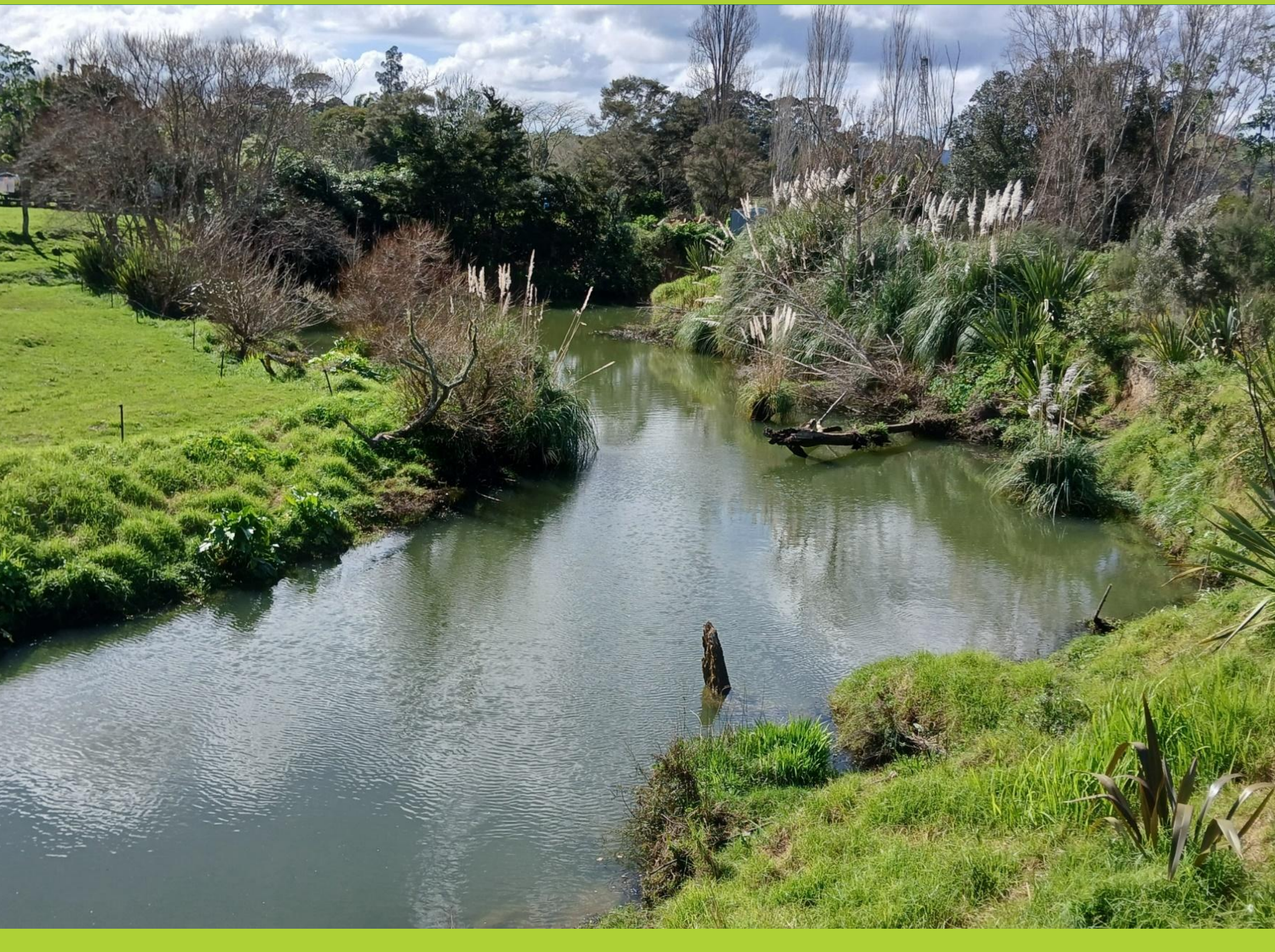
Northland REGIONAL COUNCIL
Te Kaunihera ā rohe o Te Taitokerau

ŌTAIKA CATCHMENT WATER ALLOCATION ASSESSMENT



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Abbreviations

7d-MALF	7-day Mean Annual Low Flow
AR6	Sixth Assessment Report
DO	Dissolved Oxygen
DOC	Department of Conservation
EFSAP	Environmental Flow Strategic Assessment Programme
FDC	Flow Duration Curve
FDE	Farm Dairy Effluent
FMU	Freshwater Management Unit
IPCC	Intergovernmental Panel on Climate Change
MALF	Mean Annual Low Flow
MfE	Ministry for Environment
NIWA	National Institute of Water and Atmospheric Research
NPS-FM	National Policy Statement for Freshwater Management
NRC	Northland Regional Council
PA	Permitted Activity
PRPN	Proposed Regional Plan for Northland
PSPs	Professional Service Providers
REC	River Environmental Classification
RMA	Resource Management Act 1991
SOE	State of the Environment
WAT	Water Allocation Tool

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Executive summary

The Ōtaika catchment was identified as fully allocated for surface water in 2017 in accordance with the Proposed Regional Plan for Northland (PRPN). The current allocation exceeded the regional default allocation limit at the time of notification of the PRPN (in 2017), such that the current allocation became the limit. This catchment specific assessment was initiated to evaluate the impacts of the current water allocation regime, identify the pressures of the catchment using catchment specific information, and come up with recommendations.

The assessment involved estimating hydrological metrices for the Ōtaika catchment, current water allocation and comparing that with the actual water use for the catchment. The assessment spanned eight water years from 1 July 2015 to 30 June 2023, based on the availability of water use data.

Some of the key findings were:

- Both the current water allocation and the actual water use significantly exceeded the regional default allocation limit confirming a catchment that is fully allocated. In addition, the current allocation accounted for 95% of the 7-day Mean Annual Low Flow (7d-MALF). This poses a high risk of hydrological alteration when the water takes are fully exercised under low flow conditions.
- The actual water use ranged from 0% to 69% of the annual allocation limits for individual consent holders. At catchment level, the actual water use constituted 36% to 49% of the annual allocation.
- At both the individual consent holders and catchment levels, actual water use was significantly lower than the consented allocation meaning the catchment is characterised by high levels of consented yet unused water. This aligns with previous studies undertaken in other regions in New Zealand.
- There is severe pressure on the headwaters of the catchment because both surface and groundwater takes are mainly concentrated in the upper reaches of the catchment.
- Minimum flow conditions are not consistently incorporated into some water take consents.
- The impacts of the current water allocation regime on water quality could not be assessed because most consented water takes are in the headwaters of the catchment, yet stream flow and water quality monitoring are undertaken towards the outlet of the catchment. The stream flow and water quality monitoring sites do not reflect the local impacts of the water takes.

Some of the key recommendations include:

- Although the Ōtaika catchment is fully allocated in accordance with the PRPN, options must be explored to reduce the current water allocation towards the regional default allocation levels so as to prevent or minimise potential risks of hydrological alteration on instream values.
- NRC needs to strictly apply its efficient water allocation policy to ensure that the volumes specified in the applications for water take consents or renewals are not too high and can be justified in light of the high levels of consented water that is not exercised by consent holders.
- There is need to promote water allocation options such as high flow harvesting for fully allocated catchments to reduce pressure on low flow water allocation.
- There is need to improve the estimates of permitted activity (PA) takes for Northland.
- NRC needs to explore undertaking a more focussed investigation based on adaptive monitoring to assess the impacts of the water allocation regime on water quality and ecology.

1. Introduction

Background

The Ōtaika catchment is one of the catchments in Northland that has been identified as fully allocated for surface water in 2017 in accordance with the RPN.

Policy H.4.3 under the PRPN is that if the current allocation (sum of consented and permitted takes) exceeds the regional default limit at the date of the notification of the PRPN, the current allocation becomes the limit, and the catchment is considered fully allocated. As of 6 September 2017, when the PRPN was formally notified, the allocation for the Ōtaika catchment exceeded its regional default allocation limit (30% of the 7d-MALF for coastal rivers), thus making the Ōtaika catchment fully allocated.

The hydrology and limits of the Ōtaika catchment are outlined in Table 1 below:

Table 1: Hydrological and catchment characteristics for the Ōtaika catchment

Parameter	Value	
River water quantity management unit	Coastal river	
Minimum flow limit [1]	90% of 7d-MALF	
Allocation limit [2]	30% of 7d-MALF	
Total catchment area	59.14 km^2	
Flow station catchment area	35.37 km^2 (Ōtaika at Kay)	
Mean flow [3]	0.856 m^3/s	856 L/s
7d-MALF [3]	0.142 m^3/s	142 L/s
Allocation (30% of 7d-MALF)	0.0426 m^3/s	42.6 L/s
Minimum flows (90% of 7d-MALF)	0.1278 m^3/s	127.8 L/s
Groundwater recharge [4]	6 177 902 m^3 / year	195.5 L/s

[1] Based on Policy H.4.1 of the PRPN

[2] Based on Policy H.4.3 of the PRPN

[3] Based on continuous site-specific data from the Ōtaika at Kay flow recorder site (2011 – 2023)

[4] Based on Booker (2012)

Overall, from a water resources management perspective, there are a number of the Ōtaika catchment characteristics that contribute to its allocation status as outlined below.

- The Ōtaika stream catchment falls under the coastal river water quantity management unit. This was based on an Environmental Flow Strategic Assessment Platform (EFSAP) modelling study for Northland. The study determined that where 30% or more streams in a catchment are at a high risk of hydrological alteration and are a habitat to flow sensitive fish species, the catchment is classified under the coastal river water quantity management unit. The water resources of coastal management units in Northland Region are managed in such a way that 90% of the 7-day Mean Annual Low Flow (7d-MALF) should be set aside for the minimum flows and the allocation limit is capped at 30% of the 7d-MALF. As such, coastal rivers and streams are managed in such a way that a higher proportion of the 7d-MALF is set aside for minimum flows (90%) and that a smaller proportion becomes available for allocation (30%) compared to the large or small river categories that have less conservative limits.

The Ōtaika catchment has 19 current water take consents consisting of eight stream water, one dam water and ten groundwater take consents. Additionally, there are 38 PA takes registered after a survey conducted between 2010 and 2011. These are mostly for stock drinking, domestic use and household irrigation.

Although the PA takes are low volume water takes, their cumulative effect adds pressure on the finite water resources of the catchment that is small and has a high current allocation. Since the registration of PA takes is not compulsory, the number of such PA water users and the associated take rates may be higher than recorded in the PA register at that time.

The total current authorised surface water takes for the Ōtaika catchment (consented and PA takes) amount to 135 L/s which translates to 316% of the allocation limit of 42.6 L/s or 95% of the 7d-MALF of 142 L/s. This is well above the regional default allocation limit for the catchment.

- Some of the water take consents have authorisations for high volume abstractions. This includes consents for water take authorisations of between 500 and 8,156 m^3 per day. The highest water take consent is authorised to abstract 2,978,979 m^3 per year at a rate of 94.4 L/s from three water take points that are located in the headwaters of the catchment.
- Stream flows for Northland flow stations are not naturalised, meaning they do not take into account the permitted and consented water takes. Although the modelled regional flows are naturalised, they were estimated in 2012 and need to be reassessed. Naturalisation is an important process in freshwater accounting and management as it considers the effects of anthropogenic activities on the natural environment (Terrier et al 2021). Using unnaturalised streamflow data results in water being managed based on continually reduced minimum flows and allocations because of prior authorised water takes. This can be compared to the shifting baseline syndrome as documented by Soga and Gaston (2018).
- There is some notable groundwater and surface water interaction in the upper reaches of the Ōtaika catchment. The main aquifer in the catchment is the Maungatāpere basalt aquifer to the north and north-western parts of the catchment. Very small parts of the catchment are underlain by the Whatitīri and Maunu aquifers. The Maungatāpere basalt aquifer consists of the fractured basalts and volcanic scoria cones that overlay sandstone. Coincidentally 90% of the groundwater take consents in the Ōtaika catchment tap from this aquifer. Similarly, 90% of the groundwater take consents in the catchment have stream depletion rates of between 0.12 and 0.65 L/s based on estimations undertaken through modelling. The implication is that part of the groundwater abstractions reduce surface water flows due to the groundwater and surface water interaction.
- Overall, most of the water take consents for both surface water and groundwater are in the upper reaches of the catchment with only one water consent holder that abstracts water from the lower reach of the catchment towards its outlet. This puts significant pressure on the headwaters of the catchment such that the upper stream reaches are under the greatest risk of impact. Consequently, this can potentially cause hydrological alteration and can hinder the ability to maintain minimum flow levels in the catchment.

Regional modelling data was used to estimate the reach level allocation and minimum flow statistics. However, the regional data may not reflect catchment specific values, information and pressures.

It is against this background that a comprehensive catchment specific study for the Ōtaika catchment (as one of the fully allocated catchments in Northland) was initiated to;

- ensure that the level of water allocation is sustainable;

- ensure that the water allocation regime meets the ecological objectives of the catchment as per the requirements of the National Policy Statement for Freshwater Management (NPS-FM) and;
- consider the impact of any alternative catchment specific allocation regime which considers the local values and water use pressures.

Overall, the study seeks to ascertain whether the current water allocation regime ensures sustainable utilisation and protection of water resources in the catchment.

Objectives

The objectives of the Ōtaika catchment specific study are as follows:

- to evaluate the current water allocation regime and water use in the Ōtaika catchment;
- to assess the impacts of the status quo (current water allocation regime) on instream values and security of supply;
- to assess the pressures on the water resources of the Ōtaika catchment;
- to evaluate (if feasible) the impacts of any alternative catchment specific allocation regimes on instream values;
- to identify any information gaps in the catchment; and
- to recommend key data and monitoring strategies for the catchment.

2. Data inventory of the Ōtaika catchment

Introduction

This section of the study documents a baseline assessment that covers the different environmental and water resources management studies that have been undertaken, and any outcomes and data sets available for the Ōtaika catchment.

The main aim of the assessment was to gather, consolidate, categorise, evaluate the data quality, results and report the outcomes from previous studies undertaken for the catchment to enable the assessment of the impacts of the existing water allocation regime. Of special interest to the study was information focusing on stream flows, surface and groundwater interaction, minimum flows, water allocation in the catchment, and compliance with such regulatory instruments.

Data Inventory Approach

The data inventory process was undertaken in three phases as outlined below:

- data gathering and collation;
- data synthesis and processing; and
- data presentation and reporting.

Data gathering and collation

The data gathering and collation phase of the compilation of the project inventory involved the following sub tasks.

Identification of the data attributes to guide the data collection process

This involved the identification of the different key hydrological, hydrogeological, water use parameters and attributes important in the gathering of the relevant data and information identified as having been collected through previous studies. This guided the data and information captured from the different studies and submitted by different stakeholders.

Assessment of the available data provided by Northland Regional Council

As NRC is the main custodian of the natural resources like water, land and air in Northland region, it was identified as the main source of data and information of previous studies, projects, surveys and measurements undertaken for the Ōtaika catchment. This involved identifying and recording the various sources of information and data relevant to the study. This included technical and scientific reports, publications, hydrological investigations, stream flow gaugings, geohydrological investigations, pump test investigations, and consents issued for the catchment. The data and information also included GIS and spatial information for the surface and groundwater monitoring stations, water users and different water resources.

The study team compiled summary tables from projects, reports, technical studies, information sheets, and recordings with the data attributes of interest to the current project. This was recorded in Microsoft Excel.

Assessment of the data provided by consultants and Professional Service Providers (PSPs)

The study team compiled all the projects and studies initiated by NRC and other stakeholders that were undertaken by consultants, PSPs and other stakeholders covering the Ōtaika catchment. The outcomes were all relevant outsourced projects covering the Ōtaika catchment including technical and scientific projects and reports, measurements, surveys, measurements and GIS and spatial data information.

Assessment of data provided by water and resource users in the catchment

The study team conducted an assessment of the data supplied by water resource users in the Ōtaika catchment. This included the water use returns and water use survey forms filled by the different water users in the catchment.

Data synthesis and processing

Summary tables of projects, reports and recordings of attributes

The study team performed quality checking of the data and information on projects, reports, technical studies, information sheets and recordings captured in the summary tables in Microsoft Excel. This involved verifying that all relevant information had been captured as well as checking for completeness, consistency, and correctness of the captured attributes where possible. This also involved deleting duplicate information and studies that were out of scope with the current Ōtaika assessment.

GIS data sets

Spatial data and information collected was sorted according to different categories including surface water, hydrology and wetlands, geology and hydrogeology and consents. Whilst due diligence was followed to prioritise spatial data that was georeferenced and had metadata in line with best management practises in spatial science, some geographical information did not have metadata. NRC spatial data was given a higher priority because it is more localised compared to data from small-scale GIS maps (i.e. national datasets).

Spatial data collected included shapefiles on catchment and sub-catchment boundaries, river and stream networks, surface and groundwater monitoring stations, digital river networks, River Environmental Classification (REC) classes, geology, aquifers, consents and permitted takes.

Data presentation and reporting

The data and GIS tables are presented in Appendices 1 and 2.

3. Study area

The Ōtaika catchment is located to the south-west of the city of Whangārei within the Northland region. The town of Maungatāpere is located along the north-western boundary of the Ōtaika catchment. The catchment drains an area of 59.1km^2 and falls within the Whangārei Harbour Freshwater Management Unit (FMU).

Hydrology

The main stream in the catchment is the Ōtaika whose source is on the southern outskirts of the town of Maungatāpere. The tributaries of the Ōtaika stream include the Otakaranga, Whakapai, Mokupara and Puwera streams. These streams comprise the sub-catchments that were used in the analysis of the Ōtaika catchment in this report.

The sources of the Ōtaika, Whakapai, Otakaranga and Mokupara streams are along the boundary of the Maungatāpere basalt aquifer. These streams are partially sustained by groundwater from spring discharges, which continue to flow even during dry seasons. (Cameron *et al*, 2001). As a result, the Ōtaika stream and its tributaries are mainly perennial streams. The streams in the catchment generally flow from west towards east and drain into the South Pacific Ocean via the Whangārei Harbour. The size of the different sub-catchments of the Ōtaika catchment is shown in Table 2.

Table 2: Area of the sub-catchments of the study area

Sub Catchment	Area (km^2)	Percentage of catchment area
Ōtaika	17.21	29.1%
Puwera	16.97	28.7%
Otakaranga	13.26	22.4%
Mokupara	6.45	10.9%
Whakapai	5.25	8.9%
TOTAL	**59.14**	**100%**

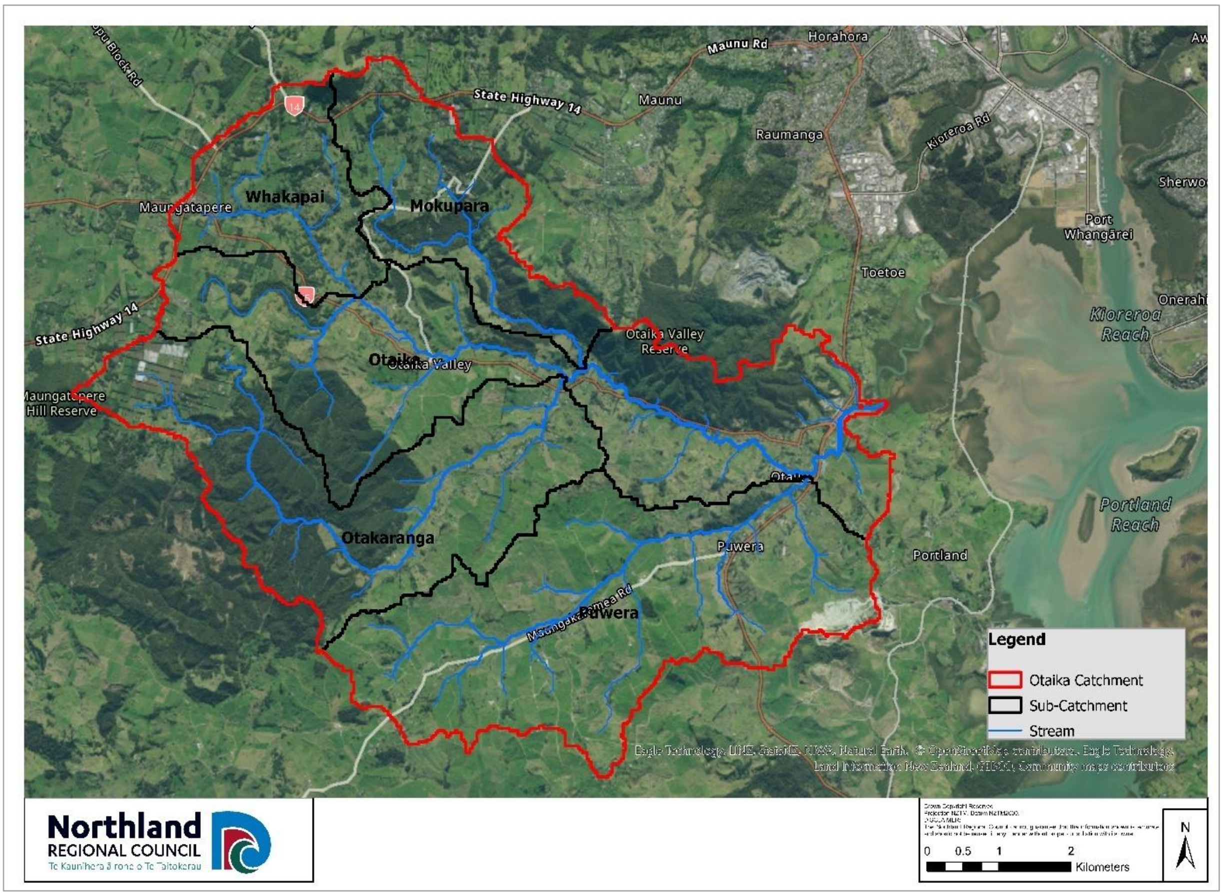

Fig 1: Location of the Ōtaika catchment and respective sub-catchments

Fig 2: Ōtaika stream at the Loop Road bridge (26 July 2024)

Fig 3: Ōtaika stream at the Cemetery Road bridge (26 July 2024)

Geology

The Ōtaika catchment has a geology that can be broadly categorised into the Early Pleistocene to Late Pleistocene igneous rocks, Cretaceous sandstone, Quaternary sand, shale and/or gravel and Jurassic greywacke (Cameron *et al* 2001; Roke and McLellan, 1983). The north and north-western parts of the catchment are characterised by prominent volcanic plateau of the Cenozoic Era that overlies the older and complex sedimentary rocks.

