Pukepuke Lagoon

A summarising of reports and monitoring history

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horizons
REGIONAL COUNCIL

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Background

Pukepuke Lagoon is a shallow (max 1.3m depth, 18 ha area) aeolian[1] dune lake in the Himatangi area. The Horizons Regional Council (HRC) Regional Plan (One Plan) breaks surface water catchments into water management zones and subzones. The Pukepuke Lagoon sits within the Northern Manawatu Lakes (West_6) subzone, along with Lake Kaikokopu, Omanuka Lagoon, Lake Koputara, and several other small unnamed waterbodies. West_6 has identified area-wide values of a lowland sand life-supporting capacity, aesthetics, contact recreation, mauri, industrial abstraction, irrigation, stock water, existing infrastructure and the capacity to assimilate pollution; the site-specific value of whitebait migration apply on Four Mile Creek, which is the main outlet from the lagoon.

Pukepuke lagoon is characterised by a large dune lake surrounded by raupō reedland and tī kōuka/harakeke tree/flaxland. Woody vegetation around the wetland's margin is comprised of small stands of crack willow, hukihuki/swamp coprosma and toetoe. Along the northern boundary lies a narrow shelterbelt of oak trees, while patches of blackberry can be found all along the wetland boundary.

There is a drain along the lake's northern perimeter that leads to two westward outlets. One outlet contains a weir constructed from railway sleepers and concrete bollards, with an effective fish passage constructed from gradually sloping rocks. The second outlet is a concrete ford that acts as an overflow for when the weir is overtopped. Both outlets reconvene in the same outlet drain.

On the 8th of April, 2026, a routine sampling helicopter flyover of the Lagoon by staff of the Environmental Data team of Horizons Regional Council (HRC) noted extremely low, or potentially dry, water levels. A visit was organized for the following day, the 9th of April, for a subsequent inspection which observed that the lake bed was completely dry with many dead and dying tuna present. Horizons Regional Council then notified the Department of Conservation. A site visit on the 10th of April at 9:00am was conducted with HRC staff from Environmental Data, Science and Compliance teams; Department of Conservation staff; Manawatu District Council staff; and members from Ngā Wairiki Ngāti Apa, Rangitāne o Manawatū Settlement Trust, Ngā hapū o Himatangi (Ngāti Te Au, Ngāti Turanga) and Ngāti Parewahawaha.

The following report is a brief summary of available knowledge on the Lagoon, and of site visit information from HRC. It draws on a range of reports commissioned by HRC and other parties prior to this event, academic research, Horizons data, and from notes taken during visits to the site between 8th and 10th of April 2026. The present report does not seek to attribute causality for the drying event, rather attempts to outline relevant background and context leading up to the drying event in April 2026.

Brief History of Pukepuke Lagoon

The duneland of the west coast of the Horizons Region is in a state of constant change. Pukepuke Lagoon is understood to have formed around 1600 AD, when the water table rose and joined smaller dune lakes between two sand dune complexes with wind-blown sand then blocking the lagoon's natural drainage (Wildlands, 2018). The lagoon in its current state is only around 100 years old, due to migrating sand dunes changing its extent over time (Shand, 2018). Seasonal fluctuations in the extent of open water have previously been reported at the site with the lake edge becoming exposed during dry periods (Wildlands 2018).

[1] formed by wind-blown sand deposits and sand dunes

The sand dune landscape that holds Pukepuke Lagoon has four identified phases: the Foxton phase (~6500 years ago) and Motuiti phase (~4500-3500 years ago) occurred before the formation of Pukepuke (Shand, 2018). The early Waitarere phase (~600 years ago) and late Waitarere phase (~200 years ago) occurred after Pukepuke's formation (Shand, 2018). These Waitarere phases are related to Māori and European arrival, as vegetation was cleared and sand dunes that were previously stabilized by trees and grasses became mobile and windblown again (Shand, 2018). Instances of complete or near-complete drying have been observed frequently (Ogden & Caithness, 1982; Burton, 2016).

Environmental Context

Geology

Bore records from the area around Pukepuke provide useful information on the area's geology. When bores are drilled, logs are kept of the types of materials that are struck at different depths. The bore logs from this area show layers of sand and gravel, with layers of clay at various depths to around 170 m underground (Mark-Brown, 1978; Jacobs, 2017). Iron pan layers in some areas restrict underground water movement through the ground, while the lakebed itself consists of dark sand, with a probable ironpan or silt layer underneath that helps retain water in the lagoon, along with some areas of sandy gravels (Jacobs, 2017; Shand, 2018; Edwards & Clayton, 2002). Massey University students in the 1990s struggled to collect pollen samples in the sandy sediments, supporting the understanding that the lagoon is relatively young as muddy sediments haven't yet developed (Shand, 2018).

Climate

Pukepuke Lagoon sits in one of the driest areas of the North Island (Figure 1, left panel), averaging under 900mm of rainfall every year, with rainfall typically evenly spread across the whole year (Chappell, 2015). The Himatangi area typically has around 60-70 days a year of soil moisture deficit, where there is not enough water held in the soil to maintain evaporation into the atmosphere (Chappell, 2015).

In the two-year period leading up until April 2026, the Rainfall Standardised Precipitation Index (SPI) indicates a lower than long term average level of rainfall for the Manawatu coastal area (Figure 1, right panel).

