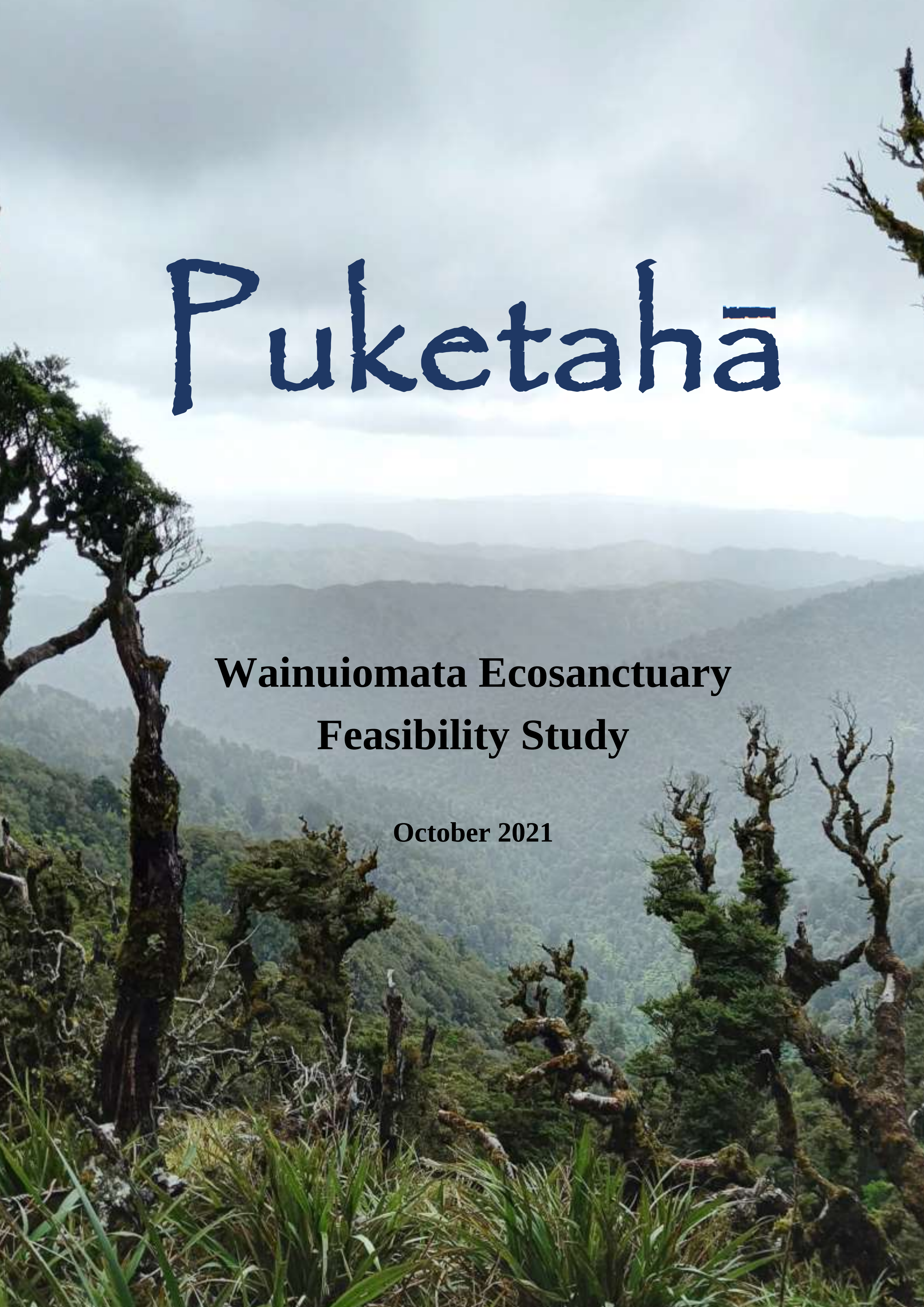
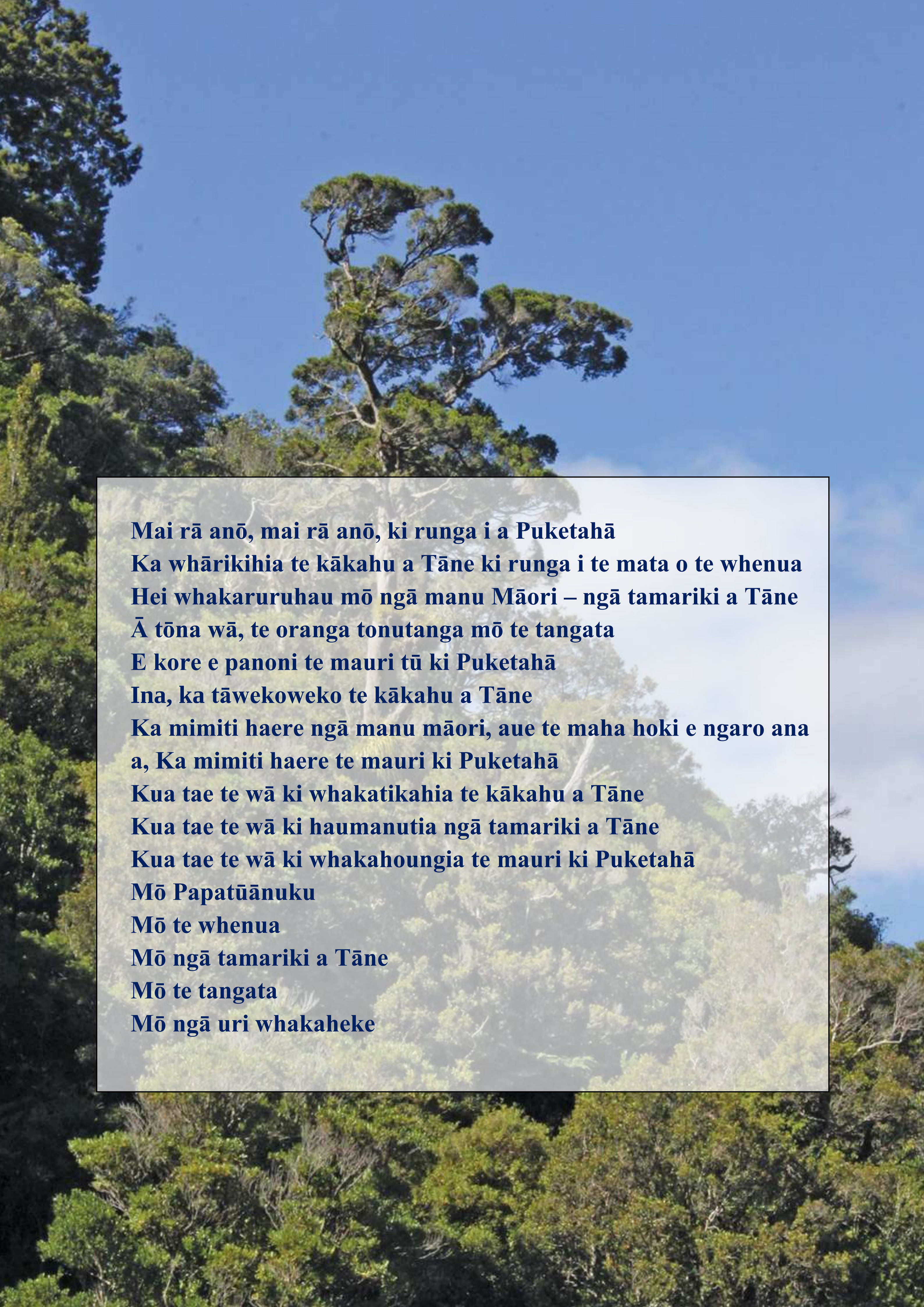


Puketahā

Wainuiomata Ecosanctuary Feasibility Study

October 2021

Contents



Mai rā anō, mai rā anō, ki runga i a Puketahā
Ka whārikihia te kākahu a Tāne ki runga i te mata o te whenua
Hei whakaruruhau mō ngā manu Māori – ngā tamariki a Tāne
Ā tōna wā, te oranga tonutanga mō te tangata
E kore e panoni te mauri tū ki Puketahā
Ina, ka tāwekoweko te kākahu a Tāne
Ka mimiti haere ngā manu māori, aue te maha hoki e ngaro ana
a, Ka mimiti haere te mauri ki Puketahā
Kua tae te wā ki whakatikahia te kākahu a Tāne
Kua tae te wā ki haumanutia ngā tamariki a Tāne
Kua tae te wā ki whakahoungia te mauri ki Puketahā
Mō Papatūānuku
Mō te whenua
Mō ngā tamariki a Tāne
Mō te tangata
Mō ngā uri whakaheke