This area has shield volcanos that are characterised by the olivine Taheke Basalts and red scoria cones of the Kerikeri Volcanic Group (Roke and McLellan, 1983). Two notable scoria cones within this geological unit are the Maunu cone that forms part of the northern boundary of the catchment and the Maungatāpere cone that forms part of the western boundary of the catchment. The scoria cones are underlain by sandstone and mudstone deposits.

The greater part of the study area is characterised by melange that consists of a matrix of mudstone with tectonic blocks of the Northland Allochthon and the Waitemata and Te Kuiti Groups (NRC, 2021b). The eastern part of the catchment that forms part of the Ōtaika Hills range is distinguished by deformed, jointed and sheared basement rocks comprising mainly the greywacke as well as argillite, chert and basalt of the Waipapa Group (Roke and McLellan, 1983; Sinclair Knight Mertz, 2010).

In contrast, the western part of the catchment is characterised by mudstone, sandstone and limestone of the Whangai Formation. Additionally, parts of the Ōtaika, Otakaranga and Puwera streams are predominantly underlain by Holocene sediments of the Tauranga Group consisting of mud, sand, gravel and peat deposits (NRC, 2021b).

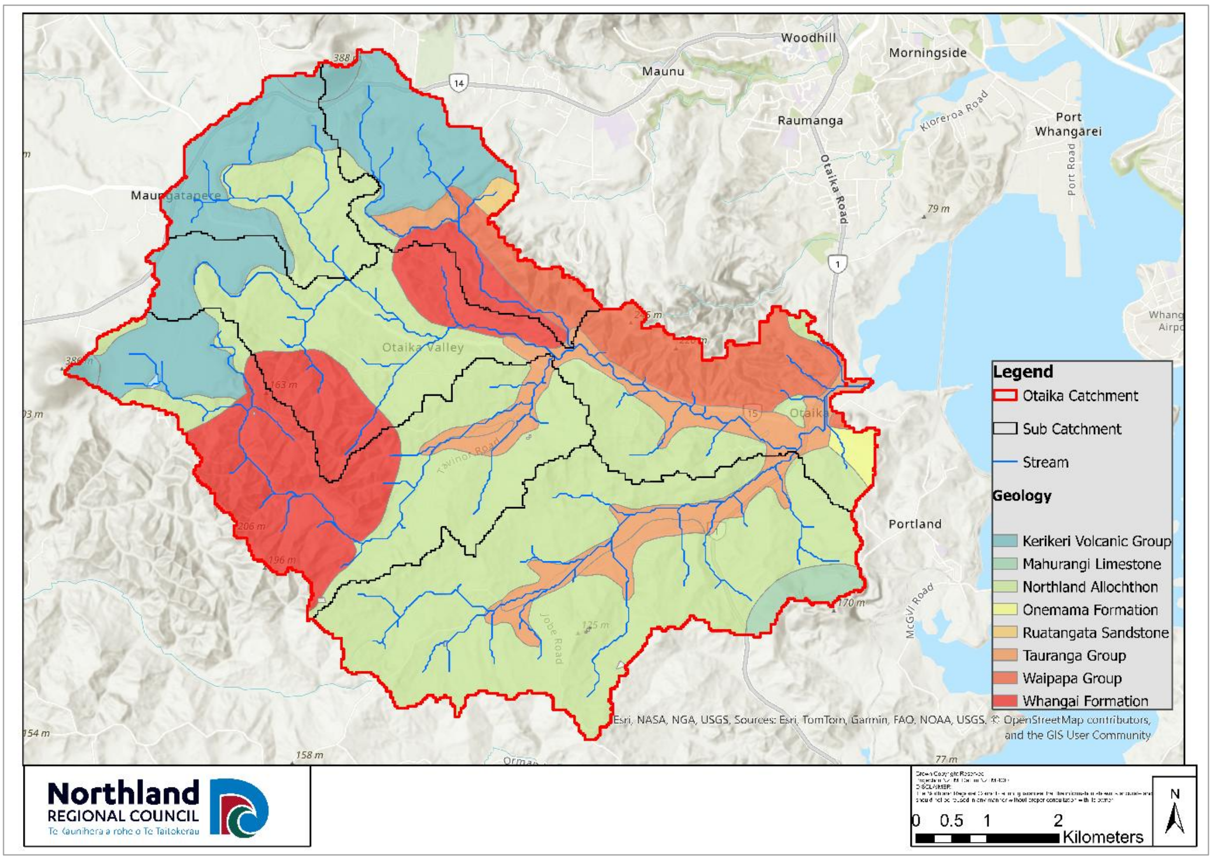

Fig 4: Main geology of the Ōtaika catchment

Fig 5: Maunu volcanic cone (26 July 2024)

Hydrogeology

The predominant aquifer unit in the Ōtaika catchment is the Maungatāpere aquifer with very small proportions of the study area falling under the Maunu and Whatitīri aquifers (NRC, 2022a). The Maungatāpere aquifer is part of the broader Maunu – Maungatāpere – Whatitīri groundwater system which Roke and McLellan (1983) subdivided into six groundwater sub-catchments. The Ōtaika catchment fell under two groundwater sub-catchments using the Roke and McLellan (1983) categorisation, mainly Southeast Maungatāpere and also (to a smaller extent) Maunu East.

A refinement of the groundwater systems by Water Management Group (2016) resulted in the Ōtaika catchment falling under the Maunu – Maungatāpere sub-catchment. Within the Ōtaika catchment, this groundwater system lies to the east and north-east of the Maungatāpere cone and generally to the southern part of the Maunu cone. The main aquifer of the Ōtaika catchment has been described by Cameron *et al* (2001) as being semi-confined and comprising of basalt and scoria that overlies sandstone or mudstone.

Groundwater generally flows radially from the Maunu and Maungatāpere scoria cones. Groundwater flows from the Maunu cone in a southerly direction towards the Whakapai, Mokupara and Ōtaika streams and in an easterly to south easterly direction from the Maungatāpere cone towards the Otakaranga and Ōtaika streams (Water Management Group, 2016; Roke and McLellan, 1983).

Most of the streams in the catchment originate as springs around the edges of the Maungatāpere basalt aquifer. A case in point is the Whakapai stream to the south of the Maunu scoria cone. The source of the stream are the series of springs collectively known as the Maunu Springs at the southern base of the Maunu scoria cone. Three high yielding springs in the area include the Tunnel, Pump and Chamber Springs that are mainly used by the Whangārei District Council as abstraction points for municipal water supply since around 1929 (Roke and McLellan, 1983).

The Ōtaika catchment is characterised by significant groundwater and surface water interaction especially in its upper reaches. This is because the upper reaches of the Whakapai, Mokupara, Otakaranga and Ōtaika streams are partially fed by groundwater through spring discharge at the edge of the basalt fields which explains why the streams mostly flow throughout the year (Cameron *et al*, 2001). This is further confirmed by the stream depletion rates of bores in the catchment.

To the east of the catchment is a potential alluvial aquifer that underlies parts of the Puwera, Otakaranga and Ōtaika streams. The potential aquifer system consists of partially consolidated sediments, including sand, silt, gravel, and peat.

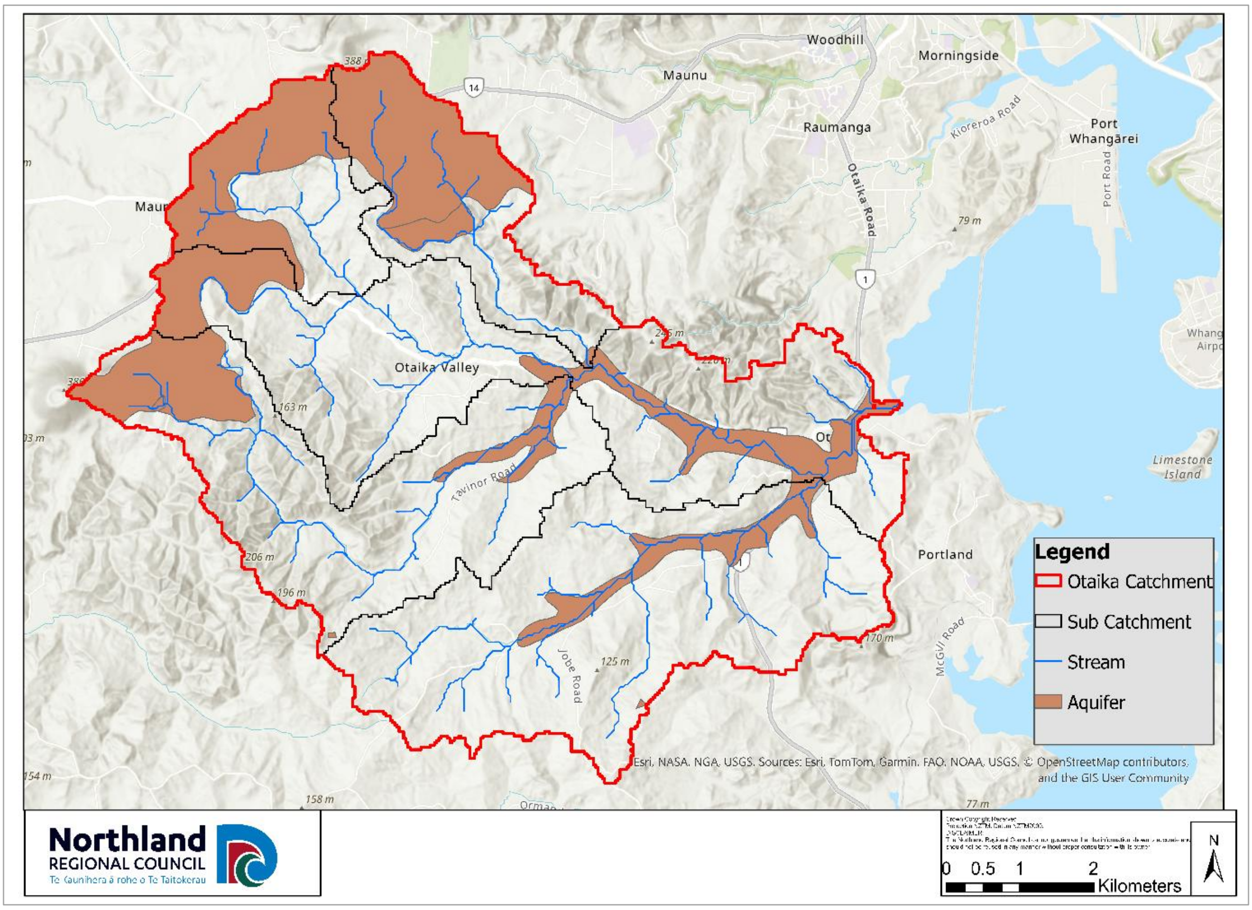

Fig 6: Aquifers of the Ōtaika catchment

Rainfall

The study area has only one active rainfall station in the upper reach of the Mokupara sub-catchment. The rainfall station is known as Ōtaika at Cemetery Road (Maunu) and is telemetered. The Ōtaika at Redwood Orchard rainfall station, although located just outside the catchment, can be considered suitable for use due to its long-term rainfall data. There are five inactive rainfall stations in the study area. Figure 8 shows the locations of the active rainfall stations. The status of rainfall stations around the study area is outlined in Table 3 below.

Table 3: Status of rainfall stations around the Ōtaika catchment

Station name	IRIS ID	Station opened	Station closed	Station status	Duration of continuous data
Ōtaika at Cemetery Road (Maunu)	LOC.547226	14-12-2011	N/A	Active	13 years
Ōtaika at Redwood Orchard	LOC.547223	01-01-1983	N/A	Active	42 years
Cemetery Road at Mokupara	LOC.547219	01-09-1979	01-10-2019	Inactive	40 years
Ōtaika at Valley View Rd (McIntosh)	LOC.547224	02-08-1995	01-09-2008	Inactive	13 years
Maungatāpere	LOC.547201	03-08-1948	01-01-1990	Inactive	41 years
Puwera	LOC.548301	01-03-1921	31-08-1932	Inactive	11 years
Kokopu at Rileys	LOC.547217	01-01-1982	01-01-1985	Inactive	3 years

The mean annual rainfall for the catchment was estimated using rainfall records from the two suitable stations located around the catchment as described above. The stations had a similar rainfall trend.

Table 4: Mean monthly and mean annual rainfall (mm) for the Ōtaika catchment.

Rainfall Station	Mean monthly rainfall (mm)												Mean Annual Rainfall (mm)
	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	
Ōtaika at Cemetery Rd (Maunu)	209.9	155.7	146.2	108.6	89.9	101.0	84.5	121.5	111.3	114.9	134.5	174.8	1,553
Ōtaika at Redwood Orchard	204.4	159.0	139.2	103.4	92.5	110.2	105.5	108.8	122.4	114.5	151.2	167.5	1,579

The average annual rainfall for the Ōtaika catchment is 1,566 mm.

Soils

The main soil texture classes in the catchment include silt loam, clay, clay loam and sand. The upper and lower reaches of the catchment are mainly characterised by clayey soils whereas silt loams are the dominant soils in the middle parts of the catchment. As a result of the dominant soil texture types, the catchment is characterised by moderate to slow, slow and moderate soil permeability. Subsequently, the catchment is characterised by moderate to high overland flow rates as a result of the slow to moderate permeability.

A soil moisture probe was installed in a pasture field next to the Ōtaika at Cemetery Road (Maunu) rainfall station on 21 November 2021. The probe measures continuous soil moisture at intervals of 150 mm up to a depth of 1,050 mm.

Table 5: Status of soil moisture stations in the Ōtaika catchment

Station name	IRIS ID	Station opened	Station status	Duration of continuous data
Ōtaika at Cemetery Rd (Maunu)	LOC.547226	22-11-2021	Active	3 years

Minimum flows and allocation limit

The Ōtaika catchment is in the Coastal River Freshwater Management Unit (FMU) for water quantity. The regional default limit for minimum flows and allocation for coastal rivers are set at 90% and 30% of the 7d-MALF respectively. Although the current regime uses 7d-MALF statistics from regional modelling based on Booker (2012), the statistics that were used for this assessment are based on flow data from the Ōtaika at Kay telemetered flow recorder site.

Surface and groundwater level monitoring

The Ōtaika catchment has one active flow recorder site. The station is located on the Ōtaika stream towards the outlet of the catchment and is telemetered. The flow station measures streamflow from four of the five sub-catchments falling under the Ōtaika catchment and does not measure flow from the Puwera stream whose confluence with the Ōtaika stream is downstream of the station. The flow station has a catchment area of 35.37km^2, which translates to measuring streamflow from about 60% of the Ōtaika catchment. The flow station details are outlined in Table 6.

Table 6: Ōtaika catchment stream flow recorder site details

Flow recorder site name	IRIS ID	Station opened	Station status	Duration of continuous data
Ōtaika at Kay	LOC.005659	27-11-2011	Active	13 years

Fig 7: Ōtaika at Kay flow recorder site and water quality continuous monitoring site (26 July 2024)

As there are only 13 years of continuous flow data since the establishment of the Ōtaika at Kay gauging station in December 2011, the lack of long-term streamflow data from monitoring stations within the catchment creates a drawback in conducting a high confidence hydrological and water resources assessment, analysis and modelling.

This is because a short-term dataset might miss long term patterns of hydrological events and recurring hydrological phenomena. Examples of such events in Northland include the droughts experienced in 1945 – 1946, 1982 – 1983 and 2009 – 2010 (Pham and Donaghy, 2017) and the floods experienced in July 1973 and March 1988 (Gray, 2003).

NRC has spot gauging sites throughout the Ōtaika catchment. These are mainly utilised for summer low flow and drought flow gauging programmes to ensure that the compliance and ecological mandates of NRC are met. The locations of the gauging sites are shown in Figure 8.

The catchment has two groundwater level monitoring bores. Both bores are located in the western part of the study area under the Otakaranga sub-catchment. There is an inactive groundwater level bore in the upper reach of the Mokupara sub-catchment. The details of the active and inactive groundwater level monitoring bores are summarised in Table 7.

Table 7: Ōtaika catchment groundwater level monitoring bore details

Station name	IRIS ID	Borehole depth	Station opened	Station closed	Station status	Duration of continuous data
Maungatāpere GW at 179 Pukeatua Rd (Campbell)	LOC.110361	29.5m	16-12-2002	N/A	Active	22 years
Maungatāpere GW at 191 Pukeatua Rd (Lee)	LOC.5471018	17.0m	19-01-2007	N/A	Active	18 years
Atkins at Maunu	LOC.5472005	67.0m	25-07-1987	30-09-1993	Inactive	6 years

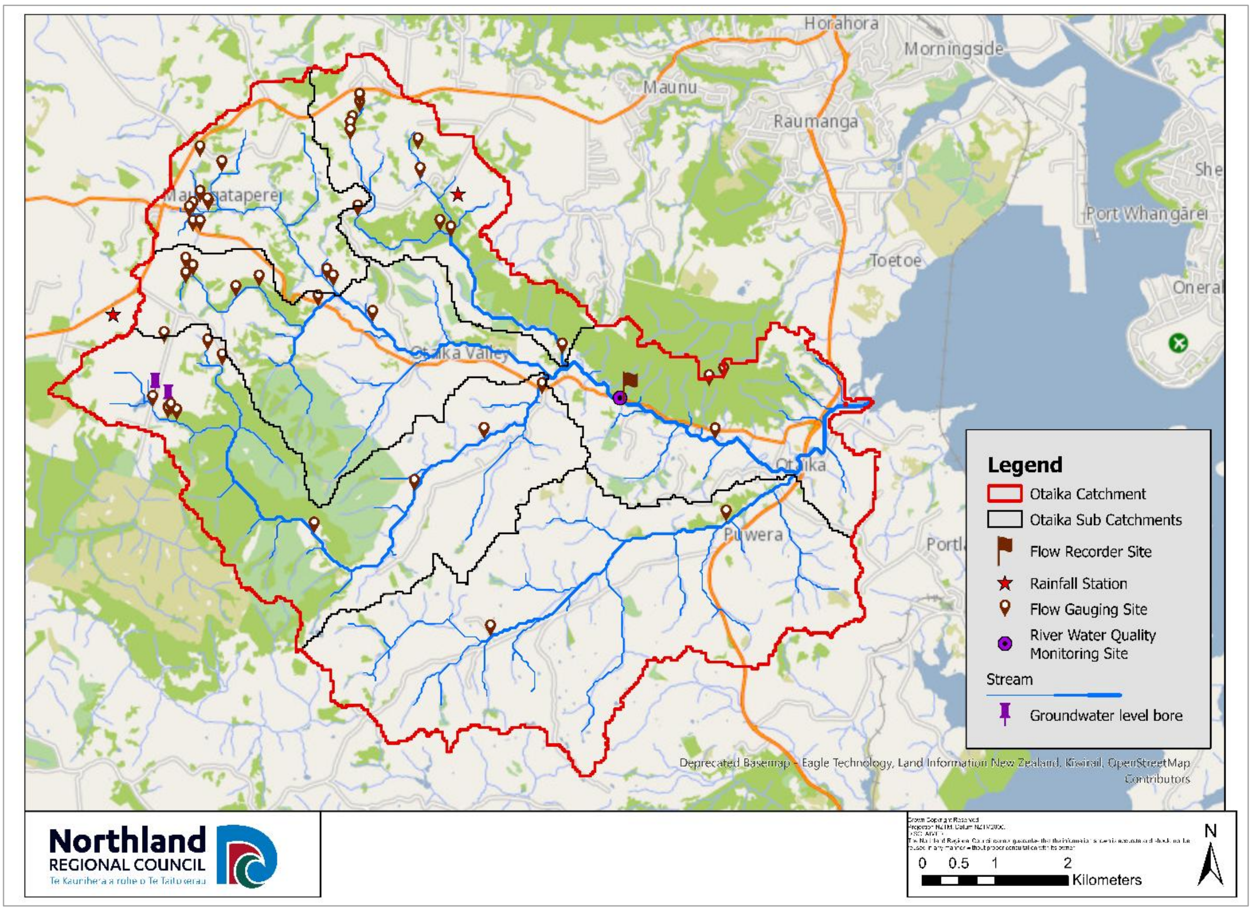

Fig 8: Locations of rainfall station, telemetered streamflow station, flow gauging sites and groundwater level bores in the Ōtaika catchment.