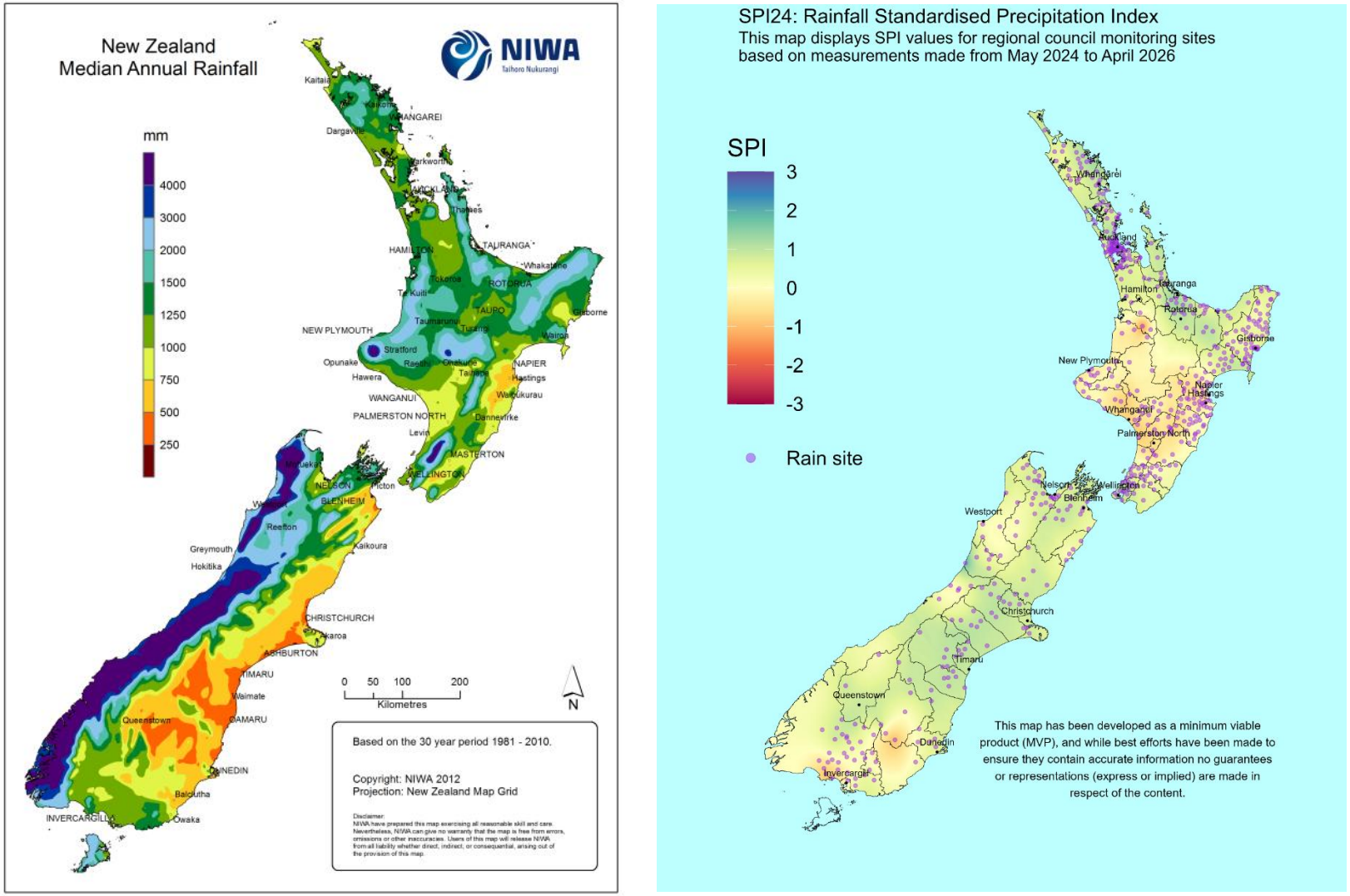


Figure 1: **Left panel** Median annual rainfall of New Zealand 1981-2010. Source: https://niwa.co.nz/climate-and-weather/overview-new-zealands-climate; **Right panel** the Standardised Precipitation Index from the two years leading up to the April 2026 drying event, showing significant rainfall deficits in the coastal Manawatū. Credit: ESNZ.

Groundwater

A 1978 study investigated the water resources and groundwater systems around the Oroua Downs drainage area, including Pukepuke Lagoon, Omanuka Lagoon and Kaikokopu Lake, and identified several known aquifers[2] around Pukepuke lagoon. There is an unconfined aquifer, which is where water moves relatively freely in fine sand, soils and recharges from rainfall being absorbed into the earth (Mark-Brown, 1978). The thickness of unconfined aquifer is considered to be between 8 m and 40 m at various points in the area, with the clay layers forming the base of the aquifer (Mark-Brown, 1978). There are two confined aquifers – the shallower aquifer referred to as A and the deeper aquifer referred to B in Figure 2. Unlike unconfined aquifers, confined aquifers have groundwater trapped and sealed within them. It is likely that these two confined aquifers are recharged from rivers (Mark-Brown, 1978).

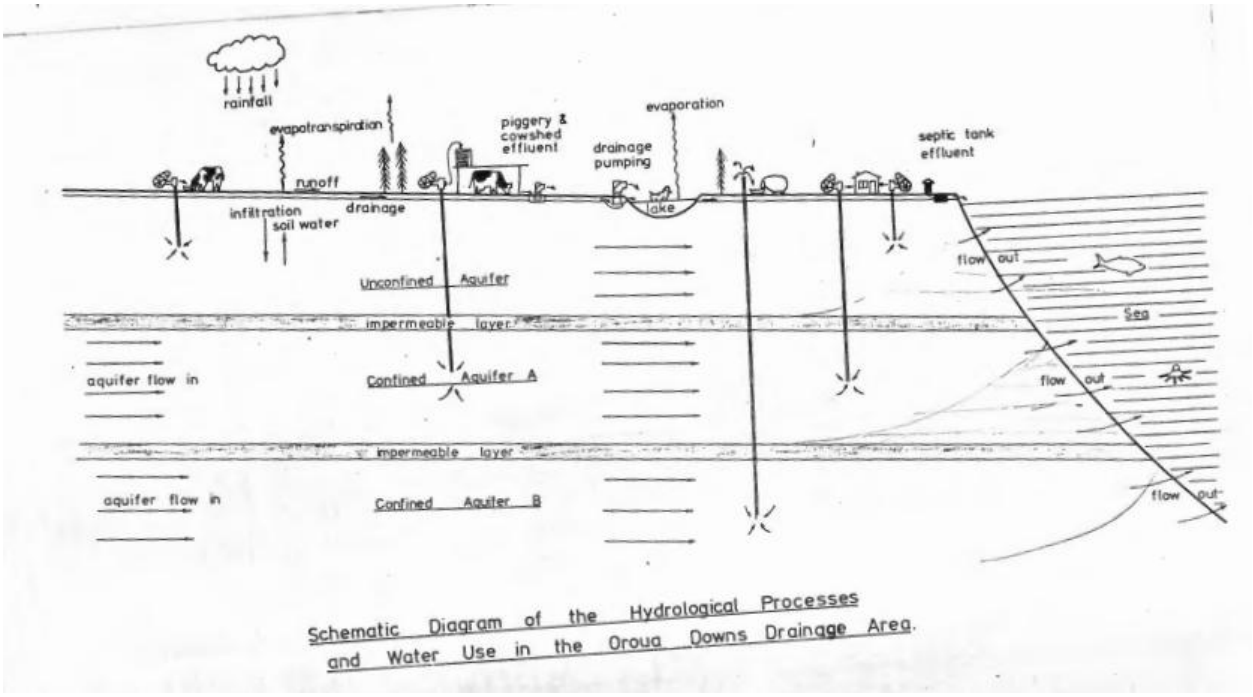


Figure 2: Diagram taken from Mark-Brown (1978) showing the different aquifers under Pukepuke and direction of groundwater flow towards the sea. Described land-use is potentially not current

Water Capture Zones for the Lagoon

Based on the available bore logs[3] in the surrounding area, the main geology in shallow areas is sand and gravel, with an estimated hydraulic conductivity of 5-100 m per day. Hydraulic conductivity is a measure of how easily water can move through soil or rock. The relatively high estimated values indicate the potential for rapid groundwater movement. It has an estimated annual groundwater recharge (where rain enters the whenua and fills up the pockets in the aquifer) of 190 mm, which is equivalent to about 20% of annual rainfall. Sand and gravel are relatively porous, so groundwater can potentially move through the surrounding sediment.

There is no definitive evidence to confirm whether the lagoon is a perched lake (primarily supplied by rainfall and surface water with limited groundwater connection) or a window lake (which is strongly connected to the regional groundwater system). However, it is reasonable to assume that

[2] where sand, rock and gravel can hold and transmit groundwater through the land
[3] records such as drawings of various substrate layers in the ground when a bore is dug

the lagoon is a shallow lake likely supported by groundwater from the shallow unconfined aquifer, together with surface water inflows from the surrounding catchment.

Several studies have been undertaken to determine or model the water capture zone of Pukepuke Lagoon. In 2017, Pattle Delamore Partners (PDP) and Jacobs estimated the surface water catchment zone (SWCZ) of the lagoon at 1,231 ha and 1,815 ha, respectively (Thomas and Nicol, 2017., Sturgeon., 2017). Prior to the Jacobs project report, a workshop was held with representatives from HRC, the Department of Conservation (DOC), Manawatu District Council (MDC), local iwi, and landowners. Participants identified that the catchment of Omanuka Lagoon, located northeast of Pukepuke Lagoon, drains into Pukepuke Lagoon. As a result, the Jacobs report combined the catchment areas of both lagoons. In either case, the estimated SWCZ is considerably larger than the lagoon itself.

The PDP report estimated two groundwater capture zones (GWCZ) for the lake based on two different methods. The first method is named the 'recharge balance approach', which is the estimated land area around the lake from which groundwater recharge would need to flow into the lake to offset the water losses. The area was initially applied as a buffer around the lake within the SWCZ. Where the buffer extended beyond the catchment, it was clipped and extended upstream until the required area was reached. This method resulted in a groundwater capture zone of 21 ha for the lagoon.

The second method, named the 'uniform flow approach' estimates the area of the aquifer that may contribute groundwater to the lake, based on aquifer properties, groundwater flow direction, and hydraulic gradients (the slope of the water table, where the ground is saturated with groundwater). This method essentially considers the lake as a small-scale abstraction from shallow groundwater and estimated a groundwater capture zone of 15,036 ha (Thomas and Nicol, 2017).