Executive Summary

1. The problem is a lack of pest-free, rimu dominant, high quality, mainland breeding habitat for kākāpō and other critically endangered species.
2. The proposal is to construct a 28.8km predator proof fence around the Wainuiomata Water Catchment (3,313 hectares), eradicate all pests (predators and browsers), keep the area pest-free in perpetuity and restore kākāpō and other endangered species to the enclosed area.
3. This site has qualities which make it uniquely suitable for this purpose, including size, abundant rimu, habitat quality, optimum configuration for fencing, and location.
4. The site has high biodiversity value as it could change the status of three nationally critical endangered species, (kākāpō, rowi kiwi and hihi) and transform the Remutaka Range.
5. In addition to the biodiversity value, the project has considerable cultural, social and economic value, including substantial economic value added to a low-income area, the creation of permanent jobs and opportunities for social engagement. It aligns with many national goals in the Aotearoa Biodiversity Strategy-Te Mana o te Taiao.
6. The site is owned by Greater Wellington Regional Council (GW) and is operated as a water supply facility under a service agreement with Wellington Water. The site could be managed in tandem with the water supply function which must continue.
7. Taranaki Whänui, through the Port Nicholson Block Settlement trust, are the mana whenua. They support the proposal. DOC and GW also support the proposal.
8. The potential partners are Taranaki Whänui as mana whenua, GW as landowner and the Department of Conservation as the national biodiversity agency. They would all need to agree to participate as partners for the project to proceed.
9. There is an option for a legal entity and governance structure which could meet the needs of all partners. This is a partner (GW/iwi/DOC) controlled charitable trust. It would need the partners to be willing to participate and a service agreement with GW for joint use of the land with Wellington Water.
10. The project is challenging but technically feasible. There is a practical route on which a fence can be constructed and once fenced, pests can be eradicated and kept out of the area, (bar mice). Mice will not affect the primary purpose.
11. The project will go through three phases over the first ten-year period. These are:

    1.Preparatory (three years) 2. Development (four years) 3. Operations (year eight +)
12. Each phase has been described in terms of its key tasks and resource requirements.
13. The total cost has been calculated as $41,823,344 over the ten-year period.
14. This is broken down into OPEX of $23,090,734 over ten years and CAPEX of $16,680,000, plus a 15% contingency allowance.
15. The operational cost after year ten is calculated as $2,523,960 p.a. in current dollars.
16. There are significant risks involved in the project. Four risks could result in abandonment of the project if they occur and cannot be managed and mitigated. These are 1. Partners do not want to participate, 2. No funding available. 3. Wellington Water does not support the project, 4. Resource consent provisions too difficult.
17. The remaining risks are mostly technical and can be managed or mitigated.

Scope of this Study

Following the proposal, and after preliminary investigation by a pilot group, the GW Environment Committee resolved to support the concept in principle and authorised a working party to pursue this feasibility study. Sponsored by Cr Thomas Nash, the Working Party consisted of Wayne O'Donnell (GM Catchment Management and lead) and Amanda Cox (Principal Advisor to the Chair of GW). A draft Terms of Reference (TOR) was prepared and James R. Lynch QSM (SDA Ltd) was contracted to manage the study. DOC was represented through Mark Fitzpatrick (Director-Terrestrial Science).

Mana whenua partner Port Nicholson Block Settlement Trust (PNBST) was invited to join the steering group but were unable to respond at the time.

The issues needing testing in the study were identified and cross checked with the TOR (see structure of the study below). A plan to complete the study was prepared and approved by the steering group. This called for the study to be completed by 30th October 2021. Funds for the study were allocated by GW and by DOC. Consulting Ecologists Boffa Miskell and BECA Engineers generously agreed to supply services pro-bono. Work got underway in May 2021.

Structure of this study

Thirteen key categories were identified as needing assessment for feasibility in this study. The categories are as follows; governance, management, costs and risks, iwi and treaty, biodiversity value, social and economic value, the need for a fence, land tenure, compatibility with the water supply function, fence route, fence construction, eradication of pests, maintaining a pest free status, restoring species to the site, and managing the 'halo'.

The study is presented in these sections:

> **Executive Summary and Scope**. This summarises the key elements of the study in one page and explains the process and method for the study.
>
> **Part one: Background and Project Description.** This part sets the scene.
>
> **Part two: Feasibility.** This contains the thirteen key projects listed above. The first section (2.1. Governance, Management, costs and risks) summarises the whole proposition, draws on the conclusions of all the subordinate projects and includes a summary of costs and risks and the overall conclusions. The subsequent sections each include the question(s), the findings of the study and a description of the issue and context. Where an issue is particularly complex (e.g., the eradication), separate papers are included as Appendices.
>
> **Part three: Appendices.** This contains all the background papers referred to in Part Two. There are seventeen appendices supporting the study.

Limitations of this study.

This study does not attempt to compare outcomes from, or expenditure at Wainuiomata with potential outcomes or opportunity costs at other sites. This is outside the TOR and would require a much wider based study. Part 2.5. Need for a Fence and Appendix E compares 'fenced with no-fence' at Wainuiomata.

This study does not attempt to identify funding options and sources. This is outside the TOR and will need to be a separate conversation amongst potential partners.

Time period for this study

Eco-sanctuaries historically take a long time to establish and reach maturity. Typically, 20 or more years at a minimum. For example, Zealandia in Wellington City was proposed in 1992 and has taken almost 30 years to reach maturity. This is because the establishment and set-up of fenced eco-sanctuaries tends to be a long and quite complex political, financial, and social process. In addition, when dealing with natural systems, it can take many years for species to establish secure populations and reach carrying capacity and for ecosystems to recover after long periods of damage. Pests and indigenous species do not always co-operate and can be very difficult to manage.

This study assumes there will be a series of three ten-year stages for the development of the sanctuary as follows.

Stage one: Establishment (2022 to 2031.)	**Stage two: Growth** (2032 to 2041).	**Stage three: Maturity** (2042 to 2051).
Establishment funding is obtained, a governance structure is established, a strategic plan is formulated, consents and core agreements are made, contracts are let, road and predator-proof fence are constructed, pests are eradicated. The first priority species (including kākāpō) are re-introduced, and resident species begin to increase. A small-scale public engagement programme is established.	All remaining target species are re-introduced, and populations establish and grow. Resident species populations reach carrying capacity. Some robust re-introduced species are establishing beyond the fence. If compatible with the water supply function, cultural, social and visitor programmes may be expanded, and additional facilities constructed.	Most reintroduced species (approximately twelve to fifteen) should be well established and/or be close to carrying capacity. Many species (but not all) are surviving and thriving in the wider Remutaka area, which is being managed as a ‘predator-free’ zone. Cultural, social and visitor programmes are at their desired optimum, depending on the water supply situation.

Note that this study deals exclusively with Stage one: Establishment. Implications for stages two and three have been kept in mind but not specifically investigated.

How we approached the task

The methodologies employed in this study are as follows.

1. Adopting a structured order of enquiry which proceeds from the broad to the particular, following a logical project development process (i.e., desired outcomes to costs and risks).
2. Commissioning substantive reports from parties with a major interest (e.g., Taranaki Whānui, DOC, etc).
3. Researching lessons from **precedents** and similar operations and situations. These are often cited during the study as there is a 20-year horizon of application for almost all the methods which will need to be employed. Those techniques and methods are well known and tested.
4. Consultation with parties who have a major interest.
5. Eliciting expert opinion from professional people who are highly regarded in their fields.
6. Eliciting design and costings from potential suppliers where possible and appropriate.
7. Research and citing of published material where relevant.

All findings were reviewed to ensure objectivity and sufficiency.

Thanks

Thanks to Ihaia Puketapu and Taranaki Whānui for their blessing, guidance and support.

Special thanks must go to our engineers (Beca) and consulting ecologists (Boffa Miskell) for generously providing their professional services pro-bono for this project. The study could not have been completed without them.

Thanks to Greater Wellington (GW) for sponsoring and supporting this study, both with co-funding and in providing staff services. Thanks also to all the GW staff and councillors who gave generously of their time in the midst of busy schedules. Wayne O'Donnell, Glen Falconer, Ricky Clarkson and Amanda Cox need special mention.

Thanks to DOC for co-funding this project and providing technical support. Thanks especially to Mark Fitzpatrick, Nikki Pindur, Keith Broome and the recovery teams for their support.

Thanks also to all those people who gave their advice and reviewed papers and supported the venture.

Please see the credits for a full list of contributors.

Figure 1. Stephen Fuller (Boffa Miskell) and Paul Wopereis (Beca) leading the survey of the fence route on the eastern ridge. Photo Ricky Clarkson.

Part 1

Background and Project Description

Figure 2 Abundant mature rimu is a feature of the catchment. Photo GW

1.1 The Problem

Nationally there are a significant number of critically endangered forest species which require predator-free habitat and where offshore islands can no longer provide sufficient of that habitat to ensure long term security of the species (e.g., kākāpō, rowi kiwi, kiwi pukupuku, hihi, tīeke, tuatara, giant weta). Currently, the Department of Conservation (DOC) depends on a small number of community sanctuaries to provide mainland habitat for most of these species.

The case for predator fencing Wainuiomata rests primarily on its habitat potential for a significant number of these critically endangered indigenous species. The unique features of Wainuiomata which make it important for threatened species management is its size (3,313 ha) and the quality of the habitat (largely unmodified lowland podocarp, broadleaf forest).

Wainuiomata has particular value for the following species.

Kākāpō. (*Strigops habroptilus).*[1]As of 2021, there are 201 kākāpō in existence and availability of secure habitat is becoming a problem.

Kiwi. The indigenous kiwi of Wellington are the little spotted kiwi (*Apteryx owenii),*[2] and the rowi kiwi *(Apteryx rowi)*[3]. Both are in need of additional secure habitat.

Hihi. (Stitchbird, *Notiomystis cincta)*[4]. Hihi are the only member of a deeply endemic NZ family, indigenous to the North Island, whose closest relations are the NZ wattlebirds.

See section 2.3 Biodiversity Value for a full analysis of these species and their needs.

There are many other species which are vulnerable or recovering, and could improve their status and increase their range, through the establishment of a large area of safe breeding habitat (tīeke/saddleback, kōkako, kākā, kākāriki, toutouwai/NI robin, pāteke/brown teal, etc).

Figure 3 Kākāpō on Whenua Hou island. Photo DOC.