Water quality monitoring and freshwater ecology sampling

The Ōtaika catchment is part of the Whangārei FMU for surface water quality. There is one surface water quality monitoring station and one sediment sampling site in the Ōtaika catchment. These are located on the Ōtaika stream towards the outlet of the catchment. There are no groundwater quality monitoring bores in the Ōtaika catchment. The details of the active surface water quality monitoring sites are detailed in Table 8.

Table 8: Ōtaika catchment surface water quality monitoring sites details

Station name	IRIS ID	Monitoring commenced	Monitoring ceased	Station status	Type of monitoring	Duration of continuous data
Ōtaika at Ōtaika Valley Road	LOC.110431	14-12-2011	N/A	Active	• State of Environment • Periphyton • Invertebrates • Fish	13 years
Ōtaika at Kay	LOC.005659	27-01-2011	30-09-2014	Discontinued	• Turbidity	3 years
		01-08-2019	19-11-2021	Discontinued	• Electrical Conductivity	2 years
		08-10-2014	07-04-2021	Discontinued	• Water Temp	6 years
Ōtaika at Kay	LOC.005659	01-08-2019	N/A	Active (Continuous monitoring site)	• Water Temp • Electrical Conductivity • Turbidity • Dissolved Oxygen	5 years

Land cover

The greater part of the Ōtaika catchment (approximately 69%), is covered by pasture as estimated using the New Zealand Land Cover Database version 5 (Manaaki Whenua Landcare Research, 2020). Indigenous forest makes up about 16% of the catchment, primarily located in the east (Ōtaika Valley Reserve) and to a lesser extent in the west, within the Otakaranga sub-catchment. Exotic forestry constitutes approximately 9% of the area, mainly in the Otakaranga and Ōtaika sub-catchments. Crop land, mostly avocado orchards, account for about 4% of the catchment, predominantly in the northern regions.

Water use

There are currently 19 consumptive water take consents within the Ōtaika catchment. Of these, eight are for stream water, one for dam water and ten are for groundwater takes (NRC, 2024a). There are 38 registered PA takes from the Ōtaika catchment PA Register based on a water use survey conducted between 2010 and 2011 (NRC, 2024b). Most of the registered PA takes are for stock drinking with a few for household use and domestic irrigation. However, the PA takes used in the analysis were based on the New Zealand Census as these were less conservative. Appendices 3 to 5 outline the lists of the consented and PA takes for the Ōtaika catchment.

The distribution of the surface water and groundwater take consents and permitted activity takes is shown in Figure 9. Most water take consents are located in the upper reaches of the Ōtaika catchment. Although there are PA takes throughout the catchment, they are slightly more concentrated in the upper reaches.

It is important to note that there are only two registered PA takes, and no water take consents in the Puwera sub-catchment. As a result, the sub-catchment was excluded from further hydrological and water resources analysis in this study to avoid introducing any bias when compared to the more hydrologically impacted sub-catchments within the Ōtaika catchment.

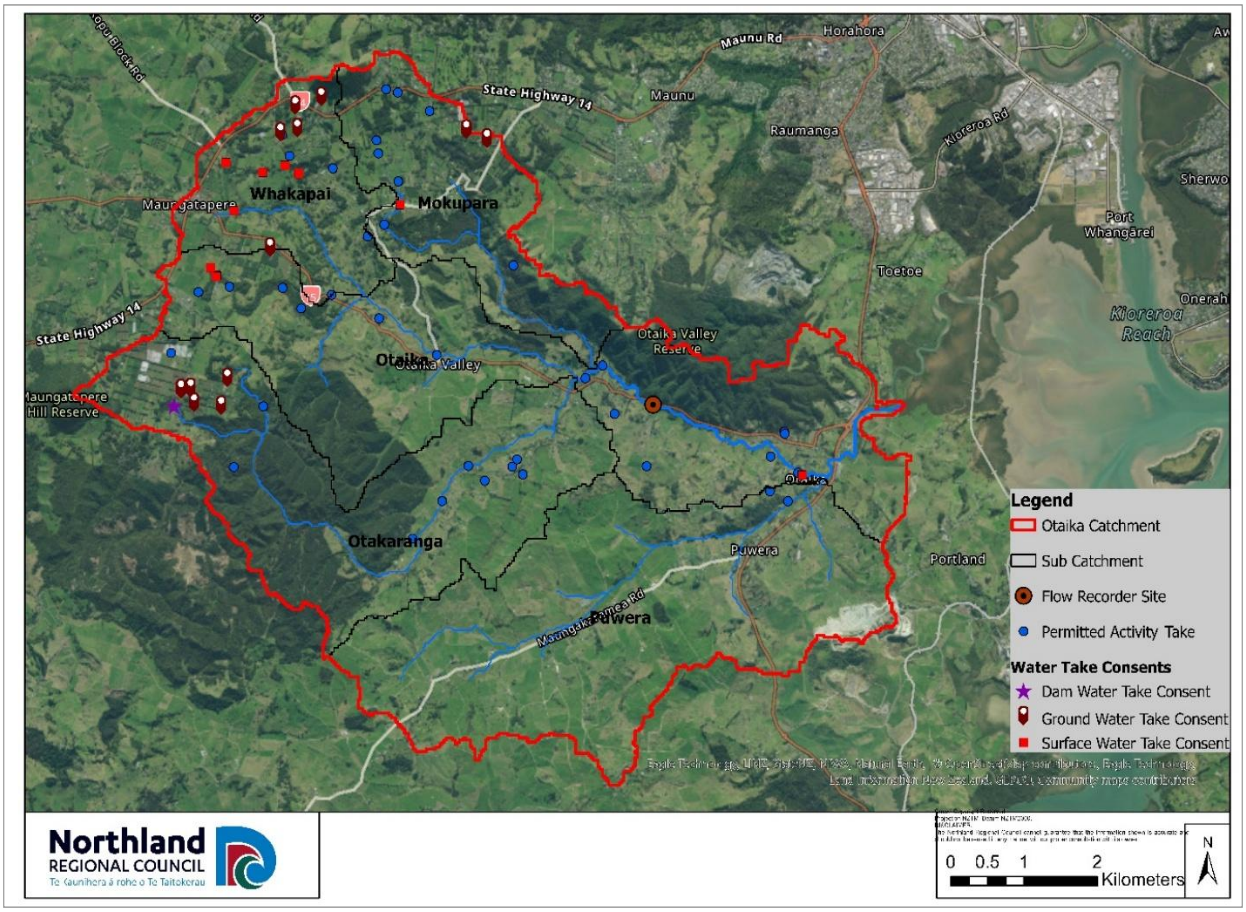

Fig 9: Distribution of surface and groundwater take consents, and registered PA takes in the Ōtaika catchment

Fig 10: Livestock farming and its reliance on PA takes for stock watering in the catchment

4. Results and analysis

Actual compared to consented water take analysis

A comparison of the consented and actual water takes is one of the good indicators of the level of water resource use in any catchment especially for catchments that are fully or over allocated on paper. In some heavily used systems, consent holders utilise up to their full consented takes or may even over abstract. However, in other cases consent holders use less than their authorised volumes due to reasons such as where irrigated crops are still in the growth and not yet mature phase, or some may apply for more than they need (i.e. inefficient allocation of water).

It is, therefore, vital to assess the extent to which consented water is actually used in a catchment. Such an assessment is an accurate indicator where water use measurement and recording and effective compliance systems are in place.

Historically in Northland, consent holders were required to measure their water use and submit records either in hard copy or via email, as part of their consent conditions. Following the introduction of the Measurement and Reporting of Water Takes Regulations in 2010, consent holders taking water at a rate of 5 litres per second or more became obligated to measure actual water use on a daily basis. The 2020 amendments to these regulations further strengthened the requirements, mandating 15-minute interval measurements and daily electronic reporting, with a staggered implementation timeline based on the rate of water abstraction.

The analysis of the actual compared to the consented water takes for this study was undertaken from 1 July 2015, the period around which the capturing of water use records became electronic for Northland, until the end of the 2022/2023 water year (30 June 2023).

The approach that was used to compare the actual and consented water use in this study involved comparing:

- consented and actual water takes on daily, daily average and annual time steps for the five biggest surface water users in the catchment;
- total annual (actual and consented) water takes at catchment level; and
- actual and consented water takes with the limits at catchment level.

To perform the various analyses, the take limits, annual volumes, and minimum flow limits for the different consent holders for surface water have been summarised in Table 9.

Table 9: Summary of surface water take consents and their limits for the Ōtaika catchment

No.	IRIS ID	Water Take	Purpose of water take	Consent Expires	Stream/Spring	Net Take (L/s)	Continuation flow (L/s)	Allocation (m^3/day)	Allocation (m^3/yr)	Remarks
1	AUT.002343.01.04	Surface Water	Irrigation – Horticulture	30-06-2035	Unnamed tributary of Whakapai stream	1.7	0.70	15	5,400	
2	AUT.002406.01.04	Surface Water	Irrigation – Horticulture	31-05-2026	Whakapai stream	5.5	18.00	350	42,000	
3	AUT.005059.01.04	Surface Water	Industry – Cement/Concrete Manufacture	31-05-2046	Ōtaika stream	10.53	35.00	910	332,150	Cease to take limit tied to the Ōtaika at Kay flow station
4	AUT.007324.02.03	Surface Water	Irrigation – Horticulture	31-05-2026	Unnamed tributary of Ōtaika stream	3.47	18.50	300	109,575	
5	AUT.002829.01.04	Surface Water	Irrigation – Horticulture	31-05-2026	Unnamed tributary of Ōtaika stream	3.5	15.00	267	97,455	
6	AUT.007213.02.02	Dam Water	Irrigation - Arable crops	31-05-2026	Unnamed tributary of Otakaranga stream	NO	1.20			No daily / annual limit
7	AUT.000964.01.03	Surface Water	Drinking - Public Water Supply	31-05-2045	Tunnel, Chamber and Pump springs in Whakapai stream catchment	94.4 (31.63 per spring)	NO	8,156	2,978,979	No minimum flow
8	AUT.029769.01.01	Surface Water	Irrigation – Floriculture	31-05-2026	Unnamed tributary of Whakapai stream	1.0	NO	80	20,000	No minimum flow
9	AUT.004000.01.04	Surface Water	Irrigation – Horticulture	31-05-2049	Mokupara stream	1.0	NO	55	6,700	Cease to take limit (120 l/s) tied to the Ōtaika at Kay flow station

Individual Consent Holder Water Use Analysis

A sample of the six largest surface water users was chosen for individual analysis as consented water use in the catchment is primarily driven by a few consent holders. The remaining consents involve low-volume water takes.

Consent Holder: AUT.000964.01.04

The consent holder is authorised to abstract a maximum of 8,156m^3/day, which translates to 2,976,940m^3/year of surface water from three springs - namely Tunnel, Pump and Chamber springs. These are located in the headwaters of the Ōtaika catchment. Water use records are submitted via telemetry. An analysis of the actual and consented water takes on a daily and annual time step is outlined in the Figures 11 and 12 and Table 10 and 11.

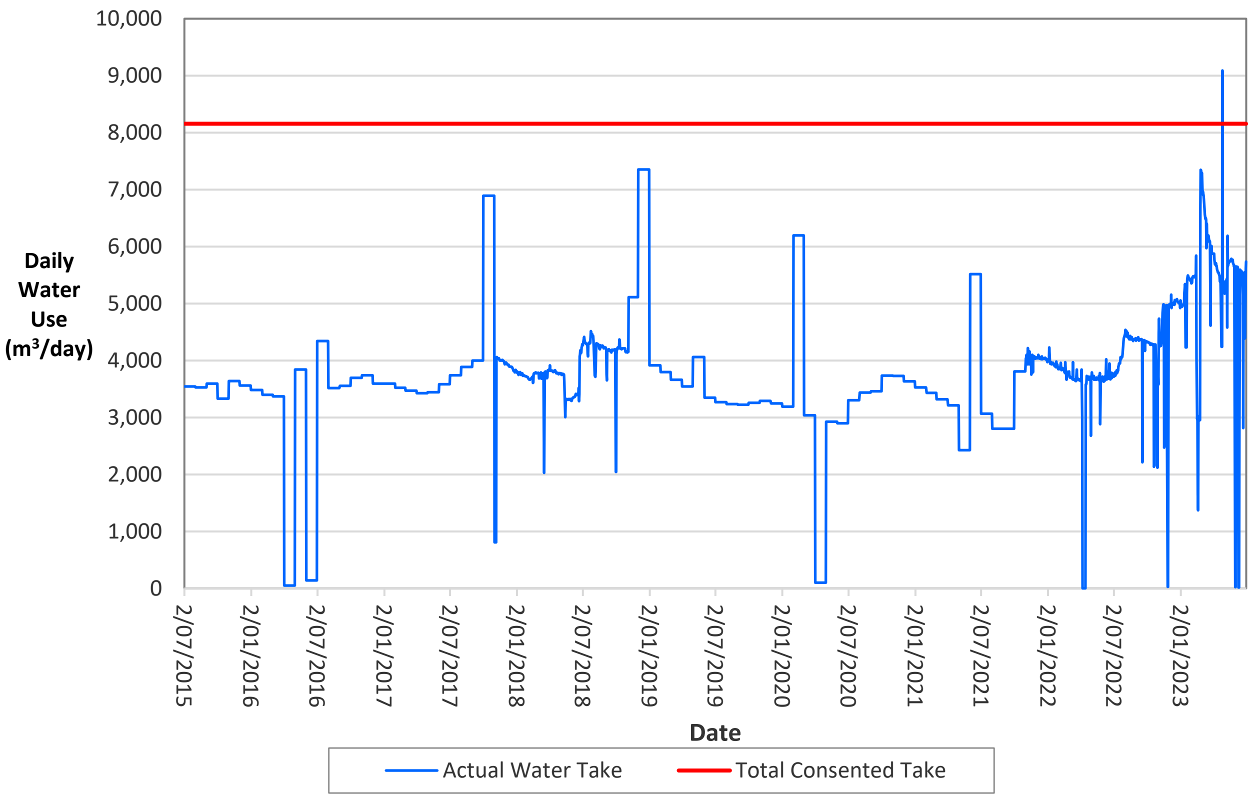

Fig 11: Actual compared to consented daily water take for consent holder AUT.000964.01.04

Table 10: Statistical analysis of actual daily water take for consent holder AUT.000964.01.04

Parameter	Actual water take (m^3/day)	Actual as percentage of consented daily take
Mean	3,729.7	46%
Median	3,638.0	45%
Minimum	0.0	0%
Maximum	9,091.0	111%

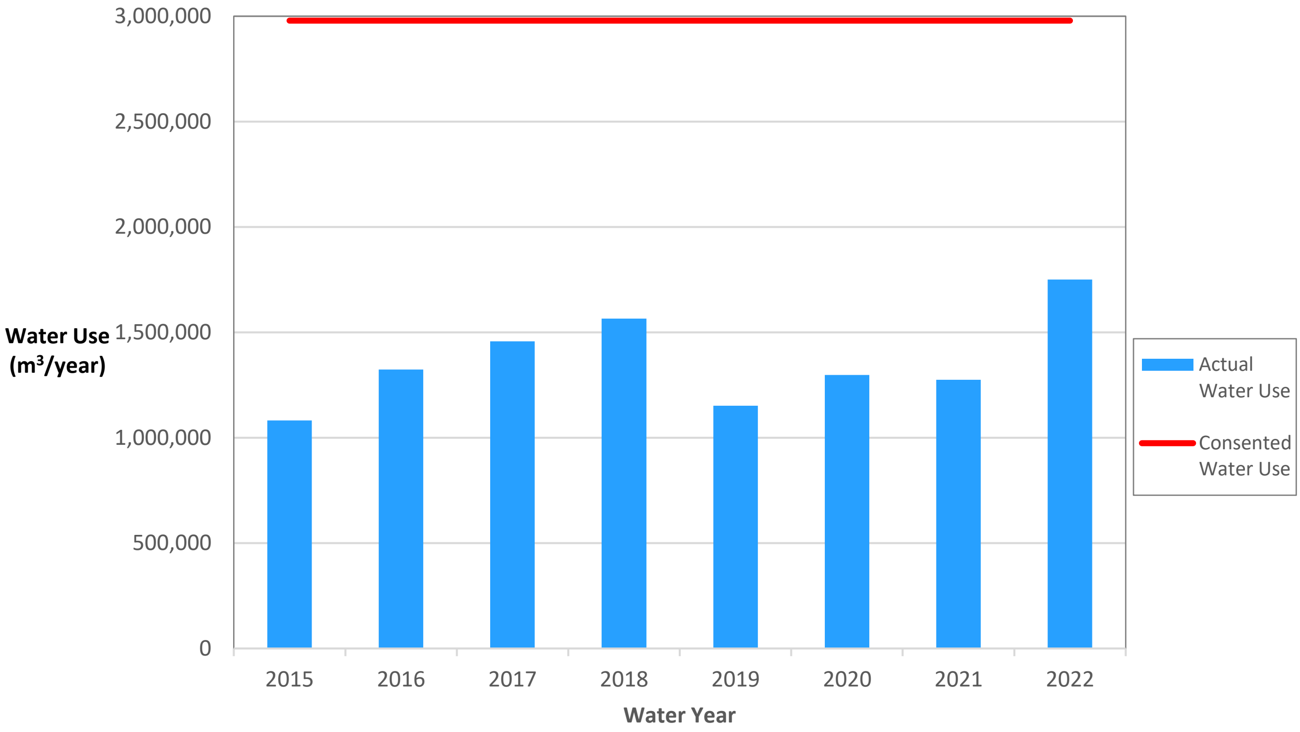

Fig 12: Actual compared to consented annual water take for consent holder AUT.000964.01.04

Table 11: Actual to consented annual water take for consent holder AUT.000964.01.04

Water Year	Actual water take (m^3/year)	Consented water take (m^3/year)	Actual as percentage of consented take
2015 / 2016	1,081,747	2,978,979	36%
2016 / 2017	1,322,976	2,978,979	44%
2017 / 2018	1,457,406	2,978,979	49%
2018 / 2019	1,565,729	2,978,979	53%
2019 / 2020	1,152,037	2,978,979	39%
2020 / 2021	1,298,442	2,978,979	44%
2021 / 2022	1,274,637	2,978,979	43%
2022 / 2023	1,750,793	2,978,979	58%

Analysis of water take data over eight complete water years showed that actual water take ranged from 36% to 59% of the total consented takes on an annual basis. The mean and median actual water takes were 1,361,428m^3/year and 1,310,709m^3/year, which correspond to 46% and 44% of the annual consented volume respectively.

Consent Holder: AUT.005059.01.04

This is the sole surface water consent holder with a water take point located in the lower reach of the Ōtaika catchment, downstream of the flow recorder site. The consent holder abstracts water from the Ōtaika stream for industrial purposes, quarry operations, dust suppression, and irrigation. There are continuous water use records for this consent holder since July 2015.

The following water take limits are applicable to the consent holder:

- daily average of 910m³ per consecutive seven-day period; or
- maximum of 6,370m³ per consecutive seven-day period; or
- 332,150m³ within each 12-month period between 1 July to 30 June.

The 7-day moving average was computed for the period from July 2015 to June 2023 and assessed against the daily take limit of 910m³. Figure 13 illustrates a line graph depicting the actual and consented water take.