Jacobs used a different approach to estimate the groundwater capture zone, using hydrogeological data such as bore logs, groundwater levels, and geological information, following the *Capture Zone Guidelines for New Zealand* (Moreau *et al*., 2014). In summary, piezometric contours[4] were developed for the area immediately surrounding Pukepuke Lagoon. These contours helped confirm the groundwater divide to the east of the lagoon and the general direction of groundwater flow from east towards the coast. Based on this approach, the groundwater capture zone was estimated to be 7,326 ha (Figure 3). Regardless of the method used, the estimated groundwater capture zone is considerably larger than the surface water catchment area. This highlights the complexity and uncertainty associated with environmental systems (Sturgeon., 2017).

Both reports conclude that the SWCZ is directly connected to the lagoon. However, a direct connection between the estimated GWCZ and the lagoon cannot be established.

[4] like topographic contours, these lines are drawn on a map where points of the groundwater are at the same height; groundwater moves from high elevation contours to low elevation contours

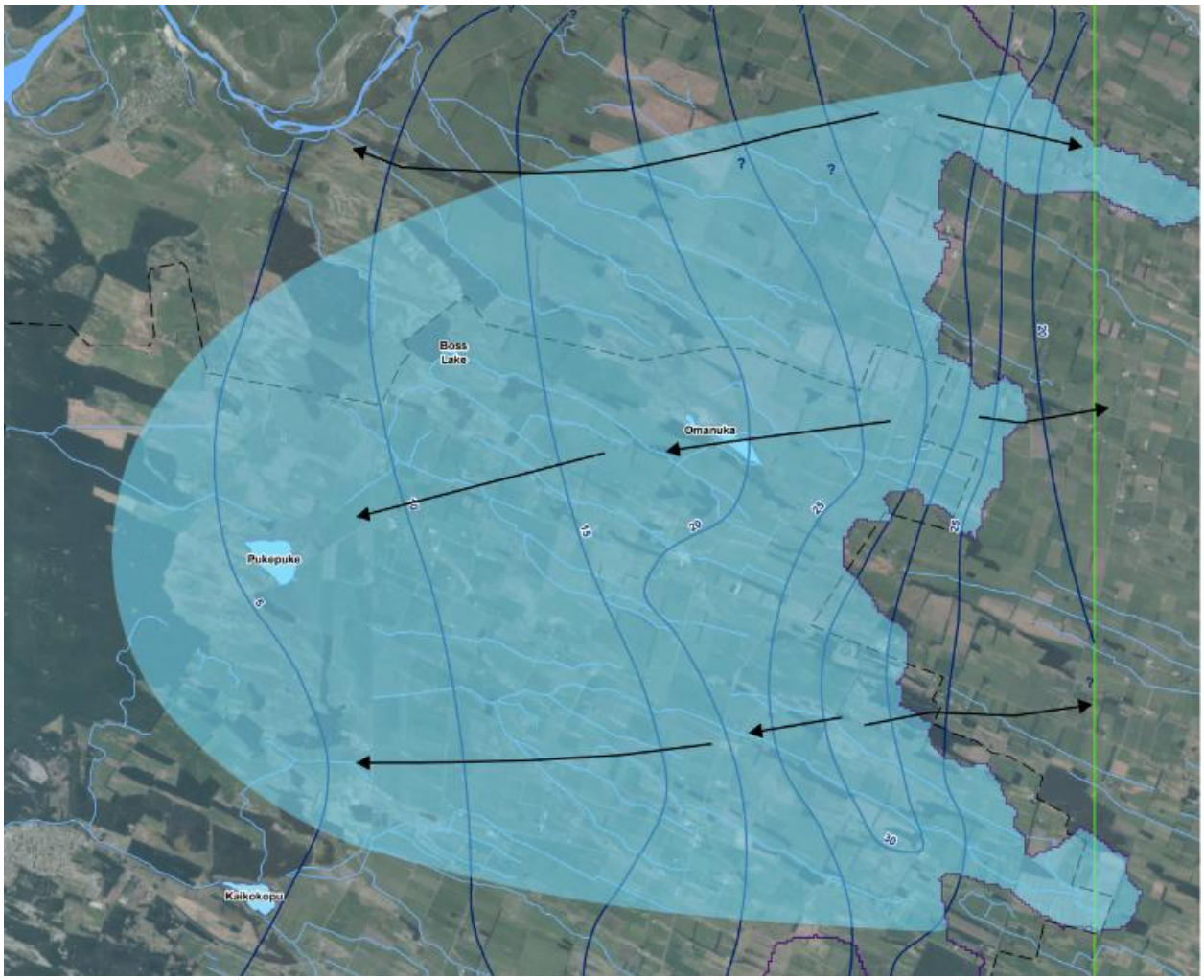


Figure 3: Image from Jacobs (2017) showing the piezometric contours (dark blue lines) and likely groundwater movement towards Pukepuke Lagoon.

Consented Water Takes from the Groundwater Capture Zone

The Regional Plan or One Plan, identifies both a surface water allocation, and a separate groundwater allocation. Permits to abstract water would fall under either a surface water take, or groundwater take (or in some cases some combination thereof). Additionally, the One Plan allows water takes that are sufficiently small in volume, and which meet a series of conditions, to be a Permitted Activity, essentially allowing the activity to be undertaken without seeking a written consent.

The lagoon is located within the Mana_6 Surface Water Management Area, which does not have any existing, consented surface water takes. The lagoon is located within the Rangitikei Groundwater Management Area, which has a One Plan allocation limit of 75,000,000 m^3/year. At the time of this summary report, approximately 62% of the available allocation had been allocated.

A summary of groundwater abstractions within the Jacobs-identified GWCZ, is displayed in

Appendix 1: Groundwater Consents Within the Jacobs-identified Groundwater Capture Zone. This indicates the presence of eighteen existing abstraction consents, and a range of historic and proposed consents.

The One Plan requires resource users to notify HRC of any water abstractions undertaken within permitted activity volumes. However, we are not aware of any permitted surface water or groundwater takes within the groundwater capture zone at this point in time.

Groundwater Level Monitoring

Horizons monitors groundwater levels in three bores at different depths within the GWCZ, as identified in the Jacobs report. Two of the three bores are approximately 2 m deep and have shown stable groundwater levels since monitoring began, with some seasonal fluctuations, which are considered normal. The groundwater level data is publicly available through Horizons Environmental Data[5]. The bore 332009 is approximately 25 m deep with a recorded static water level 1.6 m underground (below ground level). The bore has shown a 55 mm decline in groundwater levels since monitoring commenced in 1977.

Life in Pukepuke

Multiple aquatic plant (also known as macrophytes) surveys have been conducted on Pukepuke Lagoon, consistently reporting the lakebed as covered in vegetation. The ecological condition of the lake has been measured using a measure called the Lake Submerged Plant Index (LakeSPI), which uses divers in the lake to identify and map the aquatic plants present. It gives data on plant coverage in the lagoon, along with information on the native and non-native plants present. As measured by the LakeSPI, the condition of the Lagoon has varied from high ecological condition in 2001, moderate in 2015 and back to high in 2020 (Burton, 2021). This is based on a relatively high percentage of native macrophytes with medium-level impact from invasives. An extensive bed of raupō (*Typha orientalis*) was noted in 1949 (Cunningham et al, 1953), and Gibbs described different groups of species dominating in each summer (Gibbs, 1973). The drying cycles that Pukepuke experiences are suspected to be preventing the establishment and spread of some pest aquatic plants such as hornwort (Burton, 2016).