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[1] Conservation status-nationally critical.
[2] Conservation status-recovering,
[3] Conservation status-nationally vulnerable.
[4] Conservation status-nationally vulnerable.

1.2 The Proposal

The proposal is to construct a 28.8km predator proof fence around the Wainuiomata Catchment (3,313 hectares), eradicate all pests (predators and browsers), keep the area predator-free and restore all extant (previously resident and surviving) indigenous species to the enclosed area. This is to be undertaken without unduly impacting the water supply function.

This site has qualities which make it uniquely suitable for addressing the problem stated above.

Size. At 3,313 hectares it is the same size as Hauturu, the largest of the near-shore predator free islands.

Habitat quality. It is largely unmodified and is a rare example of an intact, high energy, lowland podocarp/broadleaf forest ecosystem rich in rimu. This type of ecosystem is noted for its high carrying capacity.

Configuration. The catchment is a river system headwaters, surrounded by accessible ridgetops which make it very practical and efficient to predator fence.

Location. Its central location in a large protected forested area will benefit the surrounding area and create options for large scale integrated landscape management. Its proximity to our capital city is a significant strength, with many advantages from a governance, management, educational, philanthropic and community perspective.

Initially (in the first ten years) the focus will be on restoring the biodiversity of the enclosed area. When opportune, the managed area can be extended into the Remutaka range and surrounding reserves to aid the recovery of biodiversity across a wide area (up to 40,000 ha).

Over time cultural and social programmes (membership, volunteering, visitation) can be added as seen fit – providing they do not adversely affect the water supply and biodiversity operation.

The project can be operated as a partnership between iwi, local and central government, and community to maximise benefits to and engage the various communities of interest.

See the original proposal to Greater Wellington (GW) made in April 2020.[5]

1.3 Strategic Context

In the 1980's, in response to a worsening threatened species crisis, DOC and Manaaki Whenua/Landcare Research developed the technology to eradicate rodents and other predators from off-shore islands. Since then over 40 islands have been made predator-free. In the early 1990's the concept of the 'Mainland Island' (MI), where an area is managed intensively to reduce pests to a level which will allow certain species and the ecosystem to recover, was introduced at Mapara Forest near Te Kuiti. These programmes became the central strategy for threatened species management. At the same time large scale management was improved through aerial toxin application and wild animal control to protect forests from collapse.

[5] Lynch, JR. (First version 2nd April 2020. Revised 2nd December 2020). The Wainuiomata Project – A proposal to fence the Wainuiomata Catchment and restore the biodiversity of the Remutaka Range.

In 1992, the first predator-fenced community eco-sanctuary was proposed for Karori Reservoir in Wellington City[6] and the first multi-species predator-proof fence (8.6km) was built there in 1999. Now known as Zealandia, sixteen threatened species have been returned to the 225-ha enclosed area (seven species being the first to be returned to the mainland) and the spill-over from Zealandia has made a material difference to the birdlife in the city[7].

Figure 4 The first multi-species pest-proof fence goes up in Wellington's Zealandia in 1999. Photo Stephen Fuller.

Social and economic impacts have been just as significant. Zealandia inspired a national community sanctuary movement which now encompasses 30 fenced sanctuaries and islands and protects approximately 44,000 ha of high value land[8] The largest of the fenced sanctuaries is Maungatautari near Cambridge (3,400 ha) where the fence was built in 2006. The community conservation sector has been arguably the largest growth segment in NZ conservation over the last 20 years.

In 2012, a community movement was formed to 'Make New Zealand predator free'. This has grown and a goal to eliminate at least three pest species (rats, possum, mustelids) from mainland NZ by 2050 has been adopted by DOC and a crown agency – Predator Free 2050 Ltd. Community led predator-free programmes have proliferated around NZ, seeded by crown funding, and a major research programme to develop new technologies has been initiated. However, despite eight years of effort, the only truly predator-free areas are the fenced sanctuaries. Our pest control toolbox remains very small and still relies on proven methods such as exclusion fencing, toxins, traps and hunting, largely developed in the 1980-90's.

In 2020, the Aotearoa Biodiversity Strategy was published[9]. This emphasises goals for threatened species recovery, landscape and ecosystem protection, iwi empowerment, and public and community partnerships.

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[6] Lynch JR (1992) A Native Wildlife Sanctuary for Wellington City.

[7] McArthur, N.; Flux, I.; Harvey, A. (2021). State and trends in the diversity, abundance and distribution of birds in Wellington City. Client report prepared for Greater Wellington Regional Council, Wellington.

[8] Innes J et al. (2012) New Zealand ecosanctuaries: types, attributes and outcomes. Journal of the Royal Society of NZ.).

[9] DOC. (2020). Aotearoa Biodiversity Strategy- Te Mana o te Taiao.

1.4 The Wainuiomata Catchment

Site description

The Wainuiomata water catchment is located 2km east of Wainuiomata township (part of Lower Hutt City). It is the headwaters of the Wainuiomata River, consisting of the west and east branches and many tributary streams including Sinclair's Creek and Georges Creek. It is the western section of the 7,373-hectare Wainuiomata/Orongorongo Water Collection Area which includes the headwaters of the neighbouring Orongorongo River.

The Water Collection Area is part of a major complex of protected natural areas totalling approximately 40.000 ha which includes the neighbouring Wainuiomata/Lower Hutt City and private reserves, the East Harbour Regional Park (2,250 ha), Pakuratahi Forest (8,000 ha) and Remutaka Forest park (23,000 ha). The site proposed for the sanctuary is roughly triangular in shape and is approximately 3,330 hectares in size. It is enclosed by ridges separating it from three neighbouring valleys to the west (Moore's valley), north (Whiteman's Valley) and east (Orongorongo valley). The Wainuiomata Recreation Area, from where the catchment is accessed via Whitcher Grove and Reservoir Road, is immediately to the south-west.

Figure 5 The Remutaka showing the proximity of the catchment to Wainuiomata and its strategic location.

Cultural values

The catchment is known to mana whenua as Puketahā after the maunga of the same name on the eastern pae maunga (ridgeline) that dominates the catchment and the adjacent Orongorongo catchment. The general area has been the takiwā of many iwi over time and has significant cultural value to mana whenua as a bridge between Whanganui-a-Tara and the Wairarapa. While the catchment has not been the site of settlement, it has always been a significant hunting and foraging area and has considerable history and whakapapa attached.

Figure 6 The eastern pae maunga with Puketahä as its highest point. Photo courtesy of Ihaia Puketapu.

The mana-whenua of the catchment is **Taranaki Whānui ki te Upoko o te Ika (Taranaki Whānui),** represented by the Port Nicholson Block Settlement Trust (PNBST). The iwi is Te Āti Awa and the hapū is Te Matehōu. Waiwhetu and Wainuiomata are the local Marae.

In accordance with the Treaty of Waitangi, PNBST was consulted immediately the proposal was made and has registered its interest in being a significant partner in the enterprise. PNBST was commissioned to produce a Cultural Safety Report which defines the whakapapa of the area and the interests of Taranaki Whānui.

See 2.2 – Iwi and treaty for a full analysis of the cultural issues involved and Appendix A for the Cultural Safety Report.

European and water supply history

Wainuiomata occupies a basin at the headwaters of the Wainuiomata River, between the eastern Hutt hills and the Orongorongo Range, an area once covered in dense forest and large swamps. The 1855 Wairarapa earthquake lifted the swamps and encouraged European settlement. The earliest settlements grew up around the river, where timber mills supplied the Wellington region when the demand was greatest in the 1850s and '60s.

The isolated location of Wainuiomata proved a problem for early settlers. Narrow hill-routes into the settlement were the only access during the 1850s and 1860s. The town's economy in the early days largely depended on the timber milling from the forests around the Wainuiomata River[10]. The Moore and Sinclair family farmed and operated sawmills in the upper reaches of the Wainuiomata River and by1880, they had pushed up to the headwaters of the catchment, had milled the first ridges and were farming the river flats where the Morton Dam is now located.

[10] Wikipedia (2021). Wainuiomata.

Wellington City had become the capital in 1850 and was doubling in size every five years. There was an urgent need for clean freshwater for the rapidly growing city and the peninsula lacked large rivers to supply this need. The first water supply dam was completed at Karori in 1878 but was still unable to supply Wellington's needs. The City Engineer, Nicholas Marchant, recommended the headwaters of the Wainuiomata River, the Sinclair brothers were bought out in 1882 and the land allocated to water supply. If this had not been done at this time the catchment would have been logged and burnt and we would not have this outstanding resource available to us.

A small dam was constructed at Wainuiomata in 1887 and a monumental project undertaken to pipe the water from Wainuiomata to Wellington involving three km of tunnels and 35km of cast iron pipes imported from Britain. The controversial scheme cost the huge sum of 145,000 pounds and was beset by engineering problems but finally Wellington had a reliable and adequate water supply.