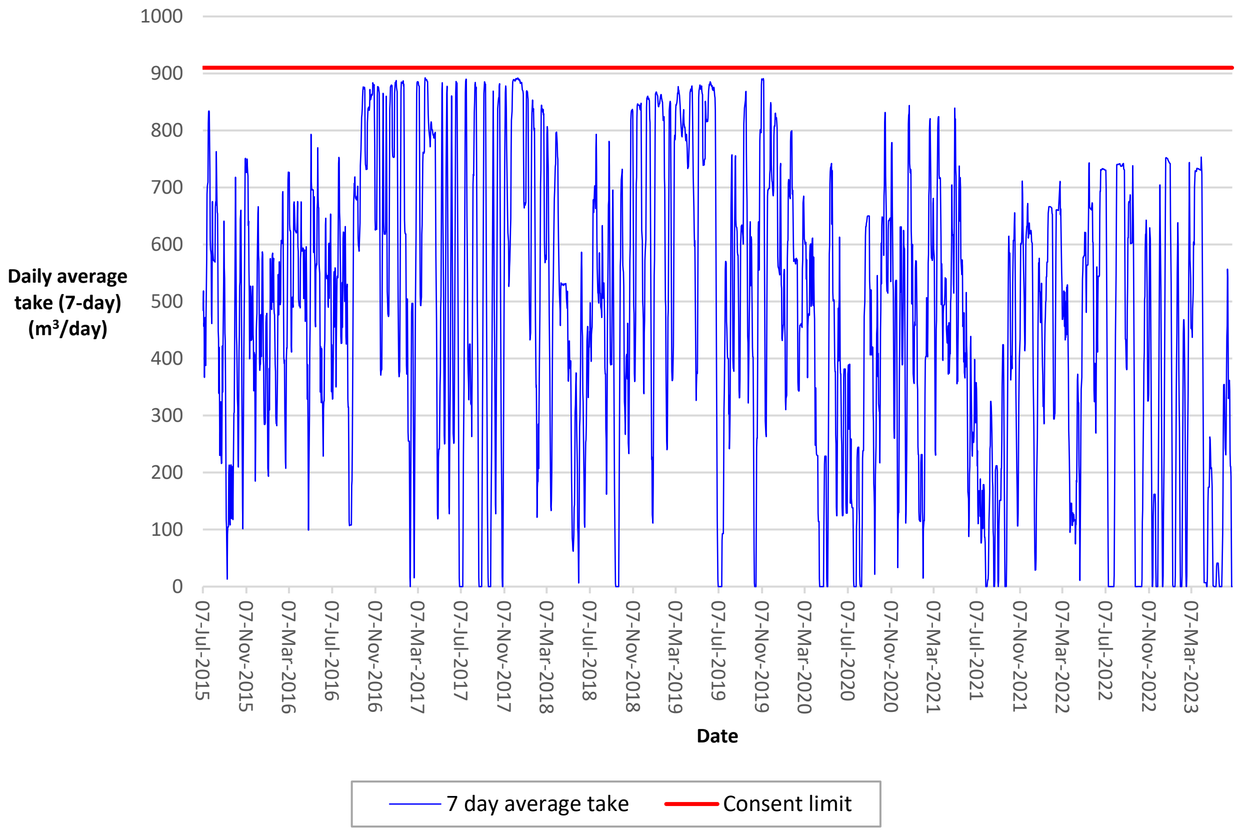

Fig 13: Actual compared to consented water take (based on 7-day average) for consent holder AUT.005059.01.04

Table 12: Statistical analysis of the 7-day average daily water take for consent holder AUT.000964.01.03

Parameter	Actual water take (m³/day)	Actual as percentage of consented take
Mean	483	53%
Median	506	56%
Minimum	0	0%
Maximum	892	98%

The mean and median daily average takes were 53% and 56% of the 7-day average consent limit respectively.

The actual annual water abstraction was computed and compared to the consented volume as shown in Figure 14.

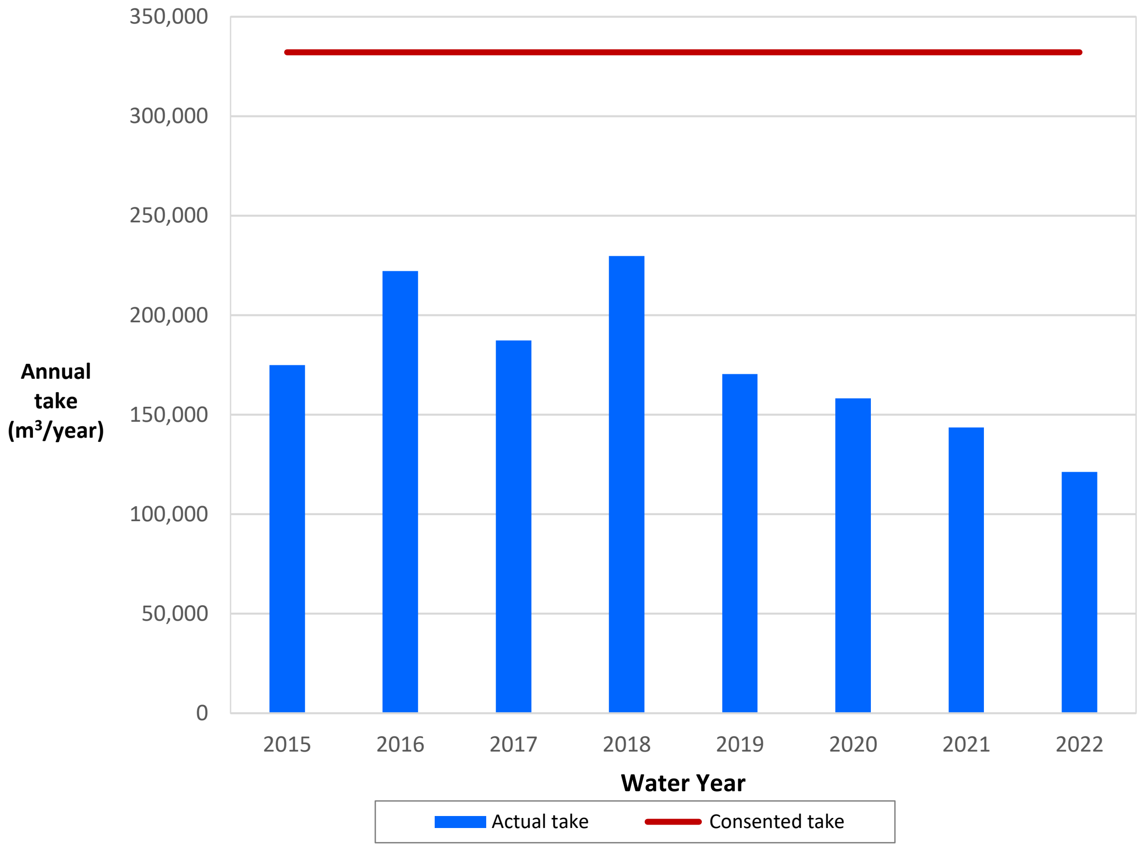

Fig 14: Actual compared to consented annual water take for consent holder AUT.005059.01.04

Table 13: Actual compared to consented annual water take for consent holder AUT.005059.01.04

Water Year	Actual water take (m^3/year)	Consented water take (m^3/year)	Actual as percentage of consented take
2015 / 2016	175,033	332,150	53%
2016 / 2017	222,243	332,150	67%
2017 / 2018	187,264	332,150	56%
2018 / 2019	229,843	332,150	69%
2019 / 2020	170,497	332,150	51%
2020 / 2021	158,229	332,150	48%
2021 / 2022	143,669	332,150	43%
2022 / 2023	121,197	332,150	36%

The annual actual water take ranged from 36% to 69% of the consented take. The mean and median actual water use were 53% and 52% of the consented volume, respectively.

Consent Holder: AUT.007324.02.03

The consent holder is subject to the following water take limits:

- A maximum of 300 cubic metres per day, and
- A maximum of 109,575 cubic metres per year for the irrigation of horticultural crops.

Over the eight-year analysis period, actual water use ranged between 0% and 1% of the consented volume annually. Both the mean and median actual annual water takes were approximately 0.3% of the consented amount. The consent holder did not exercise water takes for three water years. Overall, these figures demonstrate a consistently negligible use of the allocated water as shown in table 14.

Table 14: Actual compared to consented annual water take for consent holder AUT.007324.02.03

Water Year	Actual water take (m^3/year)	Consented water take (m^3/year)	Actual as percentage of consented take
2015 / 2016	273	109,575	0.2%
2016 / 2017	455	109,575	0.4%
2017 / 2018	0	109,575	0%
2018 / 2019	455	109,575	0.4%
2019 / 2020	615	109,575	0.6%
2020 / 2021	1,089	109,575	1.0%
2021 / 2022	0	109,575	0%
2022 / 2023	0	109,575	0%

Table 15: Statistical analysis of the annual water take for consent holder AUT.007324.02.03

Parameter	Actual water take (m^3/year)	Parameter as percentage of consented take
Mean	361	0.3%
Median	364	0.3%
Minimum	0	0%
Maximum	1,089	1.0%

Consent Holder: AUT.002829.01.04

The consent holder is permitted to abstract a maximum of 267 m^3/day or 97,455 m^3 per annum for the irrigation of horticultural crops.

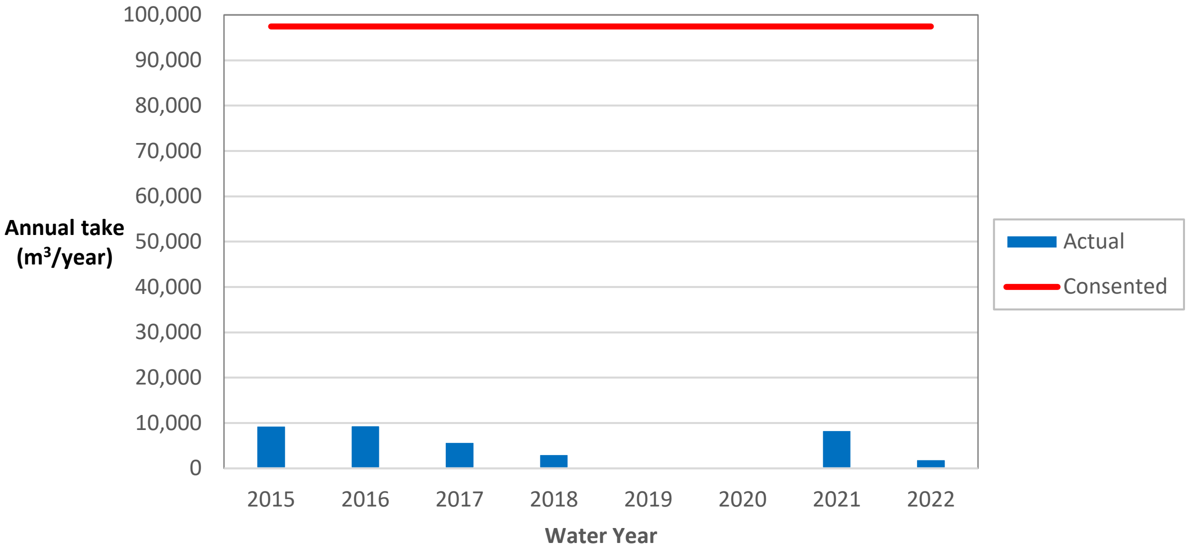

Fig 15: Actual compared to consented annual water take for consent holder AUT.002829.01.04

Table 16: Actual compared to consented annual water take for consent holder AUT.002829.01.04

Water Year	Actual water take (m^3/year)	Consented water take (m^3/year)	Actual as percentage of consented take
2015 / 2016	9,428	97,455	10%
2016 / 2017	9,524	97,455	10%
2017 / 2018	5,867	97,455	6%
2018 / 2019	3,145	97,455	3%
2019 / 2020	0	97,455	0%
2020 / 2021	0	97,455	0%
2021 / 2022	8,477	97,455	9%
2022 / 2023	2,033	97,455	2%

Table 17: Statistical analysis of the annual water take for consent holder AUT.002829.01.04

Parameter	Actual water take (m^3/year)	Parameter as percentage of consented take
Mean	4,809	5%
Median	4,506	5%
Minimum	0	0%
Maximum	9,524	10%

Actual water take ranged between 0% and 10% of the consented volume. The consent holder did not exercise water takes in the 2019/2020 and 2020/2021 water years. On average, both the annual mean and median actual water takes were just 5% of the consented take volume, indicating that a low portion of the consented water was utilised.

Consent Holder: AUT.029769.01.01

The following water take limits apply to the consent holder:

- a maximum of 80 cubic metres per day period at a rate not exceeding 1 L/s; and
- a maximum of 20,000 cubic meters per year for the irrigation of flowers.

Annually, the actual water use was between 12% and 24% of the consented amount. The mean and median actual annual water takes were 19% and 20% of the consented volume respectively. These statistics highlight a consistently low utilisation of the consented water over the eight years analysed.

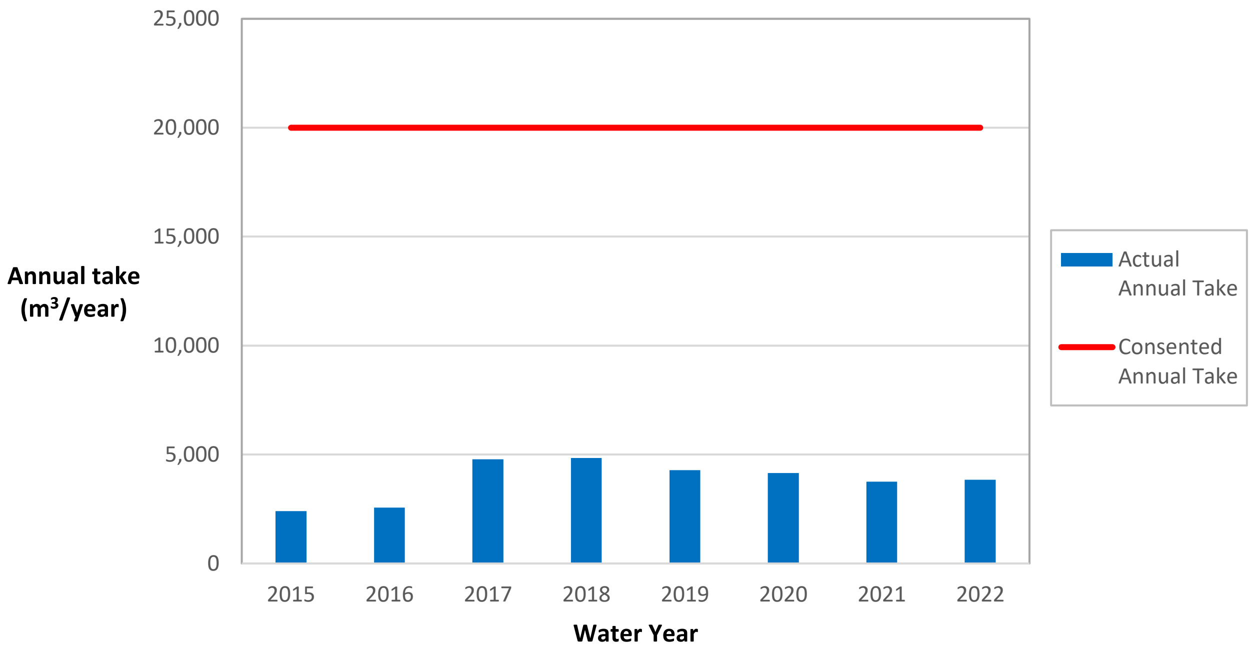

Fig 16: Actual compared to consented annual water take for consent holder AUT.0029769.01.01

Table 18: Actual compared to consented annual water take for consent holder AUT.0029769.01.01

Water Year	Actual water take (m^3/year)	Consented water take (m^3/year)	Actual as percentage of consented take
2015 / 2016	2,406	20,000	12%
2016 / 2017	2,568	20,000	13%
2017 / 2018	4,785	20,000	24%
2018 / 2019	4,842	20,000	24%
2019 / 2020	4,283	20,000	21%
2020 / 2021	4,155	20,000	21%
2021 / 2022	3,761	20,000	19%
2022 / 2023	3,838	20,000	19%

Table 19: Statistical analysis of the annual water take for consent holder AUT.0029769.01

Parameter	Actual water take (m^3/year)	Parameter as percentage of consented take
Mean	3,830	19%
Median	3,997	20%
Minimum	2,406	12%
Maximum	4,842	24%

Consent Holder: AUT.007213.02.02

The consent authorises the holder to store water in a dam on a tributary of the Otakaranga Stream for irrigation purposes. There is no limit on the amount of water that can be taken, provided that a residual dam release of 1.2 L/s is always maintained to ensure minimum flows. The actual water take pattern for the consent holder is shown in Figure 17.

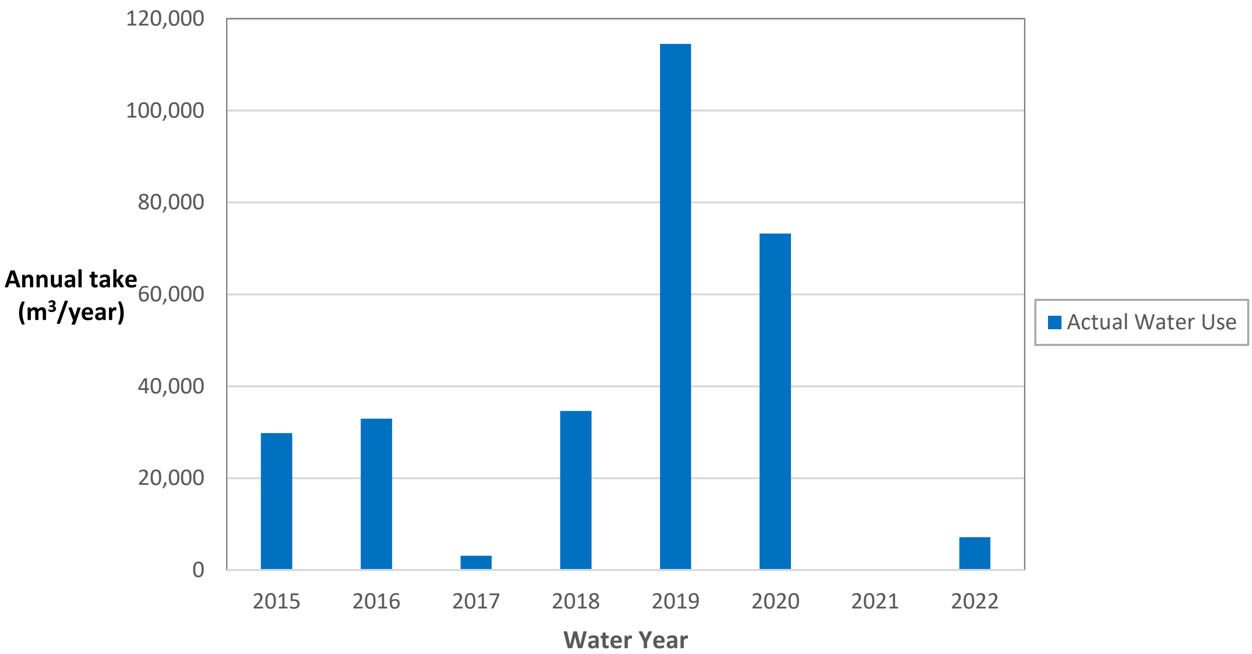

Fig 17: Water take pattern for consent holder AUT.007213.02.02 on an annual basis

Table 20: Statistical analysis of the annual water take for consent holder AUT.007213.02.02

Parameter	Actual water take (m^3/year)
Mean	37,175
Median	31,794
Minimum	0
Maximum	114,512

The consent holder did not exercise water takes for one water year in the study period. The actual annual water take ranged from a minimum of 0 m^3 in 2021/2022 to 114,511 m^3 in 2019/2020. The mean and median water takes were 37,175 m^3 and 31,794 m^3 respectively.

Analysis of water abstraction patterns among the top individual consent holders in the catchment reveals that they typically use less than 50% of their allocation volumes. This conclusion is consistent with a Ministry for Environment (MfE) study, which reported that most regional councils in New Zealand, including NRC, have consent holders who typically abstract around 50% of their consented amounts (Aqualink Research Ltd, 2010).

Catchment Scale Actual Water Takes and Current Allocation Analysis

The catchment-scale analysis of actual water take and current water allocation was conducted by comparing the total actual water takes (derived from telemetry and water use records submissions) and estimated PA takes against the catchment allocation limits and flow statistics over an eight-year period, spanning the 2015/2016 to the 2022/2023 water years.

Statistics comparing the total annual catchment water takes with the regional default allocation limit, current allocation and the 7d-MALF are shown in Table 21 and descriptions of the different scenarios have been unpacked below.

Table 21: Comparison of actual water use and various allocation measures and limits

Water Year	Actual Total Water Take (m^3/year)	7d-MALF (m^3/year)	Regional Default Allocation (Coastal River Allocation) (m^3/year)	Current Allocation (Consents & Estimated PA) (m^3/year)	Current Allocation as Percent of Regional Default Allocation	Actual Water Use as Percent of Regional Default Allocation	Actual Water Use as Percent of Current Allocation	Actual Water Use as Percent of 7d-MALF	Current Allocation as Percent of 7d-MALF
2015/2016	1,534,122	4,478,112	1,343,434	4,250,611	316%	114%	36%	34%	95%
2016/2017	1,799,593	4,478,112	1,343,434	4,250,611	316%	134%	42%	40%	95%
2017/2018	1,866,112	4,478,112	1,343,434	4,250,611	316%	139%	44%	42%	95%
2018/2019	2,053,736	4,478,112	1,343,434	4,250,611	316%	153%	48%	46%	95%
2019/2020	1,662,998	4,478,112	1,343,434	4,250,611	316%	124%	39%	37%	95%
2020/2021	1,750,471	4,478,112	1,343,434	4,250,611	316%	130%	41%	39%	95%
2021/2022	1,639,395	4,478,112	1,343,434	4,250,611	316%	122%	39%	37%	95%
2022/2023	2,078,316	4,478,112	1,343,434	4,250,611	316%	155%	49%	46%	95%

Scenario 1: Current allocation vs the regional default allocation

NRC used the analysis of the current water allocation (consented and permitted activity takes) and the regional default allocation (30% of the 7d-MALF for coastal rivers in this case) to identify the allocation status of catchments in Northland (fully, highly, moderately and lowly allocated catchments). Based on the 2017 assessment using the 7d-MALF from regional modelling data, the Ōtaika catchment was identified as fully allocated, with its allocation status estimated at approximately 331%. When site-specific flow data from the local flow station was used to estimate the 7d-MALF, the allocation status was slightly lower (316%), however the catchment is still fully allocated.