New Zealand Freshwater Fish Database records from within the Pukepuke Conservation Area show records of Cran's bully (*Gobiomorphus basalis*) in 2022, shortfin eels (*Anguilla australis*) in 2017, unidentified bullies (*Gobiomorphus*) in 2003, common bullies (*Gobiomorphus cotidianus*) and longfin eels (*Anguilla dieffenbachia*) in 1999, and Brown mudfish (*Neochanna apoda*) in 1971. While there is no fish database records of kākahi (freshwater mussels) in the lake, one was observed on the dry lake bed on 10/4/26.

On the day of the site inspection following the drying event, a number of notes were made as to both the flora and fauna identified in and immediately surrounding the Lagoon. These can be seen in "Appendix 3: Horizons' Field Notes on April 2026 Pukepuke Drying".

[5] https://envirodata.horizons.govt.nz/

Anthropogenic (Human) Factors Influencing the Lagoon

Pukepuke Lagoon has been reduced to its contemporary wetted extent through drainage, sand stabilisation, land-use changes and marginal macrophyte spread (Wood et al, 2023; Burton, 2021). Water levels in the lagoon were noted to vary up to 0.95m, with rapid rises after rainfall and shallow sections of the lagoon were sometimes observed drying entirely (Fowles, 1982; Ogden & Caithness, 1982). Historically, hand-cutting of raupō was required to maintain open water areas (Fowles, 1982), and varying water depth significantly contributing to the composition of macrophyte communities at the lagoon (Burton, 2021). Land along the west coast was forested prior to human arrival, with some areas having semi-swamp forest of tawa and kahikatea, and drier areas having tikoki and tōtara (Mark-Brown, 1978). With subsequent Māori and European arrival, deforestation caused sand dunes to remobilise (Mark-Brown, 1978). Pine forests and marram grasses were planted to try and stabilise the sand dunes again (Mark-Brown, 1978). By 1939, the mobile dunes had divided the open water lagoon into the main water body (A), and a smaller open water area (B) (Shand, 2018), closely resembling its contemporary character (Figure 4).

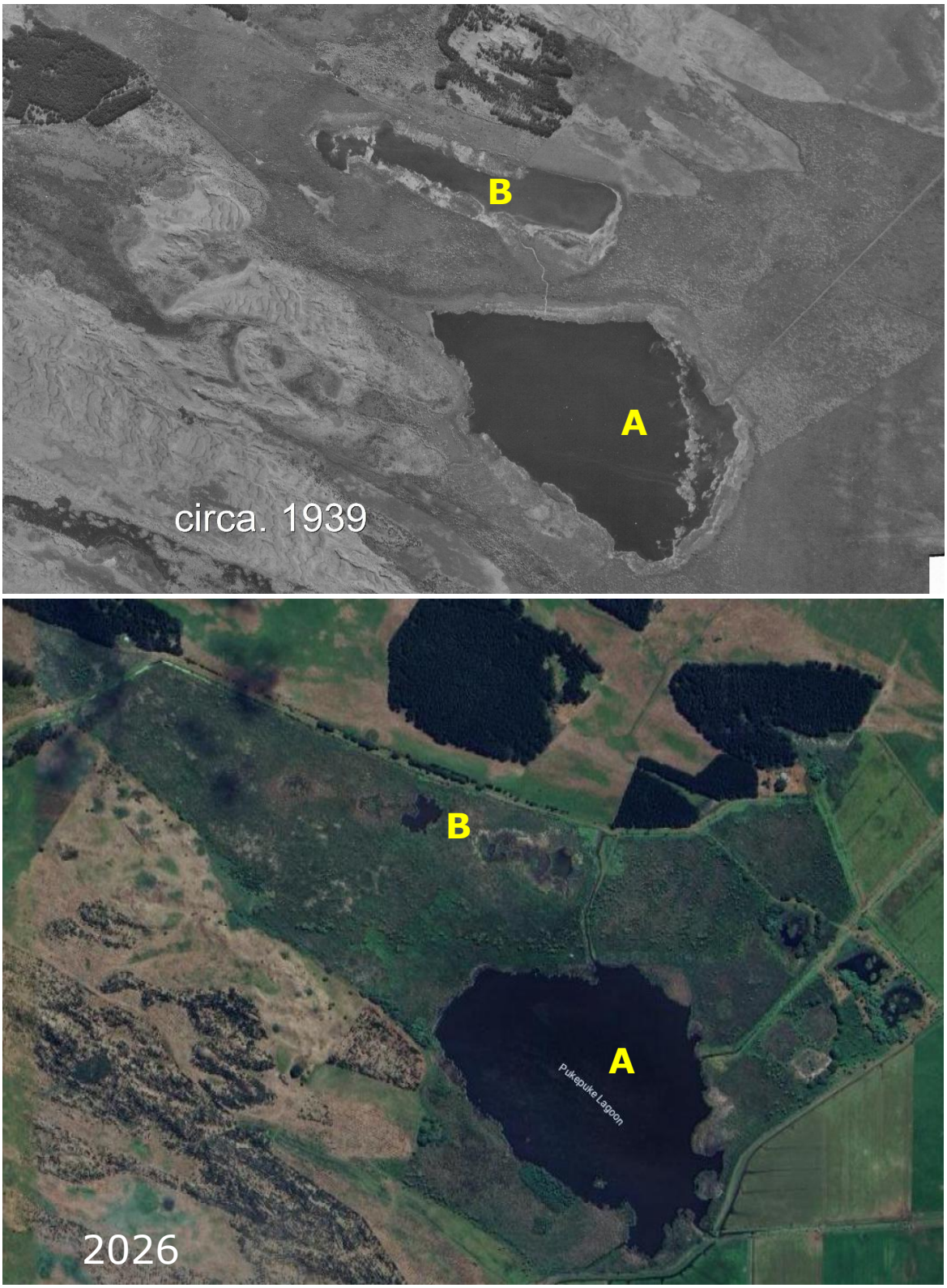


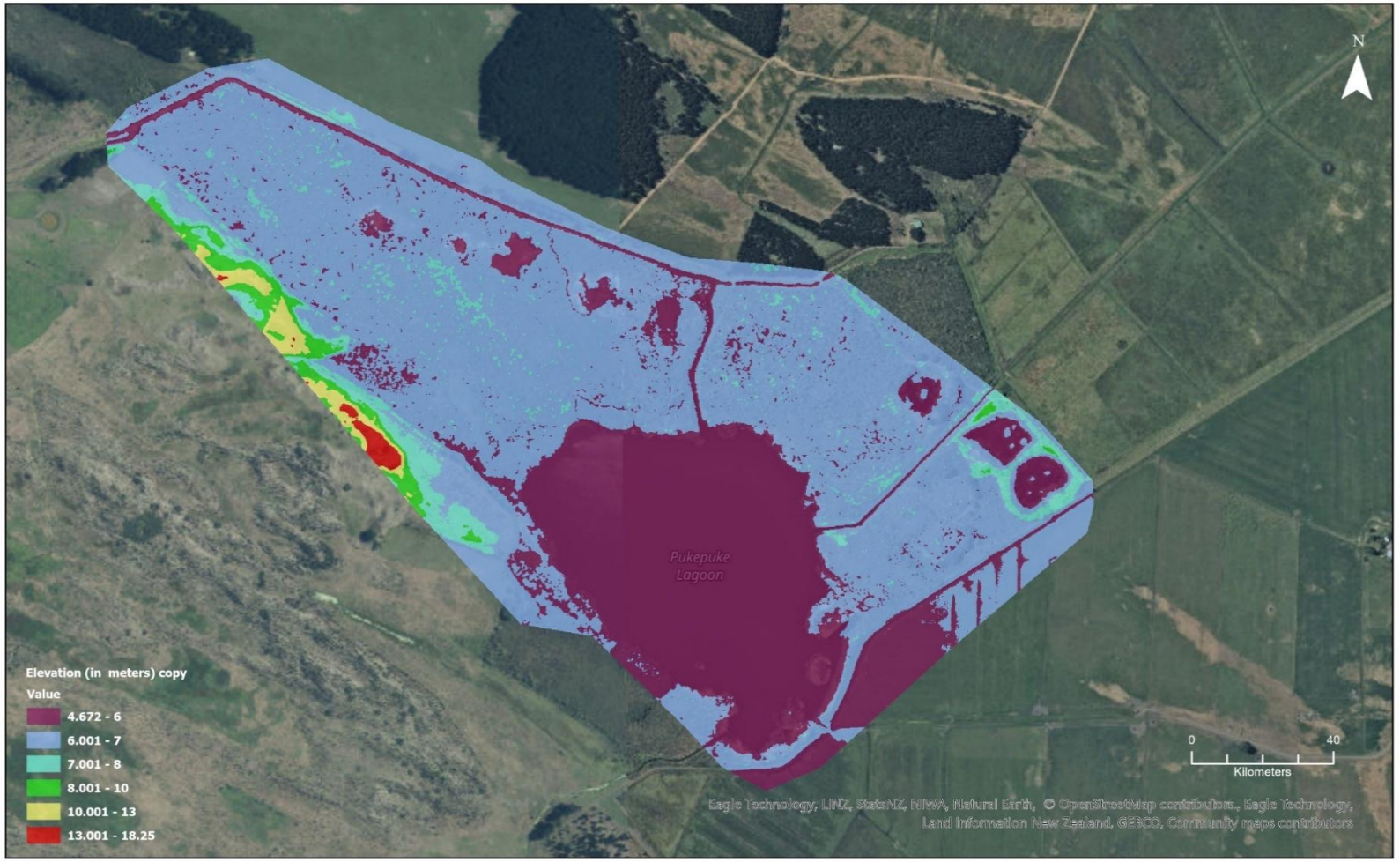
Figure 4: Aerial imagery of Pukepuke Lagoon from around 1939 (top) and 2026 (bottom). The 1939 image shows how sand drifts split the lagoon into two ('A' and 'B); the 2026 image shows the same locations today, with wetland expanding into open water