By the early 20th century, the existing Karori and Wainuiomata supplies were insufficient. The Karori supply was expanded when the Upper Karori Dam was completed in 1908. The larger Morton Dam was built at Wainuiomata in 1911 and in 1924 the Wainuiomata Water Collection area was expanded to include the headwaters of the Orongorongo river in the neighbouring catchment to the east. A weir and off-take were constructed in the Orongorongo catchment, and a tunnel driven under the hill to Georges Creek in the Wainuiomata catchment to the treatment plant. In 1986 the Morton Dam was decommissioned due to earthquake risk and silting but water is still taken from the Wainuiomata river via a weir and pipe system located further upstream from the old dam The two catchments together supply about 20% of Wellington's water.[11]

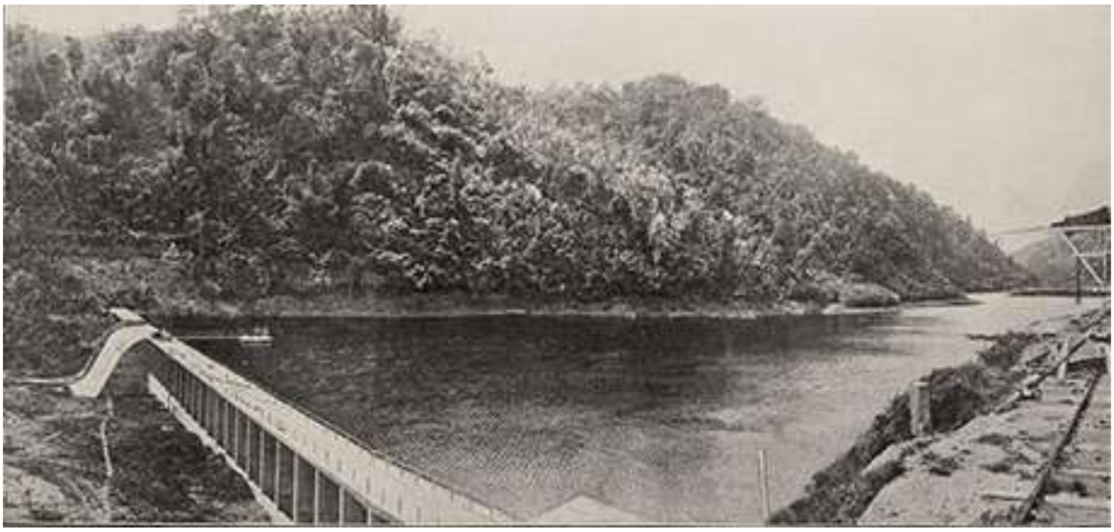

Figure 7 The newly constructed Morton dam in 1912.

Biodiversity of the catchment

The catchment is part of the Tararua Ecological district and consists primarily of lowland rimu-rata/kamahi forest, ideal for the critically endangered species to be potentially located here. This is typical of central and southern North Island lowland forest on better soils.

The forest is at low altitude (below 400 metres) and contains abundant rimu, hinau and rewarewa throughout, and in parts of the valley floor, tawa is the dominant canopy tree. Across much of the region this forest type has been impacted by land clearance, selective logging due to its accessibility and by browsing mammals. The Wainuiomata water collection area is

[11] GW. (2007) Our water History – on tap.

valued due to having not been cleared or logged for the most part and so contains all the structural elements of the original forest.[12]

A feature of the forest is the extent of rimu which covers about 85% of the site and dominates the canopy with numerous emergent rata, which needs rimu as its primary host. The forest structure (emergent, canopy, subcanopy, shrub, lianes, floor) is largely intact except for parts of the shrub and floor layers which have been damaged by historical herbivore browsing.

As with most of the Remutaka range, indigenous fauna species have been considerably depleted since European settlement and few nationally endangered species reside in the catchment. The general locality was notable for being the last stronghold of the huia (last official sighting in the Tararua 1907). The last sighting of kākāpō in the North Island was reportedly in Whiteman's Valley on the north boundary of the catchment in 1905[13]

Figure 8. The Wainuiomata catchment looking south from the Whiteman's valley (north ridge) end. Photo GW.

Biodiversity management history

The biodiversity management history of the catchment prior to 2000 is sketchy. Deer, pig, goat and possum control was undertaken when the numbers built to a point where they became an issue for the water supply. Occasional drives of deer from the catchment were reputed to net as many as 300 animals at a time and understorey damage from this era due to browsing is still visible.

In 1999 the Wainuiomata Water Collection Area (WWCA) was designated a Key Native Ecosystem (KNE) under the GWRC biodiversity programme. GW began aerial 1080 toxin applications to control possums, established professional hunting of ungulates and appointed a ranger. In 2004 a comprehensive 'Mainland Island' (MI) style bait station and trapping operation was set up in a portion of the Wainuiomata River headwaters covering 1,200

[12] Singers, N.; Crisp, P.; Spearpoint, O.; 2018 Forest Ecosystems of the Wellington Region. Greater Wellington Regional Council Report. Wellington, New Zealand.
[13] Jansen, P. pers. comm.

Figure 9.The road and deer fence on the north ridge. Note the hard rock outcrops (see geology below). Photo GW

hectares. The programme targets rodents and mustelids with a 150m X 100m management network and has been operating ever since. In 2005 a sixteen-kilometre deer fence was constructed along the western and northern boundaries to reduce the migration of deer, goats and pigs into the catchment. GW spends approximately $200,000 pa to maintain these programmes.

The results of these programmes have been variable. The MI operation is effective in controlling rats and mice but can be overwhelmed in a mast year. While 1080 operations have kept the possum numbers down, the effect of the aerial drops outside the mainland island on rodents is usually temporary and the population can spike in mast years. Deer and pigs still invade from the east and need regular operations to keep them down.

With the establishment of the mainland island, it was intended to release missing but extant species in the catchment with toutouwai/NI robin and NI kōkako being the first targets, the habitat having been assessed as suitable for both these species. In 2012 and 2013, 120 toutouwai/NI robin were transferred into Skull Gully from Waimarino Forest and Kapiti Island. There was successful breeding and fledging from at least six pairs but dispersal out of the safe site was high and meant a low establishment rate. Eight years later it appears that the robins have not survived, and the attempt has failed. Consequently, the kōkako transfer has been postponed indefinitely. The loss of the robins was the catalyst to propose that fencing the catchment be considered.[14]

[14] GW. (2018/2021). Key Native Ecosystems Operational Plan for Wainuiomata/Orongorongo.

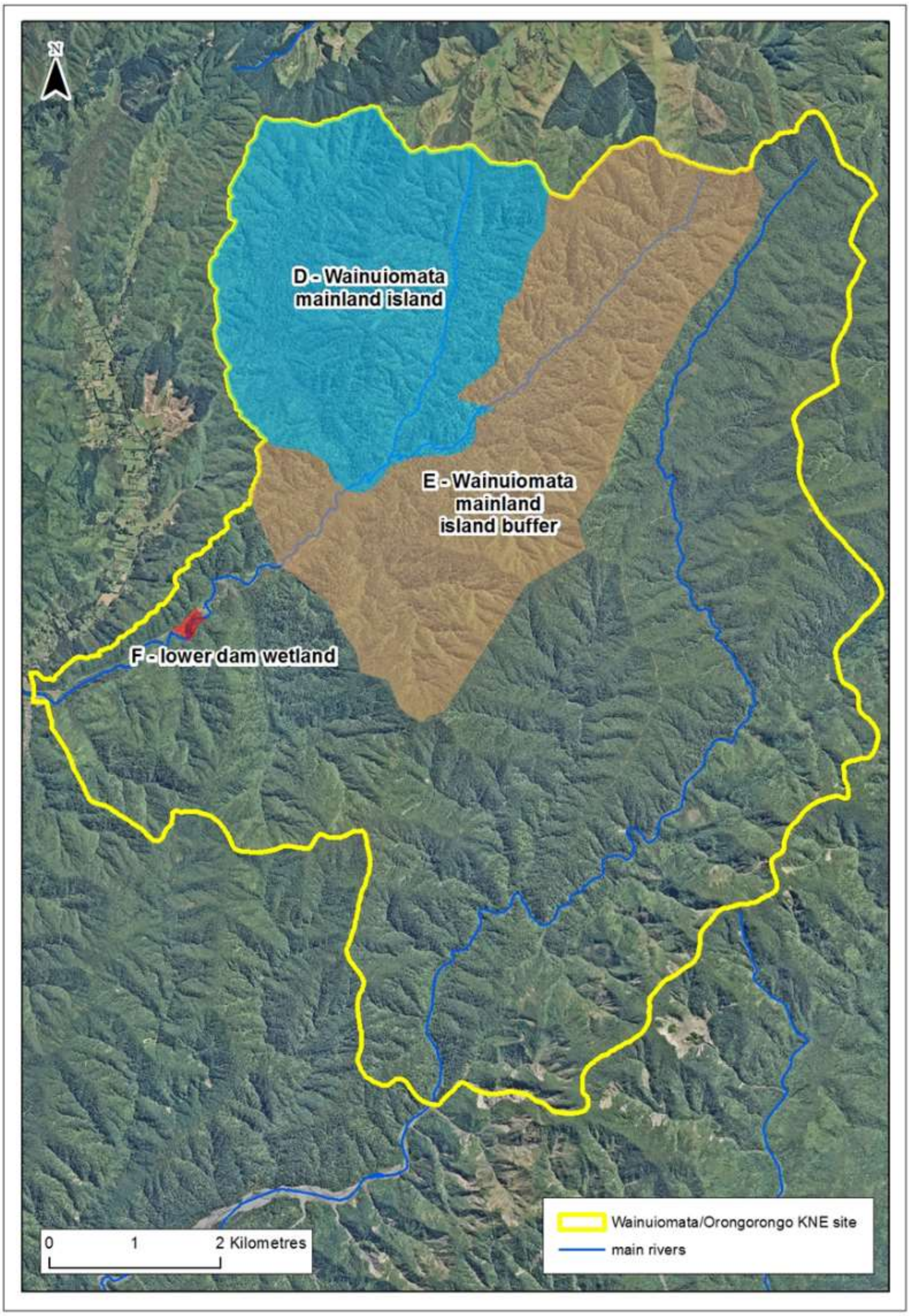

Figure 10. The Wainuiomata/Orongorongo KNE site with the mainland island and buffer zones shown. Map GW.