The implication of this analysis and scenario is that the allocation limit ceases to be based on the regional default limit for the catchment. Instead, the current allocation becomes the new limit in accordance with the PRPN. However, applying this scenario without additional management measures can potentially affect the catchment's instream values negatively especially under low flow conditions.

Scenario 2: Actual water use vs the regional default allocation

An analysis of the actual water use and the regional default allocation set at 30% of the 7d-MALF was undertaken. The actual water takes exceeded the regional default allocation limit by between 14% and 55% annually over the eight-year period. Although this shows a catchment under pressure based on the actual water take, the extent of the exceedance is considerably lower than observed under the paper allocation scenario.

Scenario 3: Actual water take vs the current allocation

This scenario compares the actual total annual water take to the current allocation (consented and PA takes) for the catchment. This is current operational water allocation scenario for the Ōtaika catchment since the current allocation became the allocation limit upon its identification as a fully allocated catchment.

An analysis of this scenario for the whole catchment over the eight-year period revealed that between 36% to 49% of the current water allocation is used in reality. This aligns with both the analysis of the individual consent holders' actual and consented water takes in the catchment and also with the study by the MfE that pointed to about 50% use of consented water (Aqualink Research Ltd, 2010). It is interesting to note that all the surface water consent holders in the catchment use significantly lower amounts of their allocated takes. It is worth investigating why there is such a trend for all consent holders, as this can indicate an inefficient use of water.

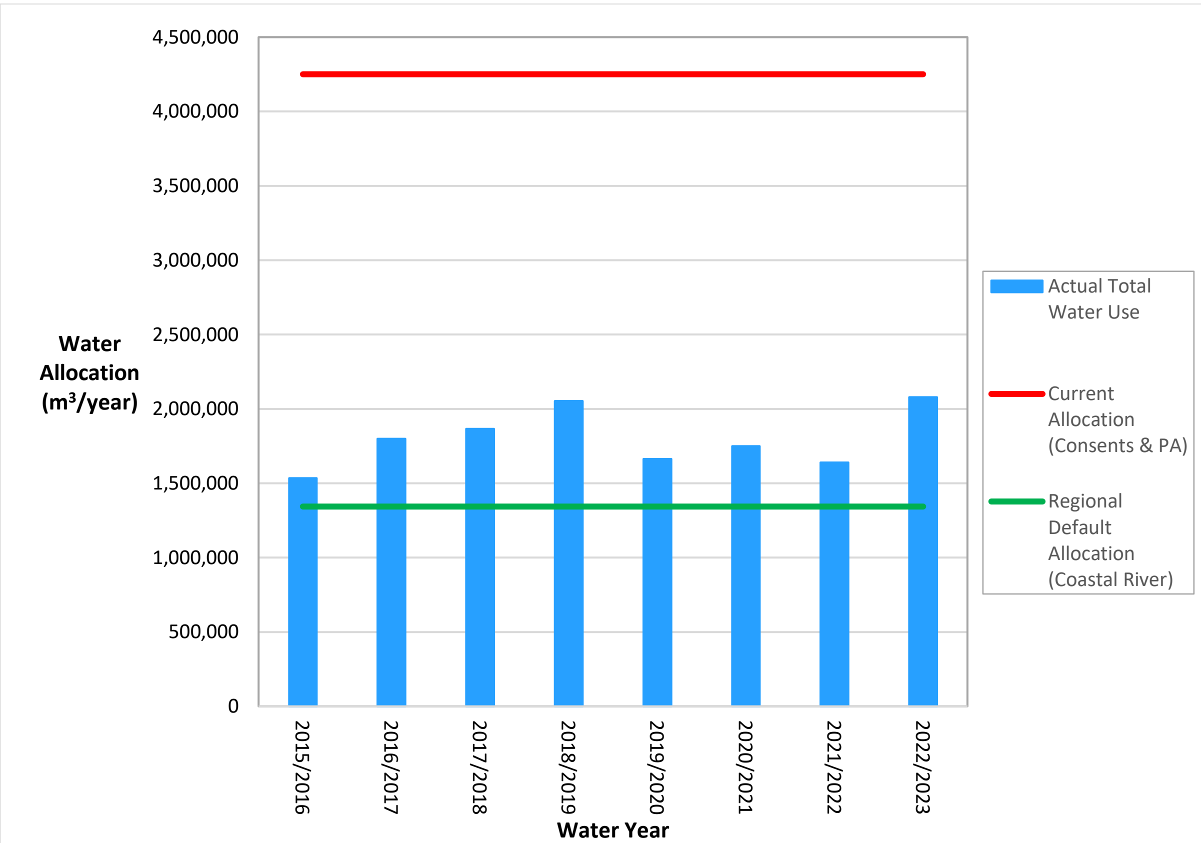

Fig 18: Comparison of the Ōtaika catchment actual water take and allocation (current allocation and regional default)

Water resources availability analysis

One of the useful techniques in the assessment of streamflow data and security of supply of water is through the use of flow duration curves. Flow duration curves (FDC) are cumulative frequency curves that show the percentage of time that a flow of a given magnitude is equalled or exceeded over a historical period (Smakhtin, 2001; Sungu, 2018). FDC can, therefore, be very useful in the evaluation of the percentage of time a stream can meet a certain demand of water through showing the flows for a range of probabilities. In order to compile a FDC, streamflow was naturalised as described below.

Naturalisation of streamflow for the Ōtaika catchment

The stream flow data available for the Ōtaika at Kay flow station is based on observed flows due to the upstream anthropogenic activities (i.e. water takes for municipal use, irrigation and industrial purposes). To be able to compare the effects of the abstractions on the natural river state, flows and frequencies, it becomes vital to naturalise stream flows. Naturalisation is the process of removing the influence of anthropogenic activities that affect river or stream flows, e.g., abstractions, damming of rivers and hydraulically connected groundwater abstractions to come up with what the flows would have been without the upstream human influences (Young and Hay, 2017). One of the assumptions of the process of naturalisation is that the water takes are consumptive and do not seep into or get discharge into the streams, which may not always be the case with irrigation.

Procedure of Ōtaika catchment streamflow naturalisation

1. Quality checked stream flow data for the Ōtaika at Kay flow station was sourced from the Hilltop Database for analysis.
    - Raw stream flow data (m^3/s) for the flow station was available on a five-minute time step from 27 January 2011 when the flow station was opened to the present day.
    - Quality checked stream flow data (m^3/s) for the flow station was available on a five-minute time step from 27 January 2011 to 22 April 2024 (as of 31 May 2024).
    - Quality checked mean daily stream flow data (m^3/s) was downloaded from Hilltop for use for naturalisation.
2. Actual daily water use for the catchment was estimated
    - All surface water take consents upstream of the Ōtaika at Kay flow recorder site were recorded.
    - Groundwater take consents with stream depletion rates were added.
    - Actual daily surface water take was downloaded from the Hilltop Database from 1 July 2015 to 30 June 2023 (project duration).
    - PA take estimates were accessed from the Water Allocation Tool (WAT) based on the latest run of 28 November 2023.
    - The surface water take downstream of the Ōtaika at Kay flow station, groundwater takes without a stream depletion rate and non-consumptive surface water takes were disregarded during the naturalisation process. The only surface water take consent that was excluded during the naturalisation process was the one for AUT.5059.01.04 because the take point is downstream of the flow station.
3. Naturalised flows were estimated for the flow station
    - The actual daily abstraction was added to the average daily stream flow to estimate naturalised flow.
    - Various flow statistics were calculated for the naturalised dataset for the flow station.

Table 22: Data specifications used during streamflow naturalisation

Data type	Start date	End date	Duration of dataset (years)	Note
Raw Stream flow (Ōtaika at Kay)	27-01-2011	Present day	13	Raw stream flow
Quality checked Stream flow (Ōtaika at Kay)	27-01-2011	22-04-2024	13	Quality checked streamflow data
Water use records	01-07-2015	30-06-2023	8	

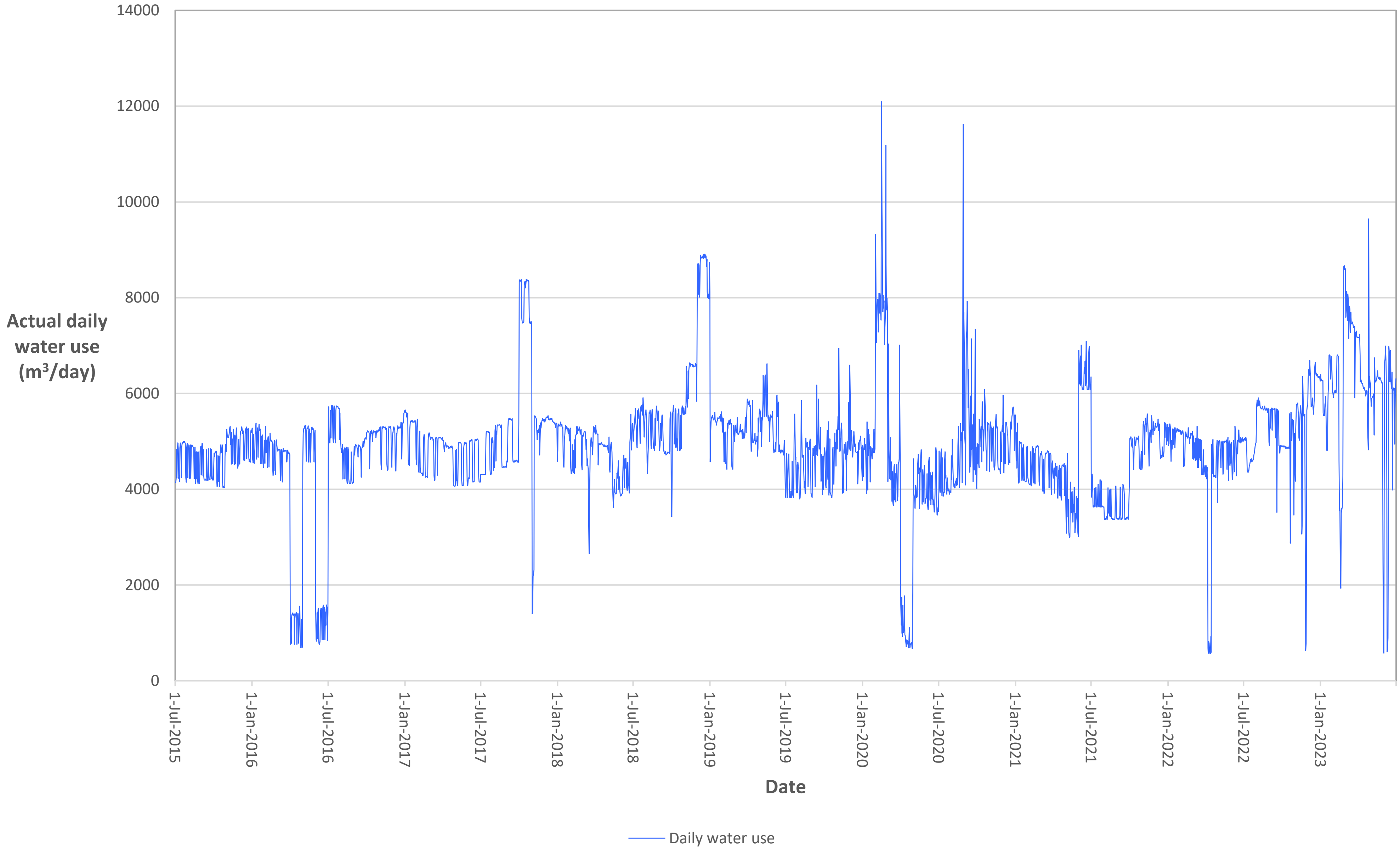

***Fig 19**:* Ōtaika catchment total daily water take (for consents upstream of the Ōtaika at Kay flow station)

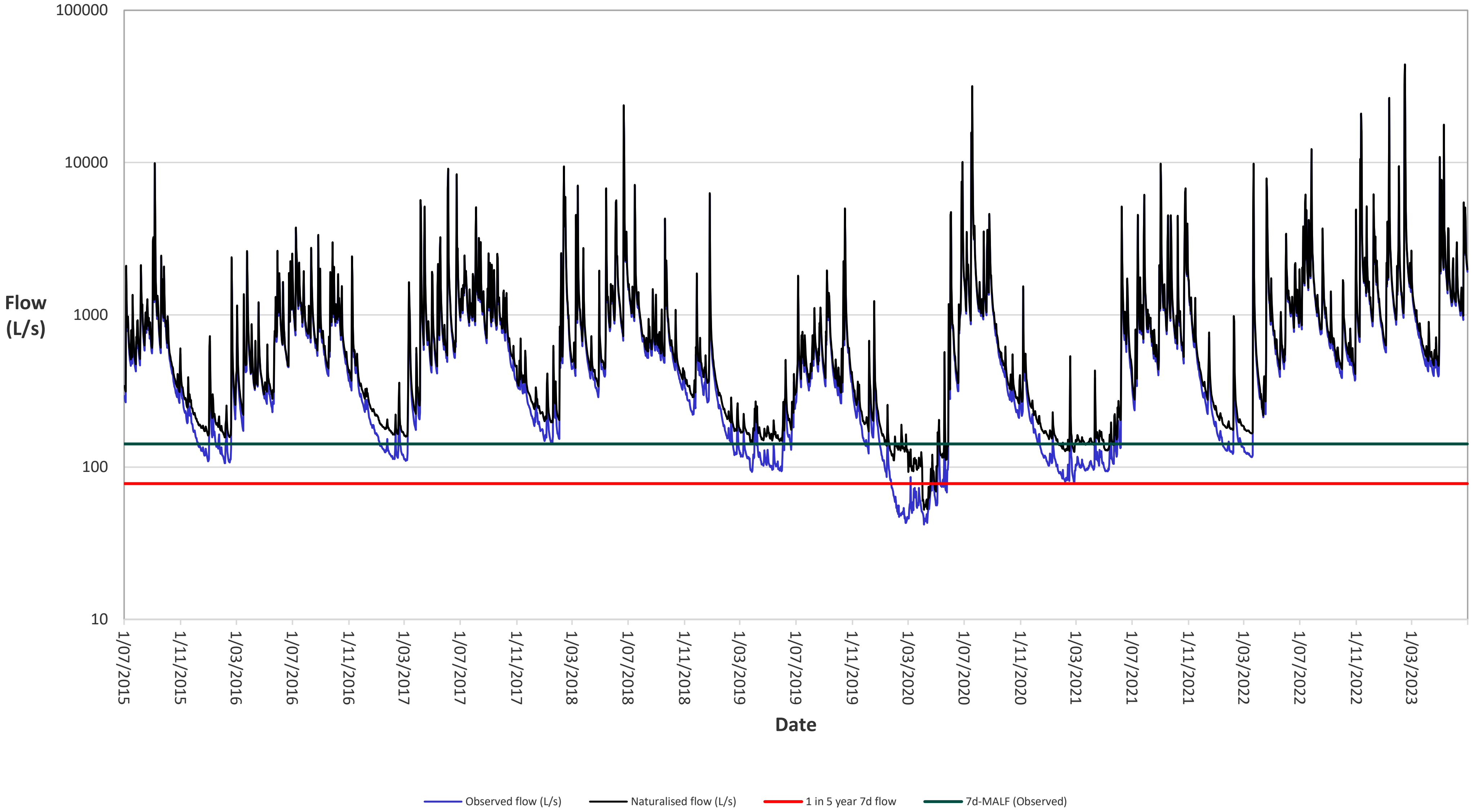

Fig 20: Observed and naturalised flows and other flow metrics for the Ōtaika at Kay flow recorder site (2015/2016 – 2022/2023)

Table 23: Observed and naturalised flow statistics for the Ōtaika at Kay flow recorder site (2015 – 2023)

Parameter	Mean (m^3/s)	Median (m^3/s)	7d-MALF (m^3/s)
Naturalised	0.920	0.515	0.187
Observed	0.869	0.462	0.142

Due to the relatively short time series data set used for the naturalisation and estimation of the flow statistics, it is important to note that the flow statistics may change once more long-term stream flow and water take data is used.

An FDC for the flow station Ōtaika at Kay was compiled using streamflow data for the period with naturalised data (2015 – 2023).

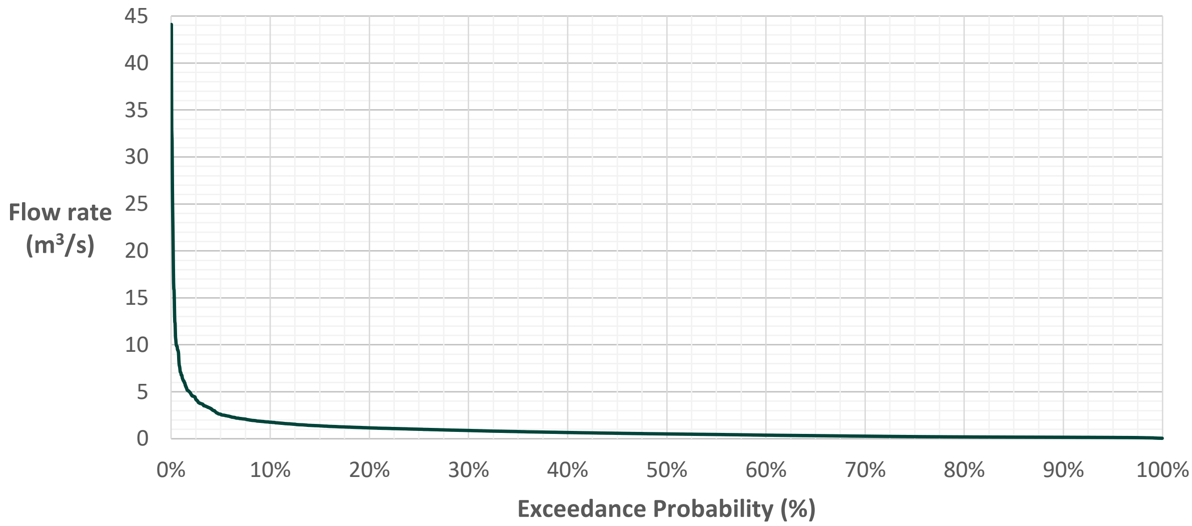

Fig 21: FDC for the Ōtaika at Kay flow station (2015-2023)

Table 24: Naturalised and observed flows for various exceedance probabilities for the Ōtaika at Kay flow station

Exceedance Probability	Naturalised stream flow		Observed stream flow	
	(m^3/s)	(L/s)	(m^3/s)	(L/s)
95%	0.14	140	0.09	90
90%	0.16	160	0.11	110
80%	0.20	200	0.15	150
70%	0.28	280	0.23	230
60%	0.38	380	0.34	340
50%	0.52	520	0.46	460
40%	0.66	660	0.61	610
30%	0.88	880	0.83	830
20%	1.16	1160	1.11	1110
10%	1.76	1760	1.70	1700
5%	2.59	2590	2.54	2540

Table 25: Naturalised mean monthly flows at various exceedance probabilities for the Ōtaika at Kay flow station

Exceedance Probability	Naturalised mean monthly flow (m^3/s)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
99%	0.12	0.13	0.10	0.05	0.11	0.18	0.31	0.44	0.38	0.27	0.20	0.16
90%	0.14	0.13	0.11	0.08	0.13	0.27	0.45	0.58	0.47	0.34	0.25	0.18
80%	0.17	0.15	0.15	0.15	0.15	0.50	0.65	0.64	0.55	0.40	0.28	0.20
70%	0.18	0.16	0.16	0.17	0.17	0.67	0.85	0.72	0.62	0.45	0.30	0.22
60%	0.19	0.18	0.17	0.27	0.33	0.87	0.99	0.80	0.70	0.50	0.34	0.24
50%	0.20	0.19	0.23	0.36	0.50	1.04	1.14	0.88	0.82	0.56	0.36	0.26
40%	0.21	0.21	0.43	0.44	0.64	1.21	1.31	0.99	0.95	0.63	0.40	0.29
30%	0.24	0.33	0.57	0.51	0.79	1.42	1.53	1.12	1.08	0.70	0.50	0.35
20%	0.33	0.92	0.79	0.59	1.22	1.89	1.85	1.30	1.30	0.90	0.73	0.49
10%	1.00	1.88	1.12	0.91	1.90	2.76	2.82	1.69	1.95	1.29	1.43	0.96
1%	4.30	11.73	4.50	5.46	7.27	9.70	10.88	3.66	6.04	4.97	8.44	3.62

Table 26: Observed mean monthly flows at various exceedance probabilities for the Ōtaika at Kay flow station

Exceedance Probability	Observed mean monthly flow (m^3/s)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
99%	0.07	0.04	0.05	0.04	0.06	0.13	0.26	0.39	0.33	0.22	0.15	0.11
90%	0.09	0.05	0.07	0.07	0.10	0.21	0.41	0.52	0.42	0.29	0.20	0.12
80%	0.12	0.09	0.10	0.11	0.10	0.45	0.59	0.60	0.49	0.35	0.23	0.14
70%	0.13	0.11	0.11	0.13	0.13	0.63	0.81	0.67	0.57	0.39	0.25	0.17
60%	0.14	0.12	0.12	0.23	0.28	0.82	0.94	0.74	0.65	0.44	0.28	0.19
50%	0.15	0.14	0.18	0.33	0.45	0.99	1.08	0.83	0.76	0.50	0.31	0.20
40%	0.16	0.16	0.38	0.40	0.59	1.16	1.26	0.94	0.91	0.57	0.35	0.24
30%	0.19	0.28	0.51	0.45	0.74	1.37	1.48	1.07	1.04	0.65	0.44	0.28
20%	0.27	0.87	0.73	0.55	1.16	1.87	1.80	1.25	1.25	0.85	0.67	0.42
10%	0.93	1.83	1.06	0.86	1.84	2.71	2.76	1.64	1.90	1.22	1.42	0.89
1%	4.24	11.68	4.45	5.41	7.21	9.65	10.83	3.61	6.00	4.92	8.38	3.55

At the Ōtaika at Kay reach level, the likelihood of meeting the minimum flows (based on the exceedances) would have been very high for winter months and a bit lower for the summer months. However, this cannot be used for the whole catchment because the minimum flow and allocation limits are applied at reach level and the flow measurement used for the statistics is only undertaken towards the catchment outlet. However, due to the levels of water takes in summer (refer to Figure 20), and the effects of droughts, the percentage of exceedance was lower for observed flows. It then becomes important for water resources managers to ensure effective minimum flow and allocation management for sustainable water resources management.