Extensive drainage channels have been constructed around the lagoon and within its broader environment, as part of the Oroua Downs Drainage Scheme. Construction of these drains pre-dated HRC as an entity, as well as the Resource Management Act (1991). An 1889 survey map shows the swamp within the Pukepuke Conservation Area was at least 330 ha in size, however this had reduced to around 125 ha by 1913 with the construction of drainage into Lake Kaikokopu (Shand, 2018). After this, drainage was also constructed to directly connect the lagoon with a creek going out to the sea (Shand, 2018). The original Boss Creek, which drained Omanuka Lagoon into the Rangitīkei River, was often blocked and flooded by the remobilized sand dunes described above, with Boss Creek then being redirected to drain into Pukepuke Lagoon (Shand, 2018). Currently, the main inlet into Pukepuke Lagoon sits on the eastern boundary, and drains surrounding farmland into the lagoon (Wildlands, 2018). This history of drainage has contributed to the lagoon's current smaller extent of 15.2 ha by 2015 (Wildlands, 2018). Raupō has continued to spread and contributed to the reduced extent of open water in the lagoon over time (Wildlands, 2019; Wood et al 2023). The surrounding landscape has undergone further extensive change from native forest to farmland and forestry (Wildlands, 2018; Shand, 2018).

Drain Heights

The drains around Pukepuke Lagoon have changed over time, and relative heights of the drain and lagoon bed can be informative. HRC's LiDAR[6] drone was flown around the lagoon and its main drain on 15 April 2026, with this data subsequently used to record the bed heights of the main drain and the lagoon (Figure 5).

[6] LiDAR = Light Detection and Ranging; shoots laser pulses towards the earth and measures how long the light takes to bounce back to create a map of points of the landscape.



Heights of the landscape at Pukepuke Lagoon based on LiDAR data (flown 15th April 2026)

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Figure 5: Landscape heights at Pukepuke Lagoon from LiDAR data, flown on 15/4/2026

Previous bathymetries and depth estimates have indicated a water depth of around 1.3-2.0 m at different points in history (Burton 2021; Wood et al 2023; Wildlands 2018), however these were not confirmed with survey markers at the times of writing, and so are difficult to verify. The Jacobs report (2017) estimates the height of the drain as higher than the lakebed based on the outlet going dry before the lake, and these previous reports indicating a 1.3 m depth in the lagoon. Note that this information was not based by a formal survey of heights at the time.

HRC used the LiDAR data displayed in Figure 5 to construct a new illustrative diagram (Figure 6) of the relative lagoon and drain bed heights. These show the height of the drain is below the height of the lakebed, which is consistent with field observations that the drain still retained water while the lagoon itself was dry. This may imply a change in drain depths through time as maintenance has been undertaken.

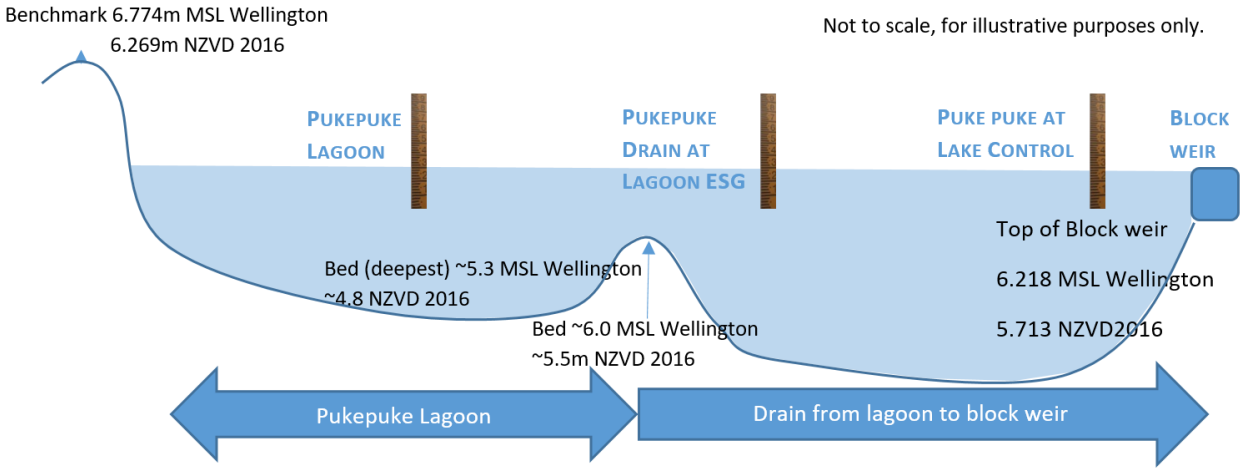

Figure 6: Diagram of bed heights of Pukepuke Lagoon and the drain from the Lagoon to the sea, based on measurements taken by the Horizons Hydrology Team on 15/04/2026. NZVD = New Zealand Vertical Datum, MSL Wellington = mean sea level in the Wellington datum

Note: additional photos of drains surrounding the Lagoon and taken on the 10/04/2026, are available in Appendix 3: Horizons' Field Notes on April 2026 Pukepuke Drying.

Horizons' Monitoring History in the Lagoon

HRC has conducted water quality and water levels monitoring in Pukepuke Lagoon. Site names and available lab tests on samples have varied as the lake sampling programme, national testing standards and site access have changed over time[7]:

- Automatic levels:
    - Puke Puke Lagoon at Lagoon 4/9/1969- 21/10/1983
    - Puke Puke at Lake Outlet 24/06/1971-01/07/1980
    - Pukepuke Drain at Lagoon ESG: 11/1/24-9/4/26
    - Pukepuke Lagoon: 9/4/26-present
- Manual levels:
    - Pukepuke Lagoon at Lake Control: 5/10/2017-present
    - Pukepuke Drain at Lagoon ESG: 5/10/2017-present
- Water Quality:
    - Pukepuke Lagoon: various-present
    - Pukepuke Lagoon (Composite): various-21/04/2021
    - Pukepuke Lagoon sites 1, 2 & 3 (Chlorophyll a): 28/09/2015-20/04/2021

All fish data collected by HRC (and various other agencies) is available in the New Zealand Freshwater Fish Database (https://nzffdms.niwa.co.nz/).