Geology

The underlying geology of the catchment is predominantly greywacke and minor argillite, being typical rocks of the Wellington area. The rocks are part of the Rakaia terrane, Torlesse Supergroup. The proposed fence route passes over strong unweathered grey rock on parts of the north and east sections. Elsewhere the fence route passes over moderately to highly weathered rock and areas with clay colluvium soil cover. There are no mapped active faults in the project area.

The pattern of prominent ridges and gullies in the catchment indicates that the present topography is a result of a combination of slow uplift of the ranges and progressive downcutting by streams. Shallow slips involving colluvial soils appear on some steep slopes and are most likely to have occurred as a result of saturation of soils after heavy rain events. Some older slips may have occurred during the large earthquake on the Wairarapa Fault in 1855[15].

This indicates that the geology of the catchment is stable enough to carry a fence, so much so that some areas may require rock drilling at added cost.

The Wainuiomata catchment includes the Wainuiomata River east and west tributary branches, the Skull Gully Stream, Sinclair Creek and Georges Creek. The highest peak in this catchment is Puketahā (800m) on the eastern ridgeline and elevation is 125m above sea level at the Morton Dam. The U-shaped river valley floors regularly flood, moving gravel eventually to the coast. Sixty percent of the land is moderately steep to steep (21-35°), and 8% is very steep (over 35°) with little flat or undulating ground.[16]

This steepness presents a challenge for access and management and a solution to pest-proof the large, fast flow river will be required.

Climate

According to NIWA (2014) average annual rainfall measured at Wainuiomata Reservoir is 1800mm per year with the highest monthly averages received in June-July at 224mm per month, and the lowest in January-February at 81 and 89mm per month. Snow falls over 800m elevations are common in winter. The higher ridges primarily receive snowfall, but snowfalls at lower elevations also occur for short periods most winters.

Extreme weather events such as storms are common in the Wellington region with high winds causing land slips, vegetation damage and localised flooding in the catchments. Periods of low rainfall average two periods per year of nineteen days and are most common in summer.

Extreme weather and deep snow would present a challenge for fence maintenance and inclement weather makes visitor programmes difficult.

Figure 11. Snow on the eastern ridgeline road. July 2021. Photo. Eve Lynch

[15] Paul Wopereis. BECA (November 2020). Geologist report.

[16] GW. (September 2016). Hutt and Wainuiomata/Orongorongo water collection areas management plan.

Part 2

Feasibility

Figure 12 The fence at Maungatautari

2.1 Governance, Management, Costs and Risks

The question

The Puketahā/Wainuiomata Sanctuary project will be a major undertaking which aims to deliver public good services on public land over a long period of time in a high-risk industry. It will involve multiple interested parties, the allocation and expenditure of substantial public and private funds and be the focus of intense scrutiny. The overriding questions are.

1. Is the project technically feasible?
2. What are the best 'fit for purpose' partnership and governance arrangements?
3. What management and operating structure is required to develop and operate a sanctuary that helps assure the future of critically endangered and iconic species?
4. What process will take the venture from start-up and development, through to an ongoing sustainable operation?
5. What resources are required to succeed?
6. What significant risks are there?

This section summarises all the issues involved and sets out how the project could unfold over the first ten years of its lifespan.

The findings of the subordinate projects

The twelve sub-projects in this study assessed the biodiversity, social and technical issues for feasibility. Their findings are as follows:

Iwi and Treaty. The catchment is known as Puketahā by mana whenua **Taranaki Whānui ki te Upoko o te Ika (Taranaki Whānui)** and are represented by the Port Nicholson Block Settlement Trust. (PNBST). They confirm the area has great cultural significance for them, they have been involved in developing this idea since its inception and they wish to be involved in the enterprise over the long term. (See section 2.2).

Biodiversity value. The Department of Conservation (DOC) supports the project. They have assessed the biodiversity value of the site and confirm it has national importance for, and could change the threat status of, three critically endangered species: kākāpō, rowi kiwi and hihi. It also has regional and local biodiversity value for other species. (See section 2.3).

Social and economic value. The project will add economic value to the region of up to $160 million over ten years, create jobs, maintain valuable ecosystem services (water supply, soil conservation and carbon sequestration), and facilitate community engagement through donations, memberships, volunteering and low-level visitation. A high-volume visitor programme is not recommended for this stage and has not been planned for in this study. (See Section 2.4)

The need for a fence. We confirm that the primary purpose of a threatened species habitat cannot be achieved without a predator-exclusion fence. (See Section 2.5)

Land tenure. The catchment, including all water infrastructure, is owned by Greater Wellington (GW) in several land parcels, and is set aside for water collection. The catchment is operated as a water supply facility under a service agreement with Wellington Water. (See Section 2.6).

Compatibility with water supply function. The catchment could be operated under dual purpose service agreements (water and sanctuary) with GW with the consent and goodwill of Wellington Water. At time of submission their position had not been established. (See Section 2.7).

A fence route. There is a viable fence route of 28.8 km around the catchment perimeter. 12.8 km is on an existing road and 16 km of new road is required. Crossing the Wainuiomata River could be achieved with a pest-proof weir. There are significant technical, consenting, and cost risks with the route and weir which will need to be resolved. (See Section 2.8)

Fence construction. There is a fence design which will exclude all target pests. The fence can be built on an existing perimeter road on the western and northern boundaries and a new road on the southern and eastern boundaries. (See Section 2.9).

Eradication of pests. All fifteen target pests can be removed from the catchment. Mice are likely to reinvade. The presence of mice will not affect the primary purpose of a threatened species sanctuary. (See Section 2.10).

Maintaining a pest free status. The fenced area can be kept clear of pests permanently, except for mice. Periodic incursions will occur but can be managed. (See Section 2.11).

Species recovery. The key target species can be reintroduced to the catchment and are likely to establish populations over the long term. (See Section 2.12).

Managing the 'halo'. It is desirable to manage the surrounding 40.000 ha of habitat to take advantage of migration from the sanctuary, increase the abundance of resident species and expand the range of re-introduced species. This has not been fully investigated by this study.(See Section 2.13)

This section referred to each of these projects and added the governance and management questions in 1 above. Costs and risks identified in these projects were summarised and the following final conclusions drawn.

The findings of the study

The following conclusions have been drawn from this entire study.

1. The project is technically and practically feasible. There are significant risks, but most of these can be managed.
2. There is an option for a legal entity and governance which could meet the needs of all partners. This is a partner (GW/iwi/DOC) controlled charitable trust. It would need the partners to be willing to participate and a service agreement with GW for joint use of the land with Wellington Water. The partners and settlors of the trust must be decided.
3. The project will go through three phases over the first ten-year period. These are: One: Preparatory (three years); Two: Development (four years) and Three: Operations (year eight and on). Each phase has been described in terms of its tasks and resource requirements.
4. The total cost has been calculated as $41,823,344 over the ten-year period. This is broken down into OPEX of $23,090,734 over ten years and CAPEX of $16,680,000, plus a 15% contingency allowance. See 18. Operating and capital cost summary.
5. The net cost to operate the sanctuary after year ten is calculated as $2,523,960 per annum in current dollars.
6. There are significant risks involved in the project. Four risks could result in abandonment of the project if they occur or cannot be managed and mitigated. The remainder can be managed.

How we approached the task

In answering the questions, we carried out the following:

- Researched current partner practices and discussion with representatives of the potential partners.
- Referred to precedents and equivalent experiences from other fenced sanctuaries. There is a large body of work to draw on in this area with established technology.
- Drawn conclusions through a series of sub-projects which have dealt with the fundamental questions and technical issues behind the enterprise. These are referenced in this document and included as separate sections in the overall study.
- Sought review of the document by partner organisations.
- Assessed costs and resources in consultation with the various working groups and with reference to precedents.

Precedents and equivalents

Other fenced sanctuaries have been used as comparisons and precedents for the various projects. There is a twenty-year record of fenced sanctuaries operating on mainland New Zealand.

Of these, there are six fully ring-fenced community sanctuaries. They all operate as charitable trusts under the Charitable Trusts Act with a variety of partnership and legal arrangements.

Sanctuary Mountain/Maungatautari (Cambridge). 3,400 hectares. Fence (48 km) built 2006**.** Has permission to reintroduce kākāpō, (although suitable habitat is limited) and have established hihi, kiwi, tīeke and tuatara. Operates as a charitable trust which has a partnership arrangement with five local iwi, the Waipa District Council, Environment Waikato, and local landowners. DOC has an MOU for technical advice. They operate through a trust deed and board made up of representatives of the partners with a co-chair arrangement for iwi engagement.

Zealandia (Wellington City). 225 hectares. Fence (8.6km) built 1999. Has reintroduced sixteen species of which seven were the first to be reintroduced to the mainland. It is a Council Controlled Organization (CCO) which operates as a charitable trust under a trust deed and a board of trustees appointed by the Wellington City Council (WCC). The WCC are settlors of the trust. The trust operates under WCC, CCO reporting and oversight requirements.

Bushy Park (Wanganui). 100 hectares. Fence (4.8 km) built 2005. Tieke, robin, hihi reintroduced. Operates as a Forest and Bird charitable trust which jointly manages the homestead and forest park.

Orokonui (Near Dunedin). 307 hectares. Fence (9km) built 2007. A charitable trust owned and managed by the Otago Natural Heritage Trust.

Rotokare (near Stratford). 250 hectares. Fence (8.2 km) built 2008. Operated as a charitable trust by the Rotokare Scenic Reserve Trust under a trust deed and board of trustees.