Water resources availability at various low flow thresholds

Although NRC manages minimum flows and water allocation at river reach levels, an evaluation of the stream flows against the 7d-MALF, minimum flow (at the stream reach of the Ōtaika at Kay flow recorder site) and for the 1 in 5-year 7-day flow for the catchment was undertaken.

The Ōtaika stream's observed flows dropped to below the 7d-MALF (for a number of the summer seasons in the study period as shown in Figure 20. This occurred during the summer seasons of the hydrological years 2015/2016, 2016/2017, 2018/2019, 2019/2020, 2020/2021 and 2021/2022.

From an aquatic ecological perspective, a period of 30 consecutive days with stream flows below the minimum flow is generally considered as a critical threshold, beyond which aquatic ecosystems are likely to suffer significant harm. This threshold was reached for the stream reach at Ōtaika at Kay flow station during the 2018/2019 and 2019/2020 droughts, with the longest consecutive periods of stream flow below the reach minimum level being 111 and 52 days, respectively. This aligns with Pham *et al.* (2022), who identified the 2018–2020 drought as the worst hydrological surface water drought in Northland's history. There were two years, 2017/2018 and 2022/2023, in which the observed flows did not fall below the stream reach minimum flows.

Table 27: Analysis of the number of consecutive days per water year the Ōtaika stream flow was below the stream reach minimum flow and the 1-in-5-year 7-day flow

Water year	Highest number of consecutive days observed flow was below the 1-in-5-year 7-day flow	Highest number of consecutive days observed flow was below the Ōtaika at Kay stream reach minimum flow
2015 / 2016	0	8
2016 / 2017	0	15
2017 / 2018	0	0
2018 / 2019	0	20
2019 / 2020	43	111
2020 / 2021	0	52
2021 / 2022	0	19
2022 / 2023	0	0

However, the minimum flow limits for the different water take consents within the catchment are not consistently set for all the consents. This is because some consents have conditions that require the consent holder to measure stream flow downstream of the point of take (and prevent the holder from reducing the flow below a certain threshold), whilst some consents do not have minimum flows as part of their consent conditions. Other consents have minimum flows that are tied to the Ōtaika at Kay flow station, such as consent holder AUT.005059.01.04 whose point of take is downstream of the Ōtaika at Kay flow station. The cease to take limit for the consent holder is about 45 L/s (sum of 35 L/s downstream of the point of take and an instantaneous take rate of 10.5 L/s) which is less than the 1 in 5-year 7-day flow of the flow station (78 L/s). Additionally, another consent holder AUT.004000.01.04 has a cease to take limit of 120 L/s that is tied to the Ōtaika at Kay flow station and yet the modelled 7d-MALF at the reach level of the consent is 7 L/s.

If the limits are properly enforced in the strictest sense as per the consent conditions, consent holders like AUT.005059.01.04 will continue abstracting water (until the cease to take limit of 45 L/s) when the streamflow will now be less than the 1 in 5-year 7-day flow (of 78 L/s) whilst the consent holder AUT.004000.01.04 will already be under a full restriction (because of the cease to take limit of 120 L/s). The benchmark of setting the minimum flow limits in the catchment is not consistent.

During the eight-year study period, the longest consecutive duration in which the observed stream flow at the Ōtaika at Kay flow station dropped below the 1 in 5-year 7-day flow was 43 days. In comparison, the highest number of days the observed flow dropped below the default minimum flow at the Ōtaika at Kay stream reach was 111 consecutive days. Both events occurred during the 2019/2020 water year, as shown in Table 26. In the other water years included in the study period, the observed stream flow levels did not drop below the 1-in-5-year 7-day flow threshold. However, the levels dropped below the default minimum flow (at the flow station stream reach), though for shorter periods than those observed in 2019/2020

Although low stream flows during some of the identified years were primarily due to drought conditions, water use records show that most consent holders continued abstracting water even when flows dropped below the minimum levels for the consents tied to the flow station or below the 1-in-5-year 7-day flow threshold (particularly during the 2018 to 2020 drought). This suggests that water takes likely exacerbated the risk of hydrological alteration during drought periods. The presence of inconsistent minimum flow limits, and the associated lack of compliance with the cease to take consent conditions, appears to have contributed to reduced stream flows in several years—especially during the critical drought period from 2018 to 2020.

Evaluation of the current water allocation regime on the instream values of the Ōtaika catchment

Assessment of the streamflow on water quality in the Ōtaika Catchment

Quite often stream flow and water quality are assessed separately. However, research has proven that they are linked and, therefore, need to be looked at holistically. Stream flows (magnitude, duration and frequency) can influence water quality through constituents like nutrients, oxygen, organic matter and sediments via pathways that include transportation, retention or processing (Nilsson and Renöfält, 2008). As such, any alterations in the flow characteristics (natural or human induced) can potentially affect water quality.

The Ōtaika catchment historically has several water quality monitoring stations for different purposes. The details of the active and historic water quality sites in the study area are shown in Table 28.

Table 28: Current and historic water quality monitoring sites for the Ōtaika catchment

Site Name	IRIS ID	Duration of monitoring	Purpose	Remarks
Ōtaika at Ōtaika Valley Road	LOC.110431	2011 – Present	SOE – River Water Quality Monitoring Network	
Ōtaika at Kay	LOC.005659	2019 – Present	Continuous site	
Ōtaika Stream at Old Bridge	LOC.100196	2013 – 2019	Whangārei Harbour Catchment Study	
Puwera at Bennetts Farm	LOC.108706	2006 – 2017	SOE Catchment Study	Site shifted 1.7km down-stream and named LOC.315381
Otakaranga at Ōtaika Valley Road	LOC.306863	2014 – 2020	Whangārei Harbour Catchment Study	Site was part of Whangārei Harbour Catchment Investigation. Site closed in 2021
Ōtaika at Cemetery Road	LOC.306865	2014 – 2020	Whangārei Harbour Catchment Study	
Puwera at SH1	LOC.315381	2016 - 2020	Whangārei Harbour Catchment Study	Site closed in 2021

The active water quality monitoring sites in the catchment are towards the outlet of the catchment. Flow rate can influence the water quality from different perspectives. Anthropogenic activities (water takes) can potentially affect water quality in several ways. High levels of abstraction of stream water in summer for irrigation can further reduce stream flows resulting in additional increases in water temperature. This can also reduce the dissolved oxygen (DO) in waterways due to low, slow to stagnant, steady flowing waterways under summer low flow conditions.

Climatic conditions, such as the droughts of 2018 to 2020, caused reduced stream flows because of sustained low rainfall and high temperatures. Therefore, even in the absence of water takes, natural changes to stream flows can affect water quality.

The influence of a water allocation regime can be more realistically estimated through the use of bivariate statistical modelling, which involves flow adjustment and hence exclusion of other variables that can potentially affect water quality. Undertaking this kind of assessment requires representative water quality monitoring and flow measurement sites around the water take points. However, both the flow measurement and water quality monitoring sites in the Ōtaika catchment are in the lower reaches of the catchment and 89% of the surface water and dam take points are in the upper reaches of the catchment. Therefore, the effect of the water allocation regime on the water quality may not be accurately estimated with the current water quality and flow measurement sites. It is recommended that a more representative monitoring network be established in the catchment to accurately establish the effect of the water allocation regime on the water quality in the catchment.

Evaluation of the current water allocation regime on the cultural values of the Ōtaika catchment

One of the useful assessments in evaluating the effects of a water allocation regime is through undertaking an assessment of the regime on the cultural values of Tāngata Whenua. The outcomes of this technical assessment will be used in initiating a cultural assessment.

Ōtaika catchment pressures and risks

The Ōtaika catchment has several factors that contribute to catchment pressures and risks from hydrological and water management perspectives as discussed below.

Distribution of water takes

The distribution of water takes in any catchment plays a key influence in both its upstream and downstream dynamics.

NRC currently manages water allocation and minimum flows at the point of take / river reach. The previous water allocation regime did not have catchment allocation limits and consents were assessed on a case-by-case basis. Applying the reach approach over existing or historic consents not only provides a good indication of the how impacted the river reaches are but additionally shows the distribution of the river reaches under pressure.

Based on NRC's Water Allocation Tool (WAT), 89% of the stream water and dam water take points are in the upper reaches of the catchment. Consequently, the upper reaches of the Otakaranga, Ōtaika, and Whakapai streams have very high percentages of surface water allocation relative to the 7d-MALF, often exceeding 100%. However, these percentages decrease from the upper to the lower reaches of the catchment due to lower allocation pressure downstream. Additionally, the upper reaches of these streams exhibit very low actual minimum flow accumulation rates, indicating that the ability to fully meet their minimum flow requirements may be compromised.

Naturalisation of stream flows

A common practice in hydrological assessments is the naturalisation of stream flows to eliminate the impact of human activities, particularly water abstractions and damming (Young and Hay, 2017; Sungu, 2018). In line with hydrological best management practices, it is essential to naturalise stream flows to prevent water management decisions from being based on reduced flows caused by previous authorisations. The flow statistics for Northland's flow stations are derived from observed flows.

With increased compliance in submitting water use records by consent holders, the adoption of telemetry for water-use records, and better estimates of permitted takes and modelling, more accurate estimates of naturalised flows can be derived for flow stations. However, there are still some challenges to naturalisation owing to incomplete water use records submitted by some consent holders, actual water takes being significantly lower than consented volumes (making consented volumes unreliable for naturalisation), and the need to enhance the accuracy of PA takes. NRC is currently exploring reassessing naturalised flows at a regional scale and naturalising stream flows for all flow recorder sites.

High current allocation / Full allocation of water

The Ōtaika catchment is one of the catchments in Northland identified as fully allocated, based on a 2017 assessment in accordance with the PRPN. According to NRC's WAT, the surface water allocation for the catchment is 135 L/s, which is 316% of the allocation limit of 42.6 L/s, or 95% of the 7d-MALF of 142 L/s. This significantly exceeds the regional default allocation limit for the catchment.

This situation indicates severe allocation stress on paper, although actual water use is much lower. If all consent holders were to fully exercise their consented water allocation, as they are entitled to do, this would pose a high risk of hydrological alteration on aquatic ecosystems and would adversely affect the security of water supply of other water users. Additionally, in fully allocated catchments, no new consent applications can be accepted for low flow allocation.

Level of Unused Consented Water

As mentioned earlier, the Ōtaika catchment has been identified as fully allocated based on the consented allocation and the regional default limits. However, an analysis of the actual usage of consented takes at the catchment level shows that only 36 to 49% of the current allocation is being used. This situation can be leveraged positively by exploring mechanisms of reducing allocation.

Consents without minimum limits conditions

Some consents in the catchment do not have minimum flow conditions. Notably, consent AUT.000964.01.03, which has the highest water take by both rate and volume in the catchment, lacks such conditions. Theoretically, such consent holders can abstract as much water as allowed by the consent without giving effect to the minimum flows downstream of the point of take. This can have more than minor hydrological impacts on instream values and can negatively affect the security of supply of other users.

Historic farm dams without water take limits

The Ōtaika catchment contains one of the historic farm dams with a water take consent. However, the water take was authorised with only a minimum flow limit downstream of the dam, and there is no upper limit on the amount of water the consent holder can abstract, as long as the minimum flow limit is met. This lack of a dam low flow allocation fails to comprehensively account for minimum flows, water takes, and storage and creates a bottleneck scenario with two main issues. Firstly, there is less water available for downstream users due to the impoundment. Secondly, the consent holder can use as much water as they want, provided the minimum flow is met. This highlights the necessity of implementing the dam low flow allocation methodology in all historic dam water take consents that did not originally consider this assessment.

Climate change projections for Northland

The most recent data and report from the Intergovernmental Panel on Climate Change (IPCC) relevant to New Zealand is the Sixth Assessment Report (AR6), released in 2021, with the Synthesis Report published in 2023. However, the modelling needed to produce downscaled climate change forecasts including hydrological projections for Northland has not yet been undertaken.

Future alternative scenarios

Following an analysis of the current water allocation regime, this section outlines some scenarios that considers alternative water allocation strategies and their possible impacts. The scenarios can be recommended to the Consents and Policy and Planning Teams for consideration.

Scenario 1: Status quo

Under this scenario, NRC might decide to maintain the current allocation regime for fully allocated catchments, essentially using the current allocation as the limit.

According to the analysis of actual and consented water takes, the current allocation represents 95% of the 7d-MALF. If NRC continues with this approach, it could significantly impact both instream and out-of-stream water uses for the catchment. This could affect minimum flows, assurance of supply, and water security. The impacts can be severe under sustained dry periods or during drought conditions as depicted for the 2018/2019 and 2019/2020 hydrological years.

While minimum flow and allocation limits are crucial for maintaining the environmental health of aquatic systems, high water allocation levels and low minimum flows can have negative impacts on Māori values and traditional practices, such as the ability to gather mahinga kai. Additionally, continuing with this scenario may conflict with Te Mana o te Wai principles, which prioritise the health of freshwater and the wider environment before water is used for out-of-stream purposes. Achieving these principles may not always be possible at such high allocation levels.

Scenario 2: Undertaking various forms of water reallocation

Given that the Ōtaika is fully allocated, one of the scenarios in which the water allocation regime can be revisited is through exploring forms of evidence based, practical and fair water reallocation strategies that lower the current water allocation levels. Several mechanisms can be adopted to achieve this, including:

Clawing back consented and unused water during consent renewal

Clawing back of water is a mechanism of water reallocation often used by regulators that involves reclaiming and/or reallocating water that would have been previously allocated. This involves reducing the consented volumes after considering aspects like usage patterns, water use efficiency or allocation efficiency during the process of consent renewal or reviews. Consent renewals can be subject to actual water usage patterns, which for this catchment have been proven to be significantly less than the paper allocation. This approach can lower the individual consent holder and catchment allocation and free up unused water once the current allocation is below the regional default allocation through fully implementing mechanisms such as the sinking lid policy. The sinking lid policy aims to gradually reduce the catchment water allocation levels over time by preventing the transfer of existing water take consents, not replacing expired water take consents or reducing allocation levels during consent renewals. This approach aims to reduce overall water demand in response to declining water availability or increased pressure on the water resource, until sustainable catchment allocation levels or limits are reached.

Clawing back can be beneficial for both instream and out of stream water uses. On the one hand, by reducing the allocation levels of individual consents, this can free up some water for instream uses whilst, on the other hand, the clawed back water can become available for out-of-stream users, like new consent applicants, once the regional default allocation limits have been reached. This mechanism could be one of the most practical options for NRC in the interim for the Ōtaika catchment. Between the 2015/2016 and 2022/2023 water years, actual water use at the catchment level ranged from 36% to 49% of the current allocation, indicating that much of the consented water is not being used by consent holders. Although the PRPN currently does not explicitly give reference to clawing back mechanisms, it gives provision for reviewing consents and encouraging efficient use of water. The author is of the opinion that fair and defensible clawing back provisions can be incorporated into future plan changes by NRC.

With five surface water consents set to expire on May 31, 2026, NRC has an opportunity to reassess and potentially reduce consented volumes based on analyses of consent holders' average or maximum annual water use based on historical records. This approach ensures that consent holders' investments are not unduly disadvantaged, as the renewed consent limits would be based on their historical water use patterns.

Shortening of consent durations

Shortening consent durations is one strategy that can be implemented as part of water allocation reform. NRC might consider adopting this approach during the renewal process or for new consents to better manage the water allocation in fully and highly allocated catchments and meet the requirements of the NPS-FM.

An example is the Gisborne District Council that has started shortening the duration of most water take consents to five years to better manage fully allocated or over-allocated catchments (Gisborne District Council, 2022).

Water take consents common expiry date

This coordinated approach involves setting all water take consents within a specific catchment or region to expire on the same date. This practice enables a comprehensive and holistic review of the cumulative impacts of all water use activities in that catchment, considering the overall health of the water bodies and ecosystems. It ensures better and more sustainable management and allocation of water resources.

Promotion of water sharing strategies by consent holders

As part of water demand management, consent holders can be encouraged to stagger their water take times or abstract water at different times of the day. This approach helps to reduce the impact of multiple water takes occurring simultaneously.

Promotion of reduction of consented yet unused allocation

Consent holders who are not using their full water allocation can be encouraged to apply for a variation of conditions or consent volumes to sustainably and better manage water resources in the catchment. This strategy can be highly beneficial if there is reasonable uptake by consent holders, given that the study found that actual water use is, on average, below 50% of the consented water use.

Case Study: Gisborne District Council: Towards water allocation reform

Managing finite freshwater resources presents significant challenges for water resource managers. This issue is increasingly affecting many councils in New Zealand, as well as water authorities abroad, as more water resources reach or exceed their allocation limits.

Gisborne District Council (GDC) has implemented a strategy of granting most water take consents for a period of five years. This approach provides GDC with a platform to address water allocation challenges in various catchments. The following benefits have been realised through this strategy:

- it allows GDC to reduce the current allocation in fully allocated and over-allocated catchments.
- the consent holders' water use history, and current needs are considered during the renewal process. This enables GDC to claw back consented yet unused water, either to reduce over-allocation or to reallocate water to other potential consent holders on the waiting list.

Despite the administrative burden of shorter consent durations, this strategy allows GDC to progressively address the problems of full allocation and over-allocation. It also addresses the problem of consent holders retaining unused water, thereby preventing other potential consent holders from accessing water resources. (Gisborne District Council, 2020)

Scenario 3: High flow harvesting

High flow harvesting involves the abstraction of water during high flows from rivers or from high groundwater levels in unconfined shallow aquifers which is stored temporarily for later use (Booker and Rajanayaka, 2023). The key distinction with high flow harvesting is that water is not used immediately but stored for later use. This can be favourable for both instream water uses and security of supply in the sense that water is abstracted when streams are above the median flow. It is less likely to affect aquatic ecosystems, and the existing consented low flow takes. However, some modalities relating to practical implementation, consenting, monitoring and simplifying high-flow harvesting are still under investigation.

5. Assumptions and limitations

The following assumptions and limitations have been acknowledged in this study.

- Naturalisation of streamflow data was conducted using water use data from the 2015/2016 to 2022/2023 water years. NRC teams took steps to verify the water take data and address gaps. However, the author notes that this data covers a limited time period, and as more water use data becomes available, the naturalised flow statistics will improve. At the time of conducting the study, this was the best available water take data.
- PA takes were estimated based on livestock numbers from the census data and the estimated water needs per animal. Livestock numbers may have changed over the years meaning the amount of water needed for livestock watering would have subsequently changed. Since the registration of PA takes is not compulsory, the volumes abstracted may be underestimated. Additionally, some farmers have transitioned from PA takes to consents, which may have led to some double accounting. In the absence of a more accurate estimation of permitted takes, this is deemed to be the more conservative approach. There may be a need for a refinement of the PA takes estimates.
- NRC currently sets the minimum flows and allocation limits at stream or river reach levels using modelled flow data (Booker, 2012). For this assessment, the estimated minimum flows at the Ōtaika at Kay flow station stream reach are based on the observed flow data from the station.