[7] All water quality and lake level data for Pukepuke Lagoon is available for request (EnvironmentalDataRequests@horizons.govt.nz)

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Appendix 1: Groundwater Consents Within the Jacobs-identified Groundwater Capture Zone

The following table identifies consented groundwater takes within the Jacobs identified groundwater capture zone, including current, historic and proposed abstractions. Note this does not include permitted activity abstractions which do not require written consent to abstract. Where a single consent authorisation (ATH Number) applies to multiple bores, the consented volume represents the cumulative allocation across those bores. For example, authorisation ATH-2013014895.00 permits a combined abstraction of 63 m^3/day from bores 333101 and 333233. It is possible that, at any given time, only one of the authorised bores is operational. Please note that ATH-2011013772.02 permits a combined groundwater abstraction of 9,980 m^3/day from the bores listed in Table 1. However, bores 333119 and 333378 are spatially located outside the groundwater capture zone modelled in the Jacobs' report.

Table 1: Groundwater abstractions within the groundwater capture zone of Pukepuke Lagoon, as identified by the Jacobs report. Source: HRC.

Status	ATH_Number	Horizons Bore ID	Bore Depth (m)	Volume (m3/Day)	Use
Authorised Activity	ATH-2008011497.00	333093	93	3,456	Dairy Pasture Irrigation Water Abstraction
Authorised Activity	ATH-2009012671.00	333125	59.8	4,320	Pasture Irrigation Water Abstraction
Authorised Activity	ATH-2010013124.00	333127	105.2	126	General Dairy Shed & Stock Water Abstraction
Authorised Activity	ATH-2011013387.00	332061	Unknown	62	General Dairy Shed & Stock Water Abstraction
Authorised Activity	ATH-2011013622.00	332058	12	77	General Dairy Shed & Stock Water Abstraction
Authorised Activity	ATH-2011013772.02	333123, 333119, 333163, 333187, 333378	82, 90, 44.1, 45.4, 43.2	9,980	Domestic, Dairy Shed, Irrigation & Stock Water Abstraction

Authorised Activity	ATH-2013014895.00	333101, 333233	39.5, 47.5	63	General Dairy Shed & Stock Water Abstraction
Authorised Activity	ATH-2014015131.00	333113	82.65	4,320	Pasture Irrigation Water Abstraction
Authorised Activity	ATH-2014015303.00	333117	118	3,197	Domestic, General Dairy Farm & Stock Water Abstraction
Authorised Activity	ATH-2015200209.00	333073	43.8	65	Domestic, General Dairy Shed & Stock Water Abstraction
Authorised Activity	ATH-2015200291.00	333169	452	10,891	General Dairy Shed, Irrigation & Stock Water Abstraction
Authorised Activity	ATH-2015200461.00	333173	420	9,456	General Dairy Shed, Irrigation & Stock Water Abstraction
Authorised Activity	ATH-2018202281.00	333183	82	3,456	Domestic, General Dairy Shed, Irrigation & Stock Water Abstraction
Authorised Activity	ATH-2018202330.00	333181	159.93	5,646	Pasture Irrigation Water Abstraction
Authorised Activity	ATH-2018202331.00	333185	90	36	Domestic Supply, General Dairy Shed & Stock Water Abstraction
Historic Activity	ATH-2008011689.00	333123	82	2,680	Pasture Irrigation Water Abstraction
Historic Activity	ATH-2008012550.00	333058, 333062	14, 14	62	Domestic, General Dairy Shed & Stock Water Abstraction
Historic Activity	ATH-2015200115.00	333169	452	10,368	Hydrological Pumping Test Water Abstraction
Historic Activity	ATH-2017201594.00	332067	64.1	6,000	Hydrological Pumping Test Water Abstraction
Proposed Activity	APP-2006011904.02	333093	93	3,456	Dairy Pasture Irrigation Water Abstraction
Proposed Activity	APP-2008013276.01	333125	59.8	2,600	Pasture Irrigation Water Abstraction
Proposed Activity	APP-2013016314.02	333113	82.65	4,320	Renewal Pasture Irrigation Water Abstraction

Appendix 2: Water Levels at Pukepuke Lagoon

Water levels at Pukepuke lagoon regularly fluctuate seasonally, though to varying degrees (Figure Figure 7). Latest Hilltop data for water-level at Pukepuke lagoon indicates a gradual decline in water level in March 2026 through to April 2026 with only a minimal increase on 27 March 2026 likely from an intense but short rainfall event (Figure 8). Instances of complete or near-complete drying have been observed on several occasions, particularly in and around 1970 (Ogden & Caithness, 1982)(Figure 9). Levels data is unavailable for the mid 1980s to mid 2010s (Figure 9).

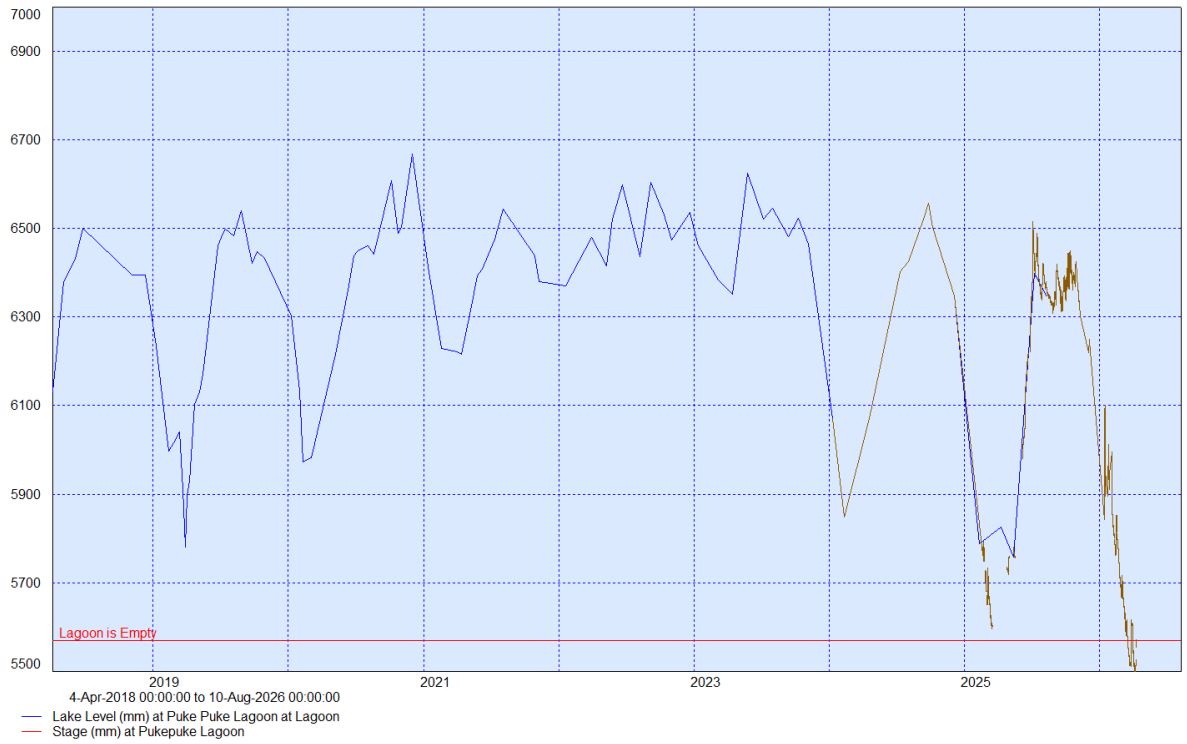

Figure 7: HRC data on Pukepuke water-level since 2018. Red line indicating water-level where lagoon is considered empty and lake is dried out.

