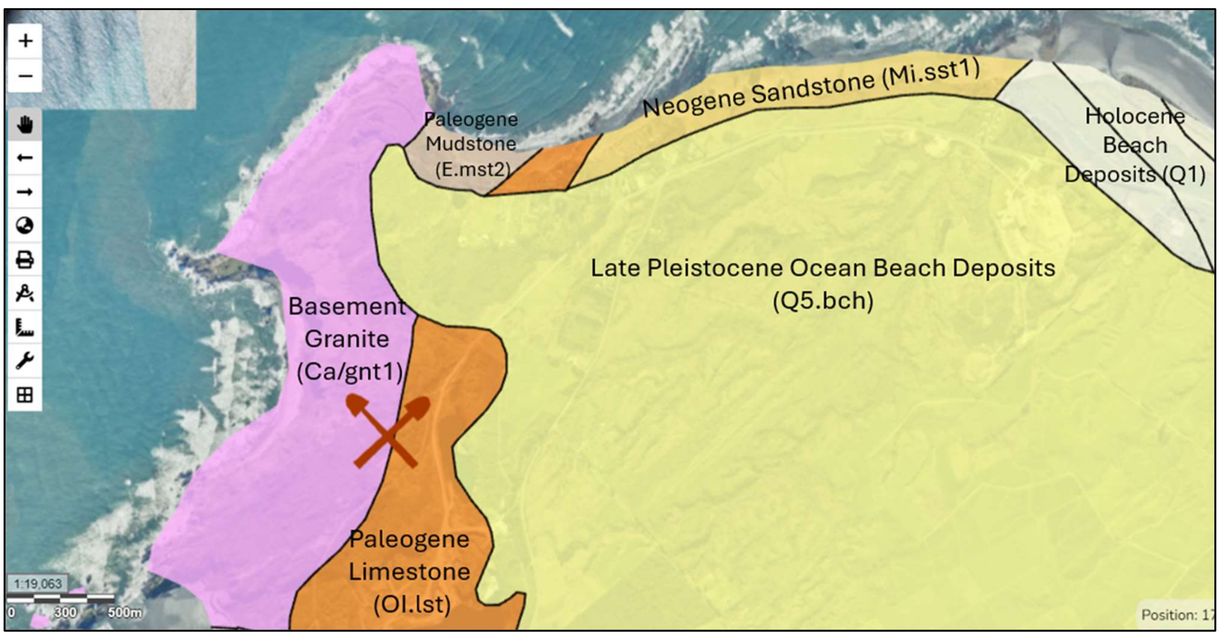

Figure B 1: GNS Geological Map 1:250K of Cape Foulwind (Basemap source: https://data.gns.cri.nz/geology/)

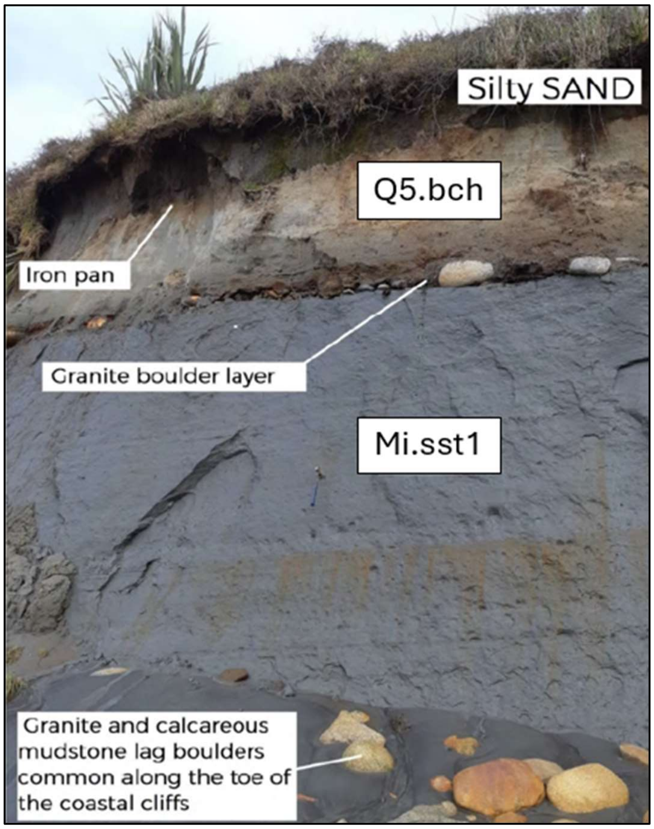

Figure B 2: Photo of cliff section near Larsen Street (Area B3), sourced from WSP (2021) with additional annotations by BTW

B.3 Soils

As noted in several reports provided to BTW by WCRC, perched groundwater was regularly encountered in the upper soil profile, due to the presence of cemented iron pans and due to poor surface drainage. The iron pans provide a low permeability layer for rainfall infiltration to perch above. The reports reviewed include: GWE (2022), GWE (2024), WSP (2021a), WSP (2021b), Davis Ogilvie (2023), Eliot Sinclair (2022), Chris J Coll Surveying (2023).