6. Conclusions

The following conclusions have been drawn from the study

1. This assessment confirms that the Ōtaika catchment remains fully allocated, with the current allocation approximately at 95% of the 7-day MALF and 316% of the default regional limit. While the current allocation becomes the allocation limit for fully allocated catchments instead of the default regional allocation limit, this approach can have a high risk of causing more than minor hydrological impacts on instream values in the medium to long term. Moreover, it may not be consistent with the principles of Te Mana o te Wai which prioritise the health and well-being of freshwater ecosystems.

2. The Ōtaika catchment has a significant amount of consented but unused surface water. Actual surface water use at the catchment level ranged from 36% to 49% of the allocated amount, suggesting that a significant portion of the consented water remains unused. Therefore, the actual water use in the catchment is less severe than the paper allocation suggests, as the allocated amount is not being fully exercised.

3. The current water allocation regime presents a potential risk to the instream values especially during severe drought years. Consent holders' instantaneous rates of water takes were maintained even when the stream flows were very low for extended periods (below the 1 in 5-year 7-day flow). For years with shorter durations of sustained low flows, the potential risks of the impacts would have been less severe.

4. The PRPN does not specifically require the use of naturalised flows when setting minimum flows and allocation limits. However, incorporating naturalised flows is essential for sustainable water resources management, as it prevents setting such limits based on continuously declining flows.

5. The PA takes are currently based on estimates from the New Zealand Census and farm dairy effluent (FDE) data, rather than actual data. The PA takes may be underestimated.

6. The Ōtaika catchment is under considerable pressure in the headwater stream reaches, as most of the surface water take and all groundwater take consents are concentrated in the upper part of the catchment.

7. Most consents in the catchment only have the minimum flow limit, requiring consent holders to abruptly stop water abstraction without a reduction in the instantaneous rate and volume, leading to a sudden "cease to take" scenario once the threshold has been reached. This can have operational challenges for consent holders for example irrigators.

8. The setting and management of minimum flows is not consistently applied in the catchment. Whilst for some consents these are managed at the point of take, some are tied to the Ōtaika at Kay flow station and some consents do not have minimum flows conditions. This presents a challenge in the proper management of such minimum flows.

9. The catchment has a dam water take consent that does not have a take limit and the relevant dam low flow allocation methodology applied. This has potential adverse effects on the downstream ecology and the security of supply of downstream water users because the minimum flows, water takes, and storage are not appropriately taken into account.

10. The effects of the current water allocation regime on water quality could not be established using the current water quality monitoring system as the flow and water quality monitoring sites are in the lower reaches of the catchment and the water take points are mainly in the upper reaches of the catchment.

7. Recommendations

Based on the conclusions and lessons drawn from the study, the following recommendations may be considered by NRC.

1. Given that this catchment-specific assessment confirms the Ōtaika catchment remains fully allocated, NRC needs to explore strategies aimed at reducing water allocation levels in fully allocated catchments. NRC could consider incorporating mechanisms of reducing high current water allocation (towards the default allocation limits) during plan changes or during the renewal process of water take consents.
2. NRC should explore ways of fully implementing the efficient allocation policy to ensure that the volumes specified in the applications for water take consents or renewals are not overestimated and can be justified. An example is the irrigation sector where the actual use of consented water was very low for the catchment. Where proposed volumes exceed estimated irrigation requirements or historical usage data, consented volumes should be adjusted accordingly, based on a water allocation efficiency assessment.
3. To enhance the reporting and inclusion of PA takes in water quantity accounting, NRC must improve the estimation of such takes. Mechanisms like implementing mandatory registration of PA takes or requiring compulsory metering could possibly be used for accounting for PA takes in fully allocated catchments.
4. The "cease to take" condition is widely used to give effect to the minimum flows. The consistent incorporation of more proactive measures giving effect to the minimum flows and allocation limits include consent conditions that explicitly state stream flow rates upon which consent holders must reduce their instantaneous take rates and later on cease taking water respectively. The rate of water takes are reduced as the stream flow approaches the minimum flow limit to delay or totally avoid reaching the cease to take limit.
5. For dam water takes, it is necessary to consistently apply water take limits and the dam low flow allocation methodology to account for such takes.
6. NRC should consider promoting high flow harvesting as a strategic alternative to low flow allocation. This eases pressure on low flow allocation in fully and highly allocated catchments because water is captured during periods of high flow for later use, avoiding adverse impacts on aquatic ecosystems and security of supply of other water users during low flows.
7. NRC should naturalise stream flows at the flow recorder site levels and reassess naturalised stream flows on a regional scale to establish a foundation for sustainably managing minimum flow and allocation limits. Furthermore, it is essential to align this approach with plan changes, as the current plan does not refer to naturalised flows in setting limits.
8. NRC should strengthen compliance with the consent conditions related to the submission of water use records to support accurate analysis, assessments and informed decision making.
9. NRC should consider undertaking a more focused and specific flow and water quality investigation using adaptive monitoring within the catchment. This is important because most water takes are in the upper reaches of the catchment whilst flow and water quality monitoring are done in the lower reaches.
10. Future hydrological and water allocation assessments must take into account the latest climate change projections.
11. Since the study did not evaluate the impacts of the water allocation regime on freshwater values of Tāngata Whenua in the catchment, it is recommended that the findings be used in a cultural assessment on freshwater values of the impacted iwi/ hapū.

References

Aqualink Research Ltd (2010) Update of Water Allocation Data and Estimate of Actual Water Use of Consented Takes 2009 – 2010. Prepared for Ministry of Environment. Report No H10002/3, October 2010

Booker, D. Woods, R. and Franklin, P. (2012) Hydrological estimates for Northland. Northland Regional Council. NIWA Client Report No. CHC2012-096

Booker, D. and Rajanayaka, C. (2023) High-flow harvesting. Part 2: guidance for devising water allocation rules with examples from Northland and Gisborne. Prepared for AIA, GNS, NRC, GDC. NIWA Client Report 2023163CH

Bright, J., Daughney, C., Jackson, B., McDowell, R., Smith, R. and van Uitregt, B. (2022) Future Focused Freshwater Accounting. Prepared for Ministry for the Environment, ARL Report RD21011/1. Aqualinc Research Limited.

Brown, C.A. and King, J.M. (2006) implications of Upstream Water Uses on Downstream Ecosystems and Livelihoods *International Journal of Ecology and Environmental Sciences.* 32 (1) 99 – 108

Cameron, S., Osbaldiston, S., Skuse, G. and Revfem, C. (2001): Northland. *In* Groundwaters of New Zealand, M.R. Rosen and P.A. White *(eds)* New Zealand Hydrological Society Inc., Wellington. P291 – 302

Dennis, I., Witthüser, K., Vivier, K., Dennis, R. and Mavurayi, A. (2012) *Groundwater Resources Directed Measures* WRC Report TT506/12 Water Research Commission, Pretoria.

Environmental Agency and Ofwat, (2011). The case for change – reforming water abstraction in England. Report GEHO1111BVEQ-E-E

Franklin, P., Temple, A., and Smith, J. (2014) Ecological flow requirements in the Otaika catchment. Prepared for Northland Regional Council. NIWA Client Report No: HAM2014-042

Franklin, P. (2024) Review of Northland's proposed water resource use limits. Prepared for Northland Regional Council

Gisborne District Council, (2020) STATE OF OUR ENVIRONMENT 2020. TE ĀHUATANGA O TE TAIAO

Gray, W. (2003) Overview of weather and coastal hazards in the Northland region. Part I: Weather hazards. Prepared for the Northland Regional Council.

Hayes, J., Booker, D., Singh, S., Franklin, P.A. (2021) Default minimum flow and allocation limits for Otago. *Cawthron Memo* CAL2157, 19p.

IRIS (2024) *AUT.000964.01.03 Whangarei District Council - Public water take supply, Newton Road, Maunu* Available on https://irisprod.nrc.govt.nz/AuthorisationDetails.aspx?AuthorisationID=20873#

Landscape DNA, (2024) *Physiographics Environments.* Available on https://landscapedna.org/maps/physiographic-environments/family/ Accessed on 29 May 2024

Manaaki Whenua Landcare Research (2020) *LCDB v5.0 - Land Cover Database version 5.0, Mainland, New Zealand*. Available from https://lris.scinfo.org.nz/layer/104400-lcdb-v50-land-cover-database-version-50-mainland-new-zealand/

Ministry for the Environment (2023) National Policy Statement for Freshwater Management 2020. February 2023.

Ministry for the Environment (2020) Mahinga kai and other Māori freshwater values factsheet. Available on https://environment.govt.nz/assets/Publications/Files/FS16-Mahinga-kai-and-other-Maori-freshwater-values-factsheet-final.pdf Publication number: INFO 999

NIWA (2019) New Zealand Climate Summary: Summer 2018-19. New Zealand's 3rd-warmest summer on record. Issued 5 March 2019

NIWA (2020) New Zealand Climate Summary: Summer 2019-20. Flooding in the south; drought in the north. Issued 4 March 2020

NIWA (2021) Aotearoa New Zealand Climate Summary: Summer 2020-21. Dry for much of the country, near average temperatures. Issued 4 March 2021

Northland Regional Council (2023) Proposed Regional Plan for Northland. Northland Regional Council February 2024

NRC (2018) *IRIS site datasets* Available on https://nrcmaps.nrc.govt.nz/portal/home/item.html?id=491a629abdf749a1aa973aaac506c1a6

NRC (2021a) *Fundamental Soils* Available on https://nrcmaps.nrc.govt.nz/portal/home/item.html?id=ab48514c48f9497b9c25d2ba019614b4

NRC (2021b) *Physiographics reference Layer* Available on https://nrcmaps.nrc.govt.nz/portal/home/item.html?id=727f5add98c04e3e8ccce1712b4c2b04

NRC (2022a) *Main Northland Aquifers* Available on https://nrcmaps.nrc.govt.nz/portal/home/item.html?id=9280e03f91f64dd19ae54160a172ea34

NRC (2022b) *Priority Rivers Catchment* Available on https://nrcmaps.nrc.govt.nz/portal/home/item.html?id=9280e03f91f64dd19ae54160a172ea34

NRC (2024a) *IRIS Authorisations – Resource Consents* Available on https://nrcmaps.nrc.govt.nz/portal/home/item.html?id=b2f4d0784f914c89a82208ae36651307

NRC (2024b) *IRIS Authorisations – Permitted Activities* Available on https://nrcmaps.nrc.govt.nz/portal/home/item.html?id=b0fc1a4145d148fb972c41aa6937d7a8

Franklin, P., Temple, A. and Smith J. (2014) Ecological flow requirements in the Ōtaika catchment Prepared for the Northland Regional Council

Osbaldiston, S. (2020) Updated approach used to determine freshwater allocation in Northland. Freshwater quantity accounting system. Northland Regional Council

Nilsson, C. and Renöfält, B.M. (2008) Linking flow regime and water quality in rivers: a challenge to adaptive catchment management. *Ecology and Society*. 13(2). pp18.

Pham, H.X. and Donaghy, J. (2017) Northland drought assessment using Standard Precipitation Index. Northland Regional Council

Pham H., Kitto S., Ruehle B., Delport C., Perquin J.C. and Naidu, R. (2022). Northland drought 2018-2020 assessment. Northland Regional Council, Whangārei, New Zealand 0110. Report No: TR2022/SWQty/01

Resource Management (Measurement and Reporting of Water Takes) Regulations 2010

Rissmann, C., and Pearson, L. (2020). Physiographic Controls over Water Quality State for the Northland Region. Land and Water Science Report 2020/05. p149.

Roke, D.L. and Mc Lellan, C.H. (1983) The Water Resources of the Maunu – Maungatāpere - Whatitīri Area. Water Resources Report No 5. Prepared by the Northland Catchment Commission and Regional Water Board.

Ruralco (2023) *Northern paradise an export earner* Available on https://www.ruralco.co.nz/About-Us/Latest-Ruralco-News/Latest-News/ArticleID/365/Northern-paradise-an-export-earner Accessed on 2 July 2024

Saveninje, H.H.G. and van der Zaag, P. (2020) Water Value Flows Upstream. *Water* 12 (2642) 1 – 11

Sinclair Knight Mertz (2010) Maunu – Maungatāpere – Whatitīri Basalt Aquifers Sustainable Yield Assessment. Report Prepared for the Northland Regional Council

Sinclair Knight Mertz (2011) Rainfall-Runoff Modelling Pilot Study – Ōtaika Stream. Report Prepared for the Northland Regional Council

Sinclair Knight Mertz (2012) Groundwater/Surface Water Integrated Management. Maunu – Maungatāpere – Whatitīri Basalt Aquifers. Report Prepared for the Northland Regional Council

Sinokrot, B. A. and Gulliver, J.S. (2000) In-stream flow impact on river water temperatures. *Journal of Hydraulic Research.* 38 (5) pp 339-349

Smakhtin, V.U. (2001) Low flow hydrology: a review. *Journal of Hydrology* 240 pp 147 - 186

Soga, M. and Gaston, K.J. (2018) Shifting baseline syndrome: causes, consequences and implications. *Frontiers in Ecology and the Environment*. 16 (4) pp 222 - 230

Sungu, R.O. (2018) An Assessment of the influence of Water Allocation on Sustainable Water Resources Management: A Case Study of the Nyando River Basin, Kenya. [Doctoral Thesis, University of the Western Cape]. UWC Scholar ETD Repository https://etd.uwc.ac.za/handle/11394/7048

Tabarmayeh, M., Zarei, M. and Batelaan, O. (2022) A new approach to quantification of groundwater resource stress. *Journal of Hydrology: Regional Studies*. 42 (2022) pp 1 - 15

Terrier, M., Perrin, C., de Lavenne, A., Andréassian, V., Lerat, J., and Vaze, J. (2021) Streamflow naturalization methods: a review. *Hydrological Sciences Journal*. 66 (1), pp.12-36.

The Water Management Group (2016) Maunu – Maungatāpere – Whatitīri Sustainable Aquifer Yield Assessment. Prepared for the Northland Regional Council

White, J. C., Khamis, K., Dugdale, S., Jackson, F. L., Malcolm, I. A., Krause, S., & Hannah, D. M. (2023). Drought impacts on river water temperature: A process-based understanding from temperate climates. *Hydrological Processes*, 37 (10), e14958. https://doi.org/10.1002/hyp.14958

White, P.J. and Perrin, N.D. (2003) Geology of the Whangārei urban area. Scale 1:25 000. Institute of Geological & nuclear Sciences Ltd

Williamson Water and Land Advisory (2019) Growing Avocado. Ngā Mahi a Wai Māori Northland Water Storage and Use Project. Available on https://www.nrc.govt.nz/media/fycf0yie/03-avocado-info-sheet-pdf.pdf Accessed on 2 July 2024

Young, R.G. and Hay, J. (2017). A framework for setting water allocation limits and minimum flows for the Takaka Water Management Area, and an assessment of the geological contribution to the nitrogen load to Te Waikoropupū. Prepared for Tasman District Council. Cawthron Report No. 2977

Appendices

Appendix 1: Data Inventory of reports, studies, and projects

Report/Project title	Description	Location where data / report is stored	Keywords	Author	Data/Report custodian / Owner	Scope of project / study	Resource type	Format	Date published / modified	Data size	Rights & restrictions
Ecological flow requirements in the Ōtaika catchment	An assessment of the fish types and the effects of the variations in flows minimum flows and variations in flows on habitats	Sharepoint / Website	Ecological flow requirements Ōtaika catchment Instream habitat fish	NIWA, NRC	NRC	Northland Region	Final Report	PDF	20-May-2014	2 MB	No restrictions
Maunu - Maungatāpere - Whatitiri Sustainable Aquifer Yield Assessment	Updated groundwater flow model and recommended sustainable aquifer yield for the Maunu – Maungatāpere - Whatitiri groundwater system	Sharepoint / Website	Aquifer Assessment Aquifer yield Groundwater system	The Water Management Group	NRC	Maunu - Maungatāpere - Whatitīri groundwater system	Final Report	PDF	Oct-2016	8MB	No restrictions
Groundwater / Surface Water Integrated Management. Maunu - Maungatāpere - Whatitiri Basalt Aquifer	An assessment of the groundwater – surface water interaction of the Maunu - Maungatāpere - Whatitiri Basalt Aquifer based on the stream depletion methods	Sharepoint / Website	Basalt aquifer Groundwater – surface water interaction Stream depletion methods	Sinclair Knight Merz	NRC	Maunu - Maungatāpere - Whatitīri groundwater system	Final Report	PDF	Feb-2012	970 KB	No restrictions

Report/Project title	Description	Location where data / report is stored	Keywords	Author	Data/Report custodian / Owner	Scope of project / study	Resource type	Format	Date published / modified	Data size	Rights & restrictions
The Water Resources of the Maunu – Maungatāpere - Whatitiri Area	An assessment of the water resources situation in the Maunu – Maungatāpere - Whatitiri area	Sharepoint	Water resources Maunu Maungatāpere Whatitiri	Northland Catchment Commission, Regional Water Board	NRC	Maunu – Maungatāpere – Whatitīri Area	Report	PDF	1983	3 MB	No restrictions
Northland Regional Council Applications for Resource Consents	Applications for new and renewal of resource consents received by the Northland Regional Council	Sharepoint	Resource consents	NRC	NRC	Northland Region	Report	PDF	02-Nov-1993	78 KB	Consideration of LGOIMA request
Standard Conditions Applying Where Relevant to all Permits	Submission with resource consent conditions to the applicant (Golden Bay Cement) and its consultant (Woodward Clyde)	Sharepoint	Conditions Consents Ōtaika Stream Golden Bay Cement Company	NRC	NRC	Ōtaika Stream	Consent Addendum (via Facsimile)	PDF	09-May-1994	606KB	Consideration of LGOIMA request
Standard Conditions Applying Where Relevant to all Permits	Submission with resource consent conditions to the applicant (Golden Bay Cement	Sharepoint	Conditions Consents Ōtaika Stream Golden Bay Cement Company	NRC	NRC	Golden Bay Cement site	Consent Addendum (via Facsimile)	PDF	07-Jun-1994	656KB	Consideration of LGOIMA request
Final Draft Consent Wordings	Final draft consent wordings for perusal by the applicant	Sharepoint	Consent Golden Bay Cement Company	NRC	NRC	Ōtaika catchment	Consent Addendum (via Facsimile)	PDF	24-Jun-1994	2.4 MB	NRC employees
Draft Recommendations	Draft conditions for the resource consent for Golden Bay Cement Company	Sharepoint	Recommendations Golden Bay Cement Company	NRC	NRC	Golden Bay Cement Site and water take points	Consent Addendum	PDF		100 KB	NRC employees

Report/Project title	Description	Location where data / report is stored	Keywords	Author	Data/Report custodian / Owner	Scope of project / study	Resource type	Format	Date published / modified	Data size	Rights & restrictions
Resource Consent	Resource Consent for the Golden Bay Cement Company	Sharepoint	Resource Consent Golden Bay Cement Company	NRC	NRC	Golden Bay Cement Site and water take points	Resource Consent	PDF	05-Dec-1994	648 KB	No limitation
Resource Consent	Resource Consent for the Golden Bay Cement Company	Sharepoint	Resource Consent Golden Bay Cement Company	NRC	NRC	Golden Bay Cement Site and water take points	Resource Consent	PDF	21-Feb-1995	7.98 MB	No limitation
Ōtaika for Whangārei Harbour Project	An assessment of the Ōtaika water resources	Sharepoint	Ōtaika catchment Water resources	NRC	NRC	Ōtaika catchment	Summary	MS Word	Aug-2013	112 KB	Consideration of LGOIMA request
Staff Report and Draft Recommendations for Water Right Application 2829: Rural Bank and Finance Corp and others and Water Right Application 4734: CB Faber	A summary of the assessment of the 2 applications for water rights.	Sharepoint	Water right Tributary of Ōtaika stream	NRC	NRC	Tributary of Ōtaika catchment	Report	PDF		144 KB	Consideration of LGOIMA request
Portland Cement Works: Summary of Assessment of Environmental Effects for resource Management Consents	A summarised assessment of the proposed activities to be applied for in resource consents, potential environmental consequences and mitigation measures.	Sharepoint	Environmental Effects Portland Cement Works	Golden Bay Cement	Golden Bay Cement	Golden Bay Cement site	Report	PDF		1 MB	Golden Bay Cement, Northland Regional Council – Consideration of LGOIMA request
Applications for resource consents for various	Statement of submission in response to the	Sharepoint	Statement of submission	Department of Conservation Northland	DoC Northland	Golden Bay Cement Site	Memorandum	PDF	30-Nov-1993	264 KB	Consideration of LGOIMA request