Brooke Waimarama (Nelson). 690 hectares. Fence (14.4 km) built 2016. Operated as a charitable trust by the Brook (Waimarama) Sanctuary Trust under a trust deed and board of trustees.

There are several sanctuaries on fenced peninsular including:

Tawharanui and Shakespeare Regional Parks (Auckland) are operated as part of Auckland Councils Parks Division.

Cape Sanctuary (Havelock North). 2,500 hectares. A privately owned peninsular at Cape Kidnappers.

It is unwise to generalise about the fenced sanctuaries as, while they are all based on the original Zealandia model, they vary hugely from the largely volunteer Bushy Park with a 100k pa budget to Zealandia with its near self-funding higher cost/high income model. There is a widespread perception that they aren’t sustainable but in fact they have all done remarkably well to achieve what they have with what funding they have been able to acquire. No sanctuary has had to be abandoned and all have reasonably healthy balance sheets. They can be vulnerable in a crisis (GFC, Covid) but do well most of the time and draw on their local communities for their support.

Objective

The objective of this part of the study is to:

- **Identify a governance and management structure which will fit the needs of the strategic partners and achieve the vision and goals of the sanctuary.**
- **Describe how the enterprise will be set up, developed, and operated for the first ten years.**
- **Summarise the conclusions, costs and risks of the whole project.**

Governance is the way an organisation is structured, sustained, regulated, and held accountable.

Management is the process of planning, operating, budgeting, and reporting to achieve stated goals.

Characteristics of the Wainuiomata Sanctuary

The Wainuiomata Sanctuary proposal has these characteristics which will help determine the nature of the governance and management arrangements:

1. **Te Tiriti o Waitangi**. As the partnership entity will involve the Crown and/or local government, it must give effect to te Tiriti-o-Waitangi.
2. **Public good**. The sanctuary will be undertaking public good services on public land. It will need to operate as a not-for-profit organisation and qualify for charitable status. It will need to attract private donations and sponsorship.
3. **Multiple stakeholders**. There are multiple stakeholders in the enterprise. The governing body will need to be able to represent the interests and needs of these stakeholders as partners. The primary stakeholders are:
    - **Mana whenua** Taranaki Whānui (TW) represented by the Port Nicholson Block Settlement Trust (PNBST).
    - **The Crown agency with biodiversity and species responsibility**. The Department of Conservation (DOC).
    - **The landowner, operational agency for biodiversity and owner of the water facility**. Greater Wellington Regional Council (GW)
    - **The local authority with jurisdiction over the land**. Hutt City Council (HCC).
4. **Specialisation.** Building and managing fenced sanctuaries is a specialised and complex task which calls on a range of disparate skills and professions and puts a premium on precision and results. These skills include cultural competence, project management, finance, risk management, engineering, construction, biodiversity and pest management, data and IT, community engagement, business management, education, and research. It needs competent, dedicated personnel on site.
5. **Project to operation.** As a 'start up' enterprise, the organisation will go through a project (development) phase and then transition to an ongoing operation. Governance will need to guide and support these phases and the transition between them.
6. **Scale and complexity.** Wainuiomata is at the upper end of the scale for fenced sanctuaries. The operation is arguably too big and complex to be managed by a community organisation. Of the two largest sanctuaries that began life as community charitable trusts, Maungatautari has had an evolving governance structure and relies on council funding[17] while Zealandia has become a CCO[18]. Other community sanctuaries operate at a small scale and survive on goodwill and public generosity, and this increases risk. We recommend that an enterprise of the size, complexity, and importance of Wainuiomata be organised and resourced to succeed and learn from the experiences of other related initiatives.
7. **Long term.** Ecosystems and species take decades to establish and grow to their optimum state and then require permanent care and attention.

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[17] Sanctuary Mountain Maungatautari (2020). Annual Report.
[18] Zealandia. (2020/21). Annual Report

The enterprise will need long term continuity of strategy and resourcing to be able to operate in perpetuity.

8. **Risk/reward and strategic alignment.** Wainuiomata is an undertaking which has risk, partly due to its scale, balanced by potentially high reward. Like any major joint project, the partners need to have the political and internal will to take responsibility for the risk and it needs to fit within their strategic priorities. This will determine which stakeholders will want to be involved as genuine partners.

Any governance arrangement and legal entity will need to meet these criteria if it is to be fit for purpose.

Options for a legal entity

The sanctuary operation will be required to be constituted as a legal entity. The options for legal entity are as follows:

1. **A GW division or part of a division**. This would meet 1,2 and 7 above. Feedback to date indicates it is unlikely to be acceptable to GW.
2. A **GW controlled charitable trust (CCO).** This would meet 1,2,4,5 and 7 above but is also unlikely to be acceptable to GW.
3. A **joint venture charitable trust** between all or some of GW, Taranaki Whānui and DOC. This would meet all the criteria above provided it is acceptable to the partners and they are willing to share the responsibility.
4. A **community charitable trust**. This would meet most of the criteria if the trust is financially underwritten by and responsible to the partners. If not, it would meet very few.
5. A **private or public company or trust** would not meet the criteria above and has not been considered further.

Under all options GW would retain ownership of the land and enter into a service agreement with the trust for the joint use of that land with Wellington Water. This would give the council confidence around the compatibility issues with, and continuity of, the water supply, but still have all the advantages stated above.

The recommended option for a legal entity

A **joint venture charitable trust** is the recommended legal entity as it is most likely to meet the criteria above, and the needs of the various partners and interested parties.

A key element in deciding the legal entity is, who are the 'settlors', i.e., the agency or agencies to whom the assets created in the catchment (fences, facilities, buildings) and liabilities of the trust (species, debts, legal agreements), will devolve in the event of dissolution. As the landowner, GW will need to be one of those settlors. If they agreed, DOC and Taranaki Whānui could be the others.

A charitable trust is the ideal structure to facilitate public good activities on public land for multiple partners. It can receive both public and private funding; it allows all interested parties to be involved, including the public; it is flexible enough to cope with both national and local levels of activity; it has formalised structures of governance and accountability; it can attract dedicated specialists; and it can have the longevity needed to pursue very long-term goals.

The conclusion is that there is an option for a legal entity and governance which will meet the needs of all partners. This is a partner (GW/iwi/DOC) controlled charitable trust. It would need the partners to be willing to participate and a service agreement with GW for joint use of the land with Wellington Water. Who the partners and settlors of the trust will be must be decided.

Objects of the trust

Some potential objects of the Trust could be to:

1. Maintain and improve the mauri of Puketahā.
2. Secure the catchment as a predator free zone by building and maintaining a predator exclusion fence and removing all pests from the enclosed area.
3. Reintroduce extant but missing species to the managed area.
4. Protect and enhance the catchment to optimise species occupancy and ecological integrity over time.
5. Act as kaitiaki for the interests of mana whenua, which includes the exchange of mātauranga Māori to inform management and decision making.
6. Achieve the goals and aspirations of mutual benefit for the partners, the community and future generations.
7. Contribute to the wider national efforts to improve biodiversity, to improve the status of threatened species and to develop and exchange knowledge.

Establishment committee

If the project receives approval to go ahead, the partners will need to form and appoint an establishment committee to get the enterprise underway. Likely comprising senior staff, the committee will need to: This activity initiates the project.

- Formalise agreements between the partners.
- Develop the trust deed.
- Appoint the board and chairs.
- Hand over to the incoming board.

$200,000 is allowed each of the first three years to cover miscellaneous establishment costs

The trust deed and board

The partners will formulate a trust deed to set out the objects of the trust and how the trust will operate. A trust board will be appointed to represent them and work to achieve the objects of the trust. The board will be constituted as follows:

- A co-chair arrangement is recommended with a mana whenua chair and a kāwanatanga chair to implement the Tiriti-o-Waitangi provisions of co-governance.
- Trustees can be appointed by the partners.
- The details of trustee’s appointments, roles, responsibilities, and general provisions will be set out in the deed in accordance with standard practice for public bodies.
- The general role of the board is to:
  - Set a strategic direction and plan
  - Secure base funding
  - Hire a Project Manager
  - Manage partner and strategic relationships
  - Monitor progress and report to partners.
- A budget of $100,000 per annum is allowed for board remuneration and expenses.

The management structure

The board will appoint a project manager to manage the project and build a team to establish and in time operate the sanctuary. The Project Manager should be skilled in project management and have the people skills to manage relationships and build a team. The Project Manager position can transition to a General Manager after phase two. This team will grow as different roles are required.

The Project Manager's role is to:

- Set out a project plan for the first two phases (seven years)
- Manage relationships and communications
- Finalise designs and negotiate contracts for specialist services
- Manage progress
- Hire and manage staff as needed
- Manage finances
- Report progress to the board.

Other staffing requirements

The Project Manager will need to take on a part time **office manager** growing to full time after two years, to assist the Project Manager, manage finances, assist with contracts, act as board secretary, handle hiring and personnel matters, and manage property, offices and accommodation.

Within one year, it would be productive to engage a **communications and fundraising** specialist whose job would be to manage the public interface and develop plans to attract donations, sponsorships, memberships, and other funding opportunities. Such a person would require a budget of $50,000 pa in addition to salary but would be expected to raise at least twice the amount of their salary and expenses. While the board and Project Manager would initiate and be involved in much of this extra funding activity, especially the larger donations, a specialist is required to secure deals, manage the relationships, keep records, and locate the smaller transactions. This person would also manage second level communications, relationships, and media.

Phasing and timing

The project is essentially a business 'start-up' which will go through three distinct phases.