The following soil and groundwater information is summarised from review of the above studies:

- Groundwater seepage was commonly observed from the contact between the shallow sand (Q5.bch) and the O'Keefe Formation (Mi.sst1). The mudstone is likely to be of much lower permeability than the overlying sands; thus groundwater of the local water table will likely flow along the top of the mudstone to discharge points, including at the cliff face.
- Natural surface soils across the sites ranged from mixes of sand through to clay loams, which consistently have reported corresponding NZS 1547 Soil Categories of 1-4:
  - Towards the north, near the cliffs, the categories tend to be more clayey, being assessed conservatively as Category 4 soils (Areas A1 and B3).
  - Further south, near Areas B1 and B2, the soil categories are more sandy, being reported as Category 3.
  - Towards the west, the Category reduces to 2 (east of Area C).

- Hardpan (iron pan) was encountered within the marine sands at most test sites across the area at varying depths, although was not present at all. The depths encountered ranged from:
  - 0.3 m bgl to greater than 1.2 m bgl along the cliffs, becoming shallower toward the east (Areas A1 and B3).
  - 0.2 m bgl to greater than 2.7 m bgl further south near Areas B1 and B2.
- Below the hardpan, the marine sands continue until Neogene sedimentary rocks are present.
- Generally, the surficial soils had varying moisture content (dry to saturated):
  - Shallow streaking/mottling was observed in several boreholes across the site. This is expected to be caused by a perched groundwater, causing limited permeability.
  - In multiple locations, perched groundwater was encountered above the hardpan. Groundwater levels are likely to fluctuate with the seasons/rainfall. The depths of perched water were reportedly as variable as the hardpan depths.

B.4 Percolation/ Soil Acceptance Capacity

Reports prepared by Kiwi Pioneer Co. (2021), WSP (2021b) and GWE (2024) all confirm the main limitation for the onsite discharge of wastewater at Cape Foulwind is the hard pan layer present at shallow depths. This creates a challenge for onsite wastewater management, forming a barrier to the infiltration of wastewater.

The soils present toward the south of the proposed development area are silty sand consistent with Category 1-3, which have good draining characteristics. This typically allows for a land application rate of 4 mm/day. However, due to the presence of the hard pan, drainage is restricted and therefore a loading rate of 2 mm/day has been recommended (GWE, 2024).

However, closer to the coast, where soils are limited to soil category 4, wastewater discharged to these soils would pool and most likely break out onto the ground surface. This was demonstrated by the interflow encountered during the Kiwi Pioneer Co. (2021) soil investigations, who reported that "*Surface water from rainfall had passed through the topsoil and subsoil layers then struck the iron pan. From there it pooled causing the surrounding soils to become saturated. This was evidenced by the wet and puggy lawns surrounding most of the existing dwellings*."

B.5 Typical Septic Systems

Documents submitted to support subdivision applications were reviewed to inform this section and two existing consented domestic systems (RC02209, RC11234). Disposal methods are influenced by the reported limiting soil categories 3-4.

The existing consents both have sub-surface drip irrigation fields. For the proposed subdivision applications, typical disposal method options included:

- Standard disposal methods with secondary treatment (WSP, 2021b):
  - Pressure compensating dripper irrigation (PCDI) up to 3.5 mm/day for category 3-4 soils, and low-pressure effluent distribution (LPED) up to 3 mm/day. The risks associated with these installations are that they can get flooded, causing the effluent to flow across the ground surface. This can be mitigated by diverting the stormwater away from the irrigation field.
  - Wisconsin Mounds, up to 16 mm/day loading for the same soils above. This is preferred where the hardpan layer is particularly shallow and groundwater is high. However, these can be expensive to construct, and can take up significant amount of

space, particularly on sloped sites. For large, flat sites, where the water table is high, or there is insufficient soil depth to the hard pan, the Wisconsin mound will be more appropriate. There are also risks associated with effluent seeping out of the mound at the interface between the mound and existing ground level. Sizing of mounds is subject to slope angle (<15%).

- Secondary treatment is recommended as a minimum, for sites that are not constrained by area for field construction and/or setback distances to nearby receptors e.g. watercourses.

- Standard disposal methods with tertiary treatment (WSP, 2021b; GWE, 2024): The above methods should have tertiary treatment where land size is constrained, and watercourses are within the minimum recommended setback distances (50 m).