Report/Project title	Description	Location where data / report is stored	Keywords	Author	Data/Report custodian / Owner	Scope of project / study	Resource type	Format	Date published / modified	Data size	Rights & restrictions
activities by Golden Bay Cement Company	application for various consents by golden Bay Cement		Department of Conservation Resource consents Golden Bay Cement Ōtaika stream								
Fish Passage Issues at the Ōtaika Weir	An analysis of the impacts of the Ōtaika weir on fish and possible mitigatory measures	Sharepoint	Fish passage Ōtaika weir Golden Bay Cement	Charles Mitchell & Associates	Golden Bay Cement	Ōtaika River weir	Report	PDF	Dec-1993	3MB	Golden Bay Cement Northland Regional Council - Consideration of LGOIMA request
Fish Passage Issues at the Ōtaika Weir	An analysis of the impacts of the Ōtaika weir on fish and possible mitigatory measures	Sharepoint	Fish passage Ōtaika weir Golden Bay Cement	Charles Mitchell & Associates	Golden Bay Cement	Ōtaika River weir	Facsimile with Report	PDF	22-Feb-1994	631 KB	Golden Bay Cement Northland Regional Council - Consideration of LGOIMA request
Ōtaika River Fish Pass and Portland Boat Ramps	Submission to evaluate to effects of the Ōtaika stream weir and boat ramps on fish in response to consent applications	Sharepoint	Ōtaika River Fish pass Boat ramps	DoC	DoC	Ōtaika River	Letter	PDF	16-Feb-1994	84KB	Department of Conservation Northland Regional Council
A Monitoring Program to Examine the Effectiveness of	Report outlining the assessment of the effectiveness of the proposed	Sharepoint	Monitoring Program Fish pass	Charles Mitchell & Associates	Golden Bay Cement	Ōtaika Stream Weir	Report (via Facsimile)	PDF	22-Jun-1994	560KB	Golden Bay Cement Northland Regional

Report/Project title	Description	Location where data / report is stored	Keywords	Author	Data/Report custodian / Owner	Scope of project / study	Resource type	Format	Date published / modified	Data size	Rights & restrictions
the Fishpass on the Ōtaika Stream Weir	fishpass at the Ōtaika weir		Ōtaika Stream Weir Golden Bay Cement Company								Council - Consideration of LGOIMA request
Legal Descriptions of properties related to the resource consents	Legal Descriptions (by the consent applicant) of properties related to the resource consents	Sharepoint	Legal descriptions Golden Bay Cement Company	Golden Bay Cement	Golden Bay Cement	Ōtaika catchment	Facsimile	PDF	27-Jun-1994	192KB	Golden Bay Cement Northland Regional Council - Consideration of LGOIMA request
Golden Bay Cement – Resource Consent Application	Responses by the applicant to concerns and recommendations raised by the Department of Conservation Northland and Northland Regional Council	Sharepoint	Resource consent application Golden Bay Cement	Golden Bay Cement	NRC	Golden Bay Cement Site and resource consent points	Letters	PDF		795 KB	Golden Bay Cement Northland Regional Council - Consideration of LGOIMA request
Sampling of Groundwater, South Terrace	Results of groundwater sampling conducted at the Golden Bay Cement Company	Sharepoint	Groundwater sampling Golden Bay Cement Company	Woodward – Clyde Engineering & Environmental Consultants	Golden Bay Cement	Golden Bay Cement South Terrace	Letter	PDF	11-Dec-1995	37 KB	Golden Bay Cement
Inspection and monitoring of the fish pass at Ōtaika Weir, March 1996	An evaluation of the effectiveness of the fish pass at the Ōtaika weir.	Sharepoint	Ōtaika Stream Weir Fish pass Golden Bay Cement Company	Charles Mitchell & Associates	Golden Bay Cement	Ōtaika Stream Weir	Report	PDF	Apr-1996	393 KB	Golden Bay Cement

Report/Project title	Description	Location where data / report is stored	Keywords	Author	Data/Report custodian / Owner	Scope of project / study	Resource type	Format	Date published / modified	Data size	Rights & restrictions
Ōtaika Stream Water Pumping Record	A time series record of the pumping rates from the Ōtaika Stream by the Golden Bay Cement Company	Sharepoint	Pumping record Ōtaika Stream Golden Bay Cement Company	Golden Bay Cement	Golden Bay Cement	Golden Bay Cement water take point	Pumping records (table)	PDF	24-Mar-1997	495 KB	Golden Bay Cement Northland Regional Council - Consideration of LGOIMA request
Groundwater Sampling at Golden Bay Cement	Results of groundwater sampling conducted at the Golden Bay Cement Company on 17 December 1997	Sharepoint	Groundwater quality sampling Golden Bay Cement Company	Golden Bay Cement	Golden Bay Cement	Golden Bay Cement water take point	Letter with groundwater quality results	PDF	19-Jan-1998	392 KB	Golden Bay Cement Northland Regional Council - Consideration of LGOIMA request
Rainfall-Runoff Modelling Pilot Study – Ōtaika Stream	Rainfall -Runoff Modelling Pilot Study – Ōtaika Stream	Sharepoint	Rainfall-runoff modelling Ōtaika catchment	Sinclair Knight Merz	NRC	Ōtaika catchment	Report	PDF	13-May-2011	8.6 MB	No restrictions
Annex 1: Discharge to Water (Stormwater)	Annex covering the Discharge of stormwater in a water resource by Golden Bay Cement	Sharepoint	Discharge to Water (Stormwater)	Unknown	NRC	Golden Bay Cement Portland site	Annexure to Resource Consent application	PDF		67 KB	Golden Bay Cement Northland Regional Council - Consideration of LGOIMA request
Annex 2: Discharge to Water (Plant Water)	Annex covering the Discharge of reclaimed plant water into the Whangārei Harbour by	Sharepoint	Discharge of plant water Whangārei Harbour	Unknown	NRC	Whangārei Harbour	Annexure to Resource Consent application	PDF		26 KB	Golden Bay Cement, Northland Regional Council

Report/Project title	Description	Location where data / report is stored	Keywords	Author	Data/Report custodian / Owner	Scope of project / study	Resource type	Format	Date published / modified	Data size	Rights & restrictions
	Golden Bay Cement										
Annex 3: Discharge to Ground and/or Water (South Terrace)	Annex covering a consent application for the disposal of waste around the South Terrace and Tokitoki Creek	Sharepoint	Disposal of waste Tokitoki Creek Whangārei Harbour	Unknown	NRC	Golden Bay Cement South Terrace and Tokitoki Creek	Annexure to Resource Consent application	PDF		39 KB	Golden Bay Cement Northland Regional Council - Consideration of LGOIMA request
Annex 5: Water Permit to Take Water from Ōtaika Stream	Annex covering a Water Permit application for taking water from the Ōtaika Stream	Sharepoint	Water take Ōtaika Stream	Unknown	NRC	Ōtaika catchment	Annexure to Resource Consent application	PDF		24 KB	Golden Bay Cement Northland Regional Council - Consideration of LGOIMA request
Annex 6: Water Permit to Take Water from On-Site Well	Annex covering Water permit application for taking water from a borehole within the vicinity of the Golden Bay Cement Portland site	Sharepoint	Abstraction of groundwater Golden Bay Portland Cement site	Unknown	NRC	Golden Bay Cement Portland site	Annexure to Resource Consent application	PDF		10 KB	Golden Bay Cement Northland Regional Council - Consideration of LGOIMA request
Annex 7: Resource Consent to Take Groundwater by way of Drainage Sumps	Annex covering a Resource consent application related to the abstraction of groundwater using drainage sumps	Sharepoint	Abstraction of groundwater Drainage sumps Golden Bay Portland Cement site	Unknown	NRC	Golden Bay Cement Portland site	Annexure to Resource Consent application	PDF		9 KB	Golden Bay Cement Northland Regional Council - Consideration of LGOIMA request

Report/Project title	Description	Location where data / report is stored	Keywords	Author	Data/Report custodian / Owner	Scope of project / study	Resource type	Format	Date published / modified	Data size	Rights & restrictions
Consents within the Ōtaika catchment	A brief overview of the consented water takes in the Ōtaika catchment	Sharepoint	Water take consents Ōtaika catchment	NRC	NRC	Ōtaika catchment	NRC Internal Memo	Word	15-Jul-2014	4 MB	Consideration of LGOIMA request

Appendix 2: Data Inventory of GIS data available for the Ōtaika catchment

Category of Spatial Data set	Title of Spatial Data set	Name of Dataset in GIS Workspace	Source of Dataset	Format	Location where spatial data is stored	Rights & restrictions
Surface water, Hydrology and Wetlands	Hydrology sites	• Surface water level • Groundwater level • Rainfall	NRC	ArcGIS Map Service	NRC GIS Portal	No restrictions
Surface water, Hydrology and Wetlands	Water Resources	• Water Catchments • Priority River Catchments • REC Catchments • REC River Class • Main Northland Aquifers	NRC	ArcGIS Map Service	NRC GIS Portal	No restrictions
Surface water, Hydrology and Wetlands	Digital River Network Catchments	• Digital River Network Catchments • DRN Hydro Catchments	Water Technology Pty Ltd	ArcGIS Map Service	NRC GIS Portal	No restrictions
Surface water, Hydrology and Wetlands	REC River Class	• REC River Class	NIWA	ArcGIS Map Service	NRC Portal	No restrictions
Surface water, Hydrology and Wetlands	Freshwater Management Units	• Catchment Name	Land Water People	ArcGIS Map Service	NRC Portal	Consideration of LGOIMA request
Surface water, Hydrology and Wetlands	Flow Gauge Historic	• Flow Gauge Historic	NRC	ArcGIS Map Service	NRC Portal	Consideration of LGOIMA request
Surface water, Hydrology and Wetlands	Water Catchments	• Water Catchments	NRC	ArcGIS Map Service	NRC Portal	Consideration of LGOIMA request
Surface water, Hydrology and Wetlands	Hydrological Modelled Catchments 2022	• Hydrological Modelled Catchments 2022	NRC	ArcGIS Map Service	NRC Portal	Consideration of LGOIMA request
Surface water, Hydrology and Wetlands	Physiographics – Hydrological	• H-PAL: Lateral Drainage • H-PAL: Artificial Drainage • H-PAL: Artificial Drainage ONLY • H-PAL: Deep Drainage • H-PAL: Overland Flow • H-PAL: Domain	Land and Water Science Ltd	ArcGIS Map Service	NRC Portal	No restrictions

Category of Spatial Data set	Title of Spatial Data set	Name of Dataset in GIS Workspace	Source of Dataset	Format	Location where spatial data is stored	Rights & restrictions
Surface water, Hydrology and Wetlands	Wetlands	• Heathland • Known Wetlands • Top 150 • Saltmarsh and Mangrove	NRC	ArcGIS Map Service	NRC Portal	No restrictions
Geology and Hydrogeology	Physiographics - Reference Layers	• Simple Landcover • Ground Reduction Potential	Land and Water Science Ltd	ArcGIS Map Service	NRC Portal	No restrictions
Geology and Hydrogeology	Fundamental Soils	• Fundamental Soils	Landcare Research New Zealand	ArcGIS Map Service	NRC Portal	No restrictions
Geology and Hydrogeology	NZ Hydrogeological System Polygon 20231115	• NZ Hydrogeological System Polygon 20231115	Institute of Geological and Nuclear Sciences Limited (GNS)	Shapefile Feature Class	GNS website	No restrictions
Geology and Hydrogeology	Main Northland Aquifers	• Main Northland Aquifers	NRC	ArcGIS Map Service	NRC Portal	No restrictions
Geology and Hydrogeology	At Risk Aquifers	• At Risk Aquifers	NRC	ArcGIS Map Service	NRC Portal	No restrictions
Geology and Hydrogeology	Physiographics – Reference Layers	• Simple Landuse • QMAP – Groundwater Reduction Potential	Land and Water Science Ltd	ArcGIS Map Service	NRC Portal	No restrictions
Geology and Hydrogeology	NZ QMAP Geology	• GNS Geological Map of New Zealand (QMAP) • Geological Units • Faults	Institute of Geological and Nuclear Sciences Limited (GNS)	ArcGIS Map Service	GNS Website	No restrictions
Authorisations and Consents	Permitted Activity (Point)	• Water Permit	NRC	ArcGIS Map Service	NRC Portal	Consideration of LGOIMA request
Authorisations and Consents	IRIS Authorisations_Resource Consent	• RC Water Take • RC Inactive • RC Bore Consent • RC Water Permit	NRC	ArcGIS Map Service	NRC Portal	No restriction
Authorisations and Consents	Water Allocation Tool – Surface Water (Latest Run)	• Groundwater Consents (m^3/yr)	NRC	ArcGIS Map Service Web Based	NRC Portal	No restrictions

Category of Spatial Data set	Title of Spatial Data set	Name of Dataset in GIS Workspace	Source of Dataset	Format	Location where spatial data is stored	Rights & restrictions
		• Indicative River Allocation • Potential Allocation Restrictions – surface water impact • Groundwater Units Percent Allocation Without Cross Boundary				
Authorisations and Consents	Water Allocation Tool – Groundwater (Latest Run)	• Water Take Consents (L/Sec) • Total Surface Water Consent Accumulation • Min Flow Accumulation • SW Zones Percent Allocation (Sub catchments) • SW Zones Percent Allocation (Catchments)	NRC	ArcGIS Map Service Web Based	NRC Portal	No restrictions

Appendix 3: Surface water and dam water take consents for the Ōtaika catchment

Number	IRIS ID	Activity Type	Water Resource	Purpose	Consent Expires	Status	Net Take (L/s)	Authorised Volume (m^3/yr)
1	AUT.007213.02.02	Resource Consent (Water Take)	Dam Water Take	Irrigation - Arable crops	31-05-2026	Current	6.6	2,409
2	AUT.000964.01.03	Resource Consent (Water Take)	Surface Water Take	Drinking - Public Water Supply	31-05-2045	Current	94.4	2,978,979
3	AUT.004000.01.04	Resource Consent (Water Take)	Surface Water Take	Irrigation - Horticulture	31-05-2049	Current	0.64	6,700
4	AUT.002829.01.04	Resource Consent (Water Take)	Surface Water Take	Irrigation – Horticulture	31-05-2026	Current	3.09	97,455
5	AUT.007324.02.03	Resource Consent (Water Take)	Surface Water Take	Irrigation – Horticulture	31-05-2026	Current	3.47	109,575
6	AUT.002343.01.04	Resource Consent (Water Take)	Surface Water Take	Irrigation – Horticulture	30-06-2035	Current	0.17	5,400
7	AUT.005059.01.04	Resource Consent (Water Take)	Surface Water Take	Industrial - Cement/Concrete Manufacture	31-05-2046	Current	10.53	332,150
8	AUT.002406.01.04	Resource Consent (Water Take)	Surface Water Take	Irrigation – Horticulture	31-05-2026	Current	4.05	42,000
9	AUT.029769.01.01	Resource Consent (Water Take)	Surface Water Take	Irrigation – Floriculture	31-05-2026	Current	0.93	20,000

Appendix 4: Groundwater Take Consents for the Ōtaika catchment

Number	IRIS ID	Activity Type	Water Resource	Purpose	Consent Expires	Status	Net Take (L/s)	Authorised Volume (m^3/yr)	Streamflow Depletion Factor
1	AUT.011708.01.02	Resource Consent (Water Take)	Ground Water Take	Irrigation - Horticulture	31-05-2035	Current	0.38	6,240	0.00
2	AUT.003971.01.05	Resource Consent (Water Take)	Ground Water Take	Irrigation - Horticulture	31-05-2050	Current	0.1	1,500	0.12
3	AUT.003318.01.04	Resource Consent (Water Take)	Ground Water Take	Irrigation - Horticulture	31-05-2035	Current	0.2	4,800	0.17
4	AUT.013279.01.02	Resource Consent (Water Take)	Ground Water Take	Irrigation - Horticulture	31-05-2040	Current	0.35	6,240	0.34
5	AUT.008665.01.03	Resource Consent (Water Take)	Ground Water Take	Irrigation – Horticulture & domestic	31-05-2035	Current	0.4	6,240	0.37
6	AUT.024976.01.01	Resource Consent (Water Take)	Ground Water Take	Irrigation – Horticulture	31-05-2025	Current	0.17	2,000	0.17
7	AUT.003499.01.04	Resource Consent (Water Take)	Ground Water Take	Irrigation – Horticulture	30-06-2026	Current	0.5	7,000	0.48
8	AUT.011387.01.02	Resource Consent (Water Take)	Ground Water Take	Irrigation	31-05-2026	Current	0.69	5,200	0.65
9	AUT.007400.01.03	Resource Consent (Water Take)	Ground Water Take	Irrigation – Horticulture	31-05-2035	Current	0.3	3,000	0.34
10	AUT.038736.01.01	Resource Consent (Water Take)	Ground Water Take	Irrigation – Horticulture & domestic	31-05-2026	Current	0.4	5,000	

Appendix 5: Registered Permitted Activity Takes for the Ōtaika catchment

Number	IRIS ID	Date Registered	Take rate (L/s)	Authorised Volume (m^3/yr)	Purpose of Take
1	AUT.010113.01.01	19-May-2013	0.12	3,650	River for stock drinking and wash down
2	AUT.010122.01.01	27-Sep-2013	0.10	37	River for stock drinking
3	AUT.010123.01.01	19-May-2013	0.03	1,095	River for stock drinking, irrigation and domestic use
4	AUT.010124.01.01	27-Sep-2013	0.12	3,650	River for stock drinking
5	AUT.010126.01.01	27-Sep-2013	0.07	26	Summer stock drinking
6	AUT.010127.01.01	27-Sep-2013	0.06	1,825	River for household use
7	AUT.010128.01.01	27-Sep-2013	~ 0.0003	12	River for stock drinking
8	AUT.010129.01.01	06-Mar-2014	0.10	365	River for household use
9	AUT.010130.01.01	27-Sep-2013	~ 0.003	102	River for household and vegetable use
10	AUT.010131.01.01	27-Sep-2013	0.12	3,650	River for stock drinking
11	AUT.010132.01.01	27-Sep-2013	0.30	803	River for irrigation and stock drinking
12	AUT.010133.01.01	27-Sep-2013	0.02	730	River for stock drinking
13	AUT.010134.01.01	27-Sep-2013	0.01	365	River for stock drinking
14	AUT.010135.01.01	27-Sep-2013	0.01	365	River for stock drinking
15	AUT.010136.01.01	27-Sep-2013	0.01	365	River for stock drinking
16	AUT.010137.01.01	27-Sep-2013	0.12	3,650	River for household and stock drinking purposes
17	AUT.010140.01.01	27-Sep-2013	0.02	821	River for household and stock drinking purposes
18	AUT.010141.01.01	27-Sep-2013	0.12	3,650	Irrigation of flowers and vegetables in summer

Number	IRIS ID	Date Registered	Take rate (L/s)	Authorised Volume (m^3/yr)	Purpose of Take
19	AUT.010145.01.01	27-Sep-2013	0.19	5,840	River for household and stock drinking purposes
20	AUT.010146.01.01	27-Sep-2013	0.01	164	Stock drinking
21	AUT.010147.01.01	27-Sep-2013	0.12	3,650	River for household and stock drinking purposes
22	AUT.010148.01.01	27-Sep-2013	0.03	913	River for stock drinking
23	AUT.010149.01.01	27-Sep-2013	0.12	3,650	River for stock drinking
24	AUT.010150.01.01	27-Sep-2013	0.02	730	River for household and stock drinking purposes
25	AUT.010151.01.01	27-Sep-2013	0.5	183	River for household use
26	AUT.010152.01.01	27-Sep-2013	0.01	730	River for stock drinking
27	AUT.010154.01.01	27-Sep-2013	0.06	1,825	River for stock drinking and irrigation
28	AUT.010155.01.01	27-Sep-2013	0.03	1,095	River for stock drinking and irrigation
29	AUT.010158.01.01	27-Sep-2013	0.003	110	River for household and stock drinking purposes
30	AUT.010169.01.01	27-Sep-2013	0.06	1,825	River for stock drinking and irrigation
31	AUT.010170.01.01	27-Sep-2013	0.02	730	River for stock drinking
32	AUT.010171.01.01	27-Sep-2013	0.06	1,825	River for stock drinking and irrigation
33	AUT.010172.01.01	27-Sep-2013	0.12	3,650	
34	AUT.010174.01.01	27-Sep-2013	0.12	3,650	River for stock drinking
35	AUT.010175.01.01	27-Sep-2013	0.02	548	River for household and stock drinking purposes
36	AUT.010176.01.01	27-Sep-2013	0.03	1,095	River for household use
37	AUT.010177.01.01	27-Sep-2013			River for household and irrigation

Number	IRIS ID	Date Registered	Take rate (L/s)	Authorised Volume (m^3/yr)	Purpose of Take
38	AUT.010159.01.01	27-Sep-2013	0.09	2,920	River for irrigation and stick drinking

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