Phase One: Preparatory. The activities required to set the organisation up and ready for the development phase.	**Phase Two: Development**. Where the major establishment projects are undertaken.	**Phase Three: Operational**. Where the project settles into a routine which will be maintained for the foreseeable future.

The following are the activities required for each phase and the time pathway.

Phase One: Preparatory (Years one to three)

- There will be a period of discussion between partners and potential funders to agree on a commitment to the project and to secure base funding, ideally to cover the first ten years. This is likely to take six months before the go-ahead is given.
- The set-up of an establishment committee. They will need six months to develop a trust deed and appoint a board.

- The board will need six months to set up the strategic plan, negotiate service agreements, and hire a Project Manager.
- The Project Manager will need six months to set up their team and base, contract key advisors and specialists, initiate design work ready for resource consent applications, and contract negotiations for construction (road, fence, weir, offices, and field base).
- Design work, resource consents and various permissions and negotiations with road and fence contractors will take up to eighteen months. This work should start in year one to ensure the high-risk components of the project (design and consents for the road and weir) can actually be done before major expenditure is committed.
- Phase two cannot proceed until the following items have been secured: agreement between partners; trust deed; service agreements; base funding commitments; governance structure operating; management structure operating; design work complete (road, fence, weir, offices, and field base); consents received; construction contracts let.

Phase Two: Development (Years four to seven)

This phase involves the following broad tasks in roughly this order and timing:

• Offices and field base construction and fit out.	One year
• Road construction.	Six months
• Field teams recruited and equipped.	Six months.
• Fence construction.	Two years.
• Monitoring and response network set up–parallel with the second year of fence construction.	One year
• Eradication of all pests. Beginning immediately after completion of the fence.	Eighteen months

- Phase three cannot commence until the following has been assured. Fence commissioned and secure. Incursion response system in place. Catchment declared free of all pests. Operations team in place.

Phase Three: Operational (Year eight and on)

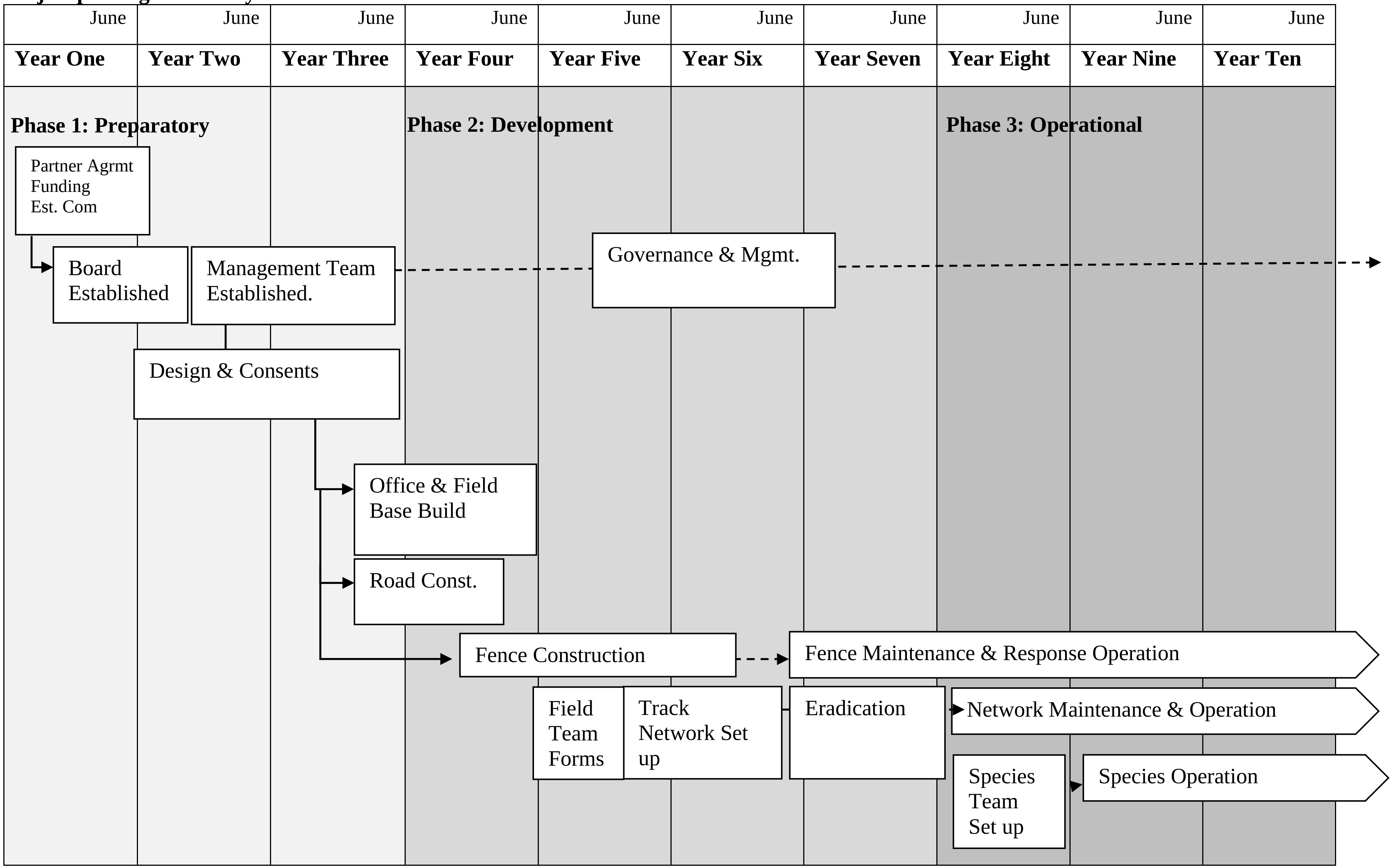
This involves the following ongoing operational activities:

- Field team scaled down to an operational mode. Immediately after all clear.
- Fence and response team in place and operating. Immediately the fence is completed.
- Species team in place and reintroductions begin. One year after all clear to allow a settling down period.
- Management team operating.
- Governance group operating.

Please note that this represents an ideal scenario where everything goes according to plan. As with most projects, the timeline is very sensitive to sequential projects being completed without disruption. See risks and contingency section.

See GANT chart below for the overall depiction of key events and timing.

Project phasing. First ten years.



Resource and cost assumptions – Phase One: Preparatory

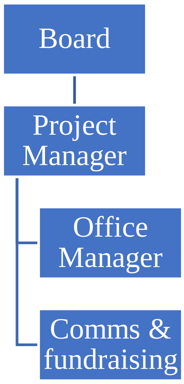
The estimates for phase one are based on these assumptions.

- Establishment committee. While committee representation would be drawn from partner staff, a part time contract should be let to provide services during the establishment process. $50,000 has been allowed for this. There will be legal costs in setting up a trust deed. $40,000 has been allowed for this. $10,000 should be allowed for running a board appointment process.
- Board costs and resourcing. Fees and costs for a small board with a co-chair arrangement. $100,000 pa has been allowed. This cost remains through all phases.
- $200,000 has been allowed for each of the first three years for general establishment costs (legal, specialist personnel, etc) to ensure the enterprise has some funds to get off the ground and to counter the weighting in the personnel formula below.
- Note that for personnel costs for this study, the GW personnel costing formula has been applied for all labour and personnel for this project. This allows a gross sum of $10,416 per month ($124,992 p.a.) for all personnel. This formula allows for balancing across grades where some personnel will be paid a lesser amount, and others will receive a higher remuneration. The formula allows for all personnel costs in addition to wages and salary, such as recruitment, training, and welfare.
- A management team of a Project Manager and two other personnel are allowed for in the preparatory phase. These are an office manager (half time for the first year) and communications and fundraising specialist. The standard formula has been applied to these positions. These are permanent positions.
- The management team will require office accommodation and expenses (allow $1,000 per month). In the preparatory phase this may be able to be provided at GW premises, otherwise space will need to be rented and outfitted. The marketing person will require a budget of $50,000 for website development, media and other communications, and marketing activities. However, it can be assumed they will more than pay their way by attracting donations, subscriptions, pro-bono services and sponsorships.
- Detailed design is required for the key capital items (road, weir, and fence) during this phase. Much of the road survey has been done, but further detail is needed. This work will be done by engineers and consulting ecologists and includes such items as an Assessment of Environmental Effects (AEE) for the resource consent application. Allow $200,000 for design and consulting fees.
- The resource consent costs are difficult to forecast. If the application is notifiable then it could be quite costly. Allow $200,000 for this process. Note these design and consent costs have been included in CAPEX under the road and weir construction.
- Design and consent costs ($565,000) have been brought forward to the second and third year to resolve this high-risk issue early before major funds are committed.

Summary of human resource requirements. Phase one Preparatory

- A Project Manager to plan and co-ordinate the whole programme and supervise the various projects.
- A half time Office Manager to back up the Project Manager. They will become full time when phase two begins.
- A Communications and Fundraising Officer to manage external issues and raise funds from the general public.
- This team can tap into the partner agencies to augment their resources in phase one.
- See next page for the phase one operating structure.

Phase One: Preparatory – Operating structure.



Resource and cost assumptions – Phase Two: Development

The estimates for phase two are based on these assumptions.