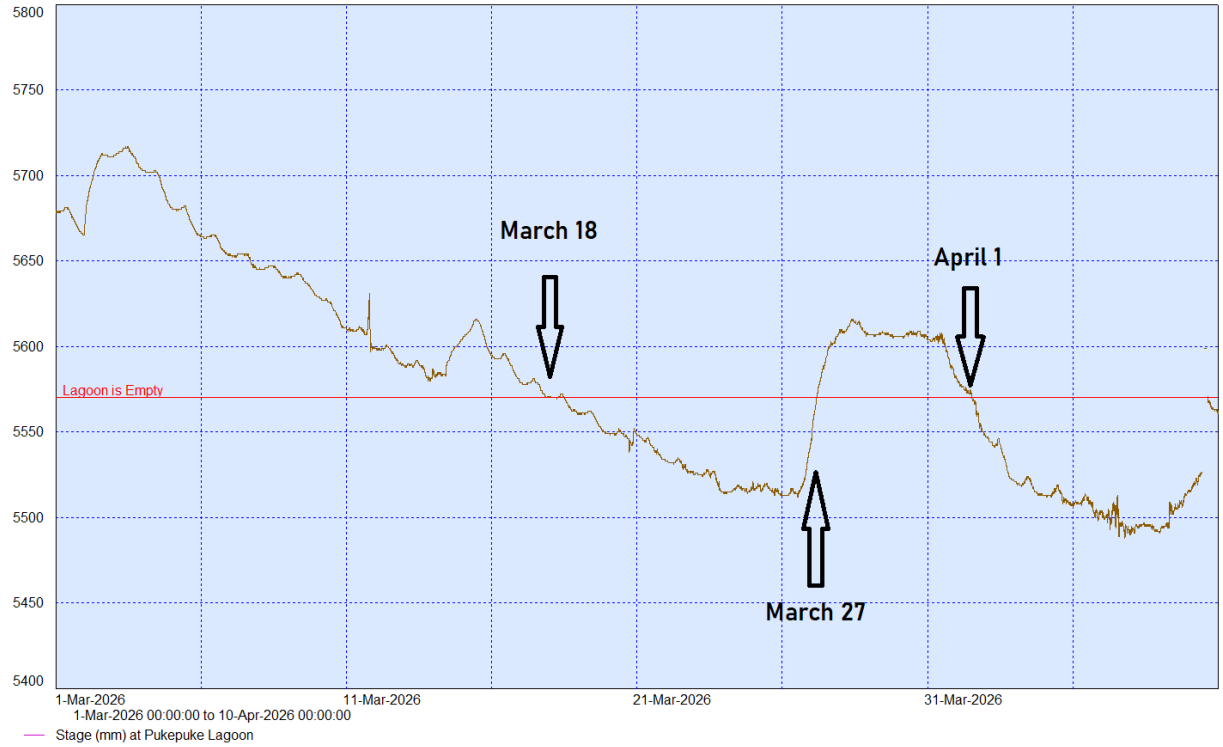

Figure 8: HRC Pukepuke water-level since March 2026. Red line indicating water-level where lagoon is considered likely empty

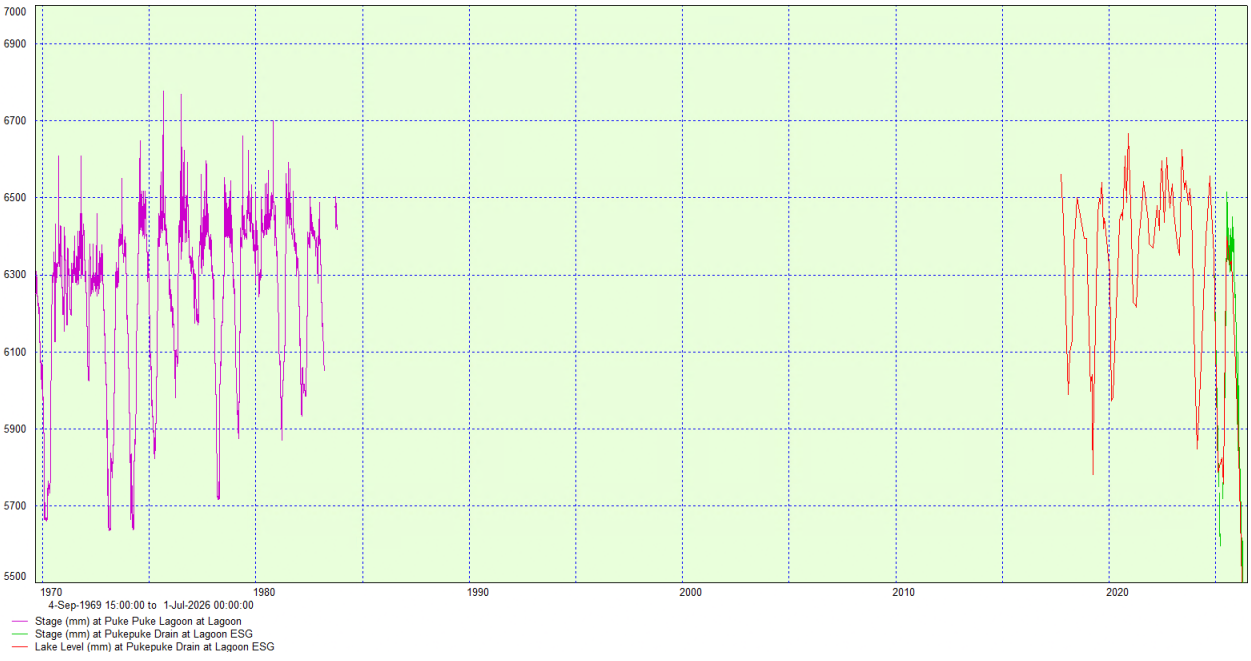

Figure 9: Measured lake levels at Pukepuke Lagoon from 1969-2026; the gap in the data indicates when measurements were no longer undertaken. Source: HRC

Appendix 3: Horizons' Field Notes on April 2026 Pukepuke Drying

Event Context

On 9/4/2026, Environmental Data team members were going out to maintain telemetry radar for lake levels on Pukepuke Lagoon and in response to previously noted dry or near dry lake conditions, and observed that the lakebed was completely dry with many dead and dying tuna present. They communicated this back to the Science Team and Compliance Teams of Horizons Regional Council. The Science Team then notified the Department of Conservation, requesting they contact mana whenua.

A site visit on 10/04/2026 at 9:00am was conducted with Horizons staff from Environmental Data, Science and Compliance teams; Department of Conservation staff; Manawatu District Council staff; and members from Nga Wairiki Ngāti Apa, Rangitāne o Manawatu Settlement Trust and Nga hapū o Himatangi: Ngāti Te Au and Ngāti Turanga (Ngati Raukawa). What follows is summarised from notes taken by HRC staff on the day.

Observations

Changes to lake extent observed at landscape level

When comparing the lake extent of Pukepuke Lagoon on satellite imagery (source: https://browser.dataspace.copernicus.eu/) from 31 October 2025 to 15 March 2026, the shape and colour of the lakes appear to have changed in a way that may indicate potential drying-out of open water and exposing lakebeds (Figure 10). Other lakes in the area do not appear to have had any similar changes visible from satellite imagery.

Note: this imagery was considered, and gave context on the day of the site visit, hence its inclusion here.

Figure 10: Satellite imagery of the Himatangi area in October 2025 and March 2026. Pukepuke Lagoon is indicated by the yellow arrows. The landscape is notably drier in the March imagery

Lakebed

Pukepuke lagoon is characterised by one main shallow water lake and several smaller open-water habitats. Raupō reedland and herbaceous wetland plant species form the vegetated margin of the main lake. The main lake was found to have dried out fully exposing the bare sediment of the lakebed (Figures 11 and 12).