Flipping soils may also be used to increase permeability (Kiwi Pioneer Co., 2021) and reduce the need for Wisconsin Mound installation. Soils with hardpans present can be successfully drained using a local technique known as flipping. Using an excavator, flipping turns the soil profile upside down to a depth of up to 2m. Flipping breaks up the iron pan(s) and compacted sands beneath and brings them to the surface. When the sand is mixed with the topsoil and subsoil the resulting soil is well drained. This would make them suitable for the application of wastewater via dripper irrigation and secondary treatment and may reduce the need for tertiary treatment.

No soak pits were recommended in any document.

B.6 Groundwater and Connection to Surface Water

No consistent local groundwater table was identified during this review. Based on the available photographs of the Omau cliffs, height being up to 64 m asl, and conceptual understanding of the above information, it is inferred that:

- Perched groundwater: Is present above the hardpan layer, which is not laterally continuous (i.e. is presents as “pockets” of water above the hardpan layer, where the hard pan layer is present). This is sourced from rainfall and interflow (lateral flow of groundwater along the hardpan from rainfall infiltration on neighbouring sites).
- Local water table: Beneath the hardpan layer, at the base of the marine sands, a continuous water table is likely present overlying the local neogene mudstone/sandstone rock layer. This presents as small seeps at the cliff face, as observed in some of the photographs within reports provided for review and in Figure B 3 . However, as noted above, a series of natural watercourses are draining the perched terrace groundwater and discharging over the cliff at positions of coves, including the Gibson and Marris Creeks to the east of the proposed rezoning area (see Figure 5.1). It is expected these water courses provide the primary drainage of the shallow water table, which then ultimately provide a pathway to discharge to sea.
- A regional groundwater table is likely present at depth, within or below the sandstone/mudstone units, at a depth relative to sea level, and thus discharging to sea at depth and distance from the coast. As such, there is likely a significant vertical separation distance between the perched groundwater and the continuous water table at this area of proposed development. Between these two features, the soils are expected to be unsaturated, creating a hydraulic separation between the perched groundwater and regional water table.

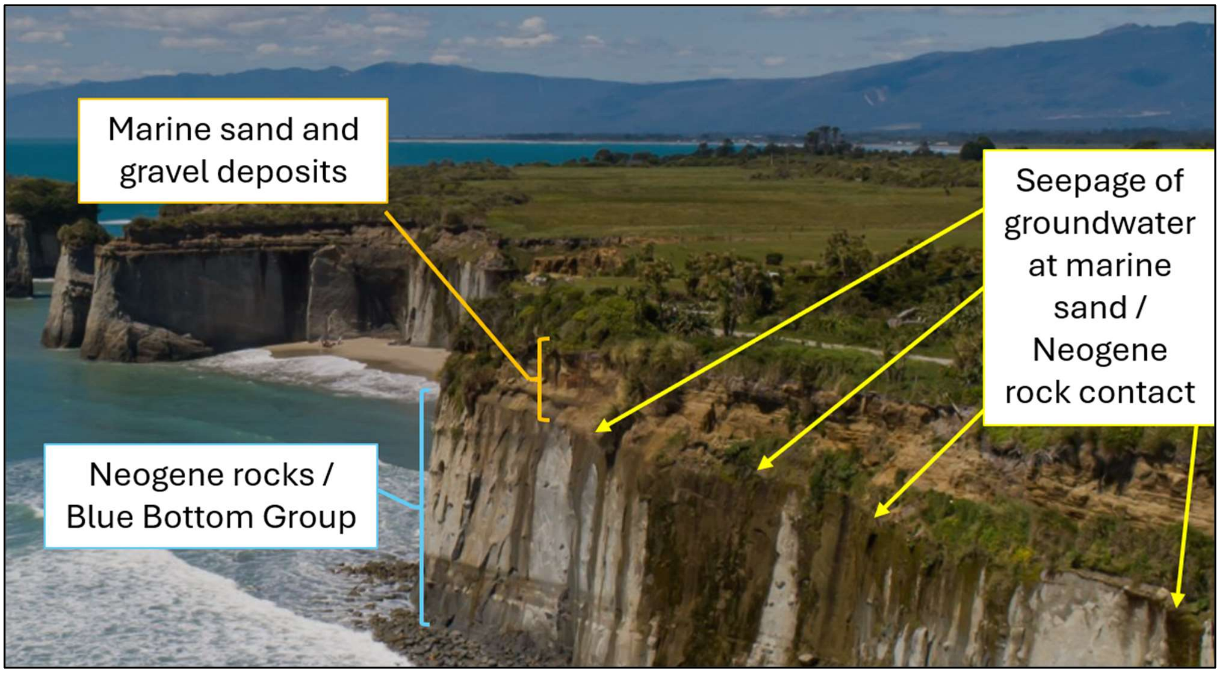

Figure B 3: Photograph of Omau Cliffs showing seepage at the top of the Neogene rock contact with shallow marine sands (source: https://thecapefoulwindproject.co.nz/subdivisions/omau-cliffs/, accessed 14/10/24)