Figure 11: Herbaceous plant margin of main open-water habitat at Pukepuke lagoon

Figure 12: Dried out main lakebed exposing sediment. Scattered herbaceous plants have started to colonise mudflat

Margin of herbaceous wetland plants includes the following species:

Figure 13: Watercress (*Nasturtium officinale*)

Figure 14: Celery-leaved buttercup (*Ranunculus sceleratus*)

Figure 15: Mudweed (*Limosella australis*)

Figure 16*:* Purslane speedwell (*Veronica anagallis-aquatica*)

These four species are also found further towards the centre of the main lake. While these species are adapted to become submerged in shallow water, their presence across all parts of the lakebed may indicate that the drying out of the lake happened over an extended timeframe that allowed those plants to colonise the exposed mudflats.

Lake Biota

Shortfin eels, goldfish and kākahi were observed on the lakebed. All kākahi and goldfish were dead; hundreds up to thousands of tuna were dead while some were still alive or digging up out of the bed of the lake. Some of these tuna then dug back down into the bed of the lake, and more could be heard below the sediments. Brief identification survey of the tuna, undertaken by trained and experienced staff of HRC, did not find any longfin eels to be present, only the shortfin eel (*Anguilla australis*).

During the site visit on the 10 April 2026 one matuku-hūrepo / Australasian bittern (*Botaurus poiciloptilus;* Threatened – Nationally Critical) was observed.

Pumphouse and Lagoon Inflow Channel

The pumphouse was briefly inspected with independent ecologists (associated with Iwi partners), present on the day (Figure 17). The area was overgrown, one cow print found in grass on margin banks but age could not be verified. If the pump has run to feed drain water into the lagoon from the neighbouring farm, it is unlikely the water could flow quickly through the vegetated channel.

Figure 17: Pumphouse outflow on Pukepuke Lagoon on 13/4/2026

There is an inflow channel which drains farmland on the eastern border of the lagoon. This was walked by Horizons staff and an independent ecological consultant on 14/04/2026 at approximately 11am. The inflow channel was significantly vegetated (Figure 18 - images A and B), with only occasional patches of water (Figure 18 - image C). Tips of raupō in the inflow drain were dry and brown (Figure 18 - image D), suggesting an extended time without water available. The disconnected water puddles showed no signs of movement or flow, and were frequently constrained by vegetation. It would likely require a high initial flow and maintenance of the inflow channel to maintain a water flow into the lagoon.

Figure 18: Photos taken on 13/4/26 showing the main inlet into Pukepuke Lagoon. The inlet is heavily vegetated (A) and frequently overgrown (B). While there are some isolated puddles (C), raupō tips are largely brown (D)

Drains

Several drains are identified to run along the boundary of the wetland with several additional drains leading into the wetland and connecting to the main lake (see Figure 19 to Figure 24 below). Drainage channels appear dry, and to have been maintained to prevent blockage from raupō with only small herbaceous plants growing in the channel.

Figure 19: Drains and weir at north-west boundary of Pukepuke lagoon

Figure 20: Drains leading north from open-water habitat at Pukepuke lagoon

Figure 21: Drains along east boundary of Pukepuke lagoon

Figure 22: Drains along south-east boundary of Pukepuke lagoon

Figure 23: View along drain channel leading north-west away from weir

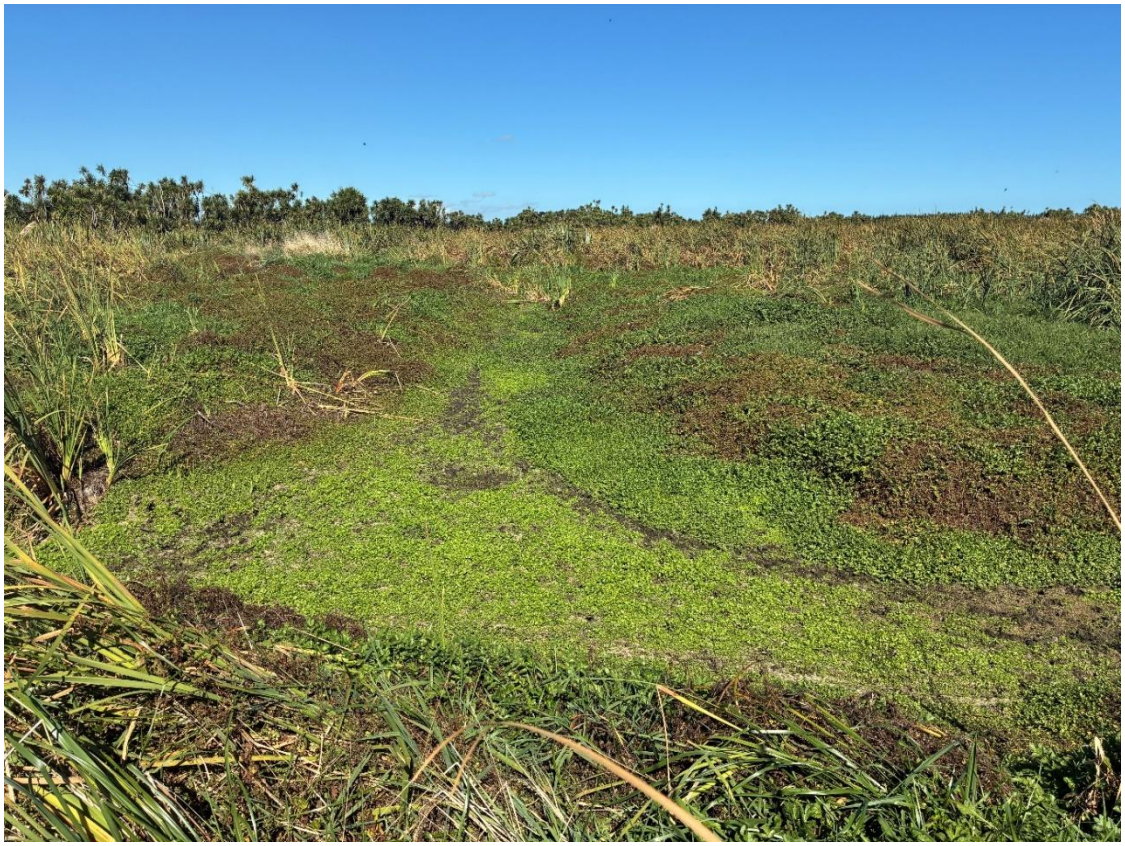

Figure 24: Drain junction along north boundary; drain connects to main open-water habitat

Pāmu Drain

Colloquially known as the "Pāmu drain", located northwest of the lagoon (Figure 25). This is a significant drain that redirects water away from the lagoon further up the catchment. Some measurements were taken by Hana Rainforth on the day, however at time of writing drain depths have not been surveyed in detail. The drain is deep and wide (Figures 26 and 27).

Figure 25: "Pāmu drain", as mapped in yellow from aerial imagery

Figure 26: Pāmu drain, facing west

Figure 27: Pāmu drain, facing east

Weir

The weir is located on the primary drain on the lagoon's northern boundary (Figure 28). The primary drain has two outlets – one is the weir constructed from railway sleepers and concrete bollards (Figure 29). No signs of tampering with weir. Weir area is overgrown.

Figure 28: Aerial image showing weir and fort at north-west boundary of Pukepuke lagoon

Figure 29: Overgrown weir at north-west boundary of Pukepuke lagoon

Weir damage is regarded as unlikely to have caused the drying. There was no immediate evidence that the weir had been tampered with, and the structure was still intact, as was the spillway.

Wetland

At the time of visiting the site any areas of open-water habitat throughout the lagoon appear to have been reduced to only the lowest lying areas remaining. Such areas include the monsoon bucket pool dug out near the weir (Figure 30).

Figure 30: Monsoon bucket pool dug upland from weir with standing water

While some of the woody vegetation along the wetland boundary showed signs of water stress, primarily oak and tōtara leaves and needles having died off, the presence of herbaceous wetland plants along the drain channels and lakebed indicate that despite lack of standing surface water soil moisture is still sufficient to support the local wetland vegetation.

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