- Office accommodation will be required on site at Wainuiomata from year four to allow it to be in place and available when the construction and field team forms. The existing ranger's base (100 square metres) will be of some use but will need to be augmented to accommodate the management and field team leaders and the species team in due course. Another 250 square metres space will be required in addition to the existing ranger's base. This will include offices, meeting rooms, kitchen facilities, and toilets. At approximately $2,500 per square metre for building costs for regulation office space including fit out, this will cost $625,000. This is allowed for as a capital item.
- A field base will be needed to house the field team and their equipment and facilities (repair, vehicles, storage, clean-up, etc). There is an existing field equipment shed near the ranger's base and it is possible that one of the older existing storage buildings could be repurposed for this. However, the existing shed is too small, and the older sheds may not be suitable or may need extensive upgrading. The field teams will need about 500 square metres of storage and facilities space. These will cost about $750 a square metre to build. Allow $350,000 as a capital item. Note that the fit out of this base is allowed for in the eradication costings under materials.
- The road and weir construction are the first of the major projects. This will take at least six months to complete. Design and consent to be done in first years to reduce risk. The costs of these have been assessed as $3,565,000 which includes all design fees, supervision, and resource consent costs. See Section 2.8 and associated papers.
- The fence construction is the next major project. This can begin soon after the road construction starts by starting on the existing road. The fence will take at least two years to complete. The costs of this have been assessed as $12,115,000 which includes kākāpō proofing, pest proofing of discreet entry points and supervision costs. See Section 2.9 and associated papers.
- The eradication is the next major project. The field team for this can begin assembling six months after the road construction starts to begin setting up the track network. The eradication will spread over two to three years. It will not be completed until the 'all clear' has been given which will signal the end of phase two. The total costs of the eradication have been assessed as $10,514,290. The eradication costs have been spread evenly over a three-year period as even though the programme is planned for two years, delay and syncing with other projects, pre-purchase and ordering of materials and early hiring of leaders will mean some costs in the earlier year.

- The eradication team will grow to as many as forty people onsite at certain times. See section 2.10 and associated papers. Overheads for the field team have been included in the eradication costs. Transport (vehicles, LUV's), communications (radios, phones), technology (computers, cameras, etc), tools and materials for the field teams is allowed for in the eradication budget. $500,000 has been allowed to fit out the field base. These will be carried over into the phase three operation.
- The management team and field leaders will move into the office accommodation at the beginning of phase two. A sum of $150,000 pa has been allowed for overheads such as insurance, power, technology, rentals and maintenance The marketing budget is included in this figure.
- The field teams will change rapidly throughout the project. Initially the emphasis is on network line cutting and hunting and preparing for the aerial toxin operation. The aerial operation is primarily undertaken by contractors backed up by the teams. After the aerial operation, the emphasis is on mopping up remnant populations and running the monitoring lines until the catchment is declared all clear of target pests.

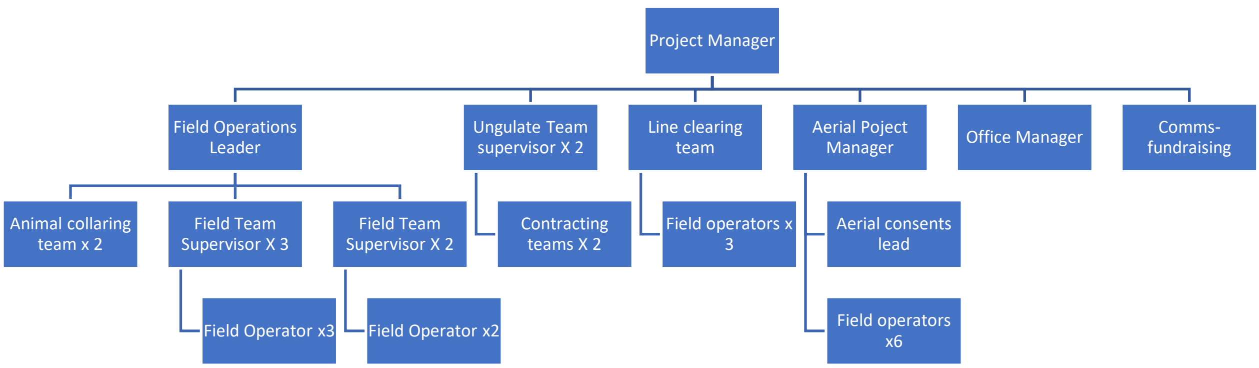
Summary of human resource requirements – Phase Two: Development

- A management team consisting of the Project Manager, Office Manager (now full time) and comms/fundraising specialist.

Pre-aerial operation the field team will consist of the following.

- A field operations leader to manage the network operation and supervise seven teams of field workers. This is a full-time and permanent position.
- Two ungulate team supervisors with contract hunters under them. These are temporary positions.
- A line clearing team to cut tracks and lines. These are temporary positions.
- An aerial project manager and team to supervise the vital aerial operation.
- Volunteer cells can be set-up to assist the team throughout the operation, as required.
- An expert reference group should be established to advise the operations manager and confirm best practice.

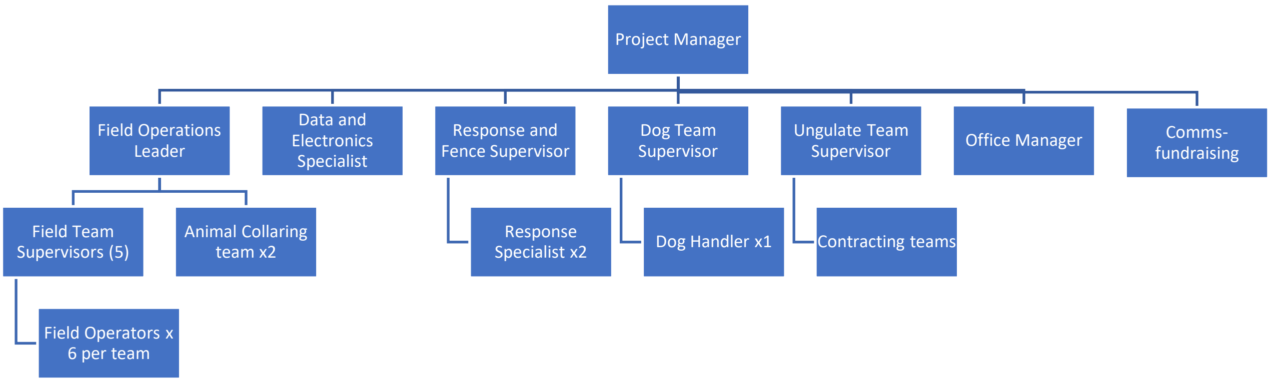
Phase two: Pre-aerial operational structure (First twelve to eighteen months)



Post-aerial operation the team will consist of the following.

- A field operations manager to manage the network operation and supervise seven teams of field workers. This is a full-time and permanent position. The teams will be reduced over time as confidence in the eradiation increases.
- One ungulate team supervisor with contract hunters under them to complete the eradication.
- A response and fence team. These are permanent positions.
- A dog team to monitor for residual pests and incursions. These are temporary positions
- A data and electronics specialist.

Phase two: Post-aerial operational structure (second twelve to eighteen months)



Facilities and equipment

All facilities and equipment required have been included in the materials budget, including vehicles, communications and field equipment needed to undertake all operations.

Resource and cost assumptions – Phase Three: Operational

The estimates for phase three are based on these assumptions.

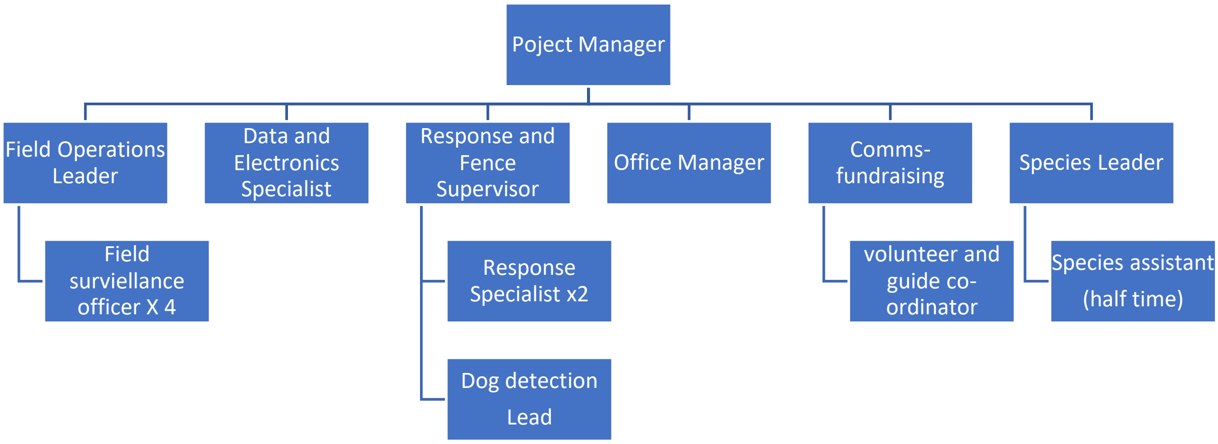
- The management team and their overheads will be similar to phase two. No expansion in public visitation is envisaged in the first ten years. Small-scale guided tours could be run by the communications/fundraising team through the volunteer co-ordinator.
- The field team is reduced in size and reconfigured to reflect a monitoring and incursion response footing. See section 2.11 and the associated paper.
- A species team is added in year eight to begin the species recovery programme. See Section 2.12 and the associated paper.
- Operating budgets are adjusted accordingly.

Summary of human resource requirements – Phase Three: Operation

- A management team consisting of the Project Manager, administration (full time), marketing person and a volunteer co-ordinator.
- A field operations manager to manage the network operation and supervise a team of four field workers. These are full-time and permanent positions.
- A response and fence team of three persons. These are permanent positions.

- A dog handler to monitor for residual pests and incursions.
- A data and electronics specialist.
- A species team of one and a half to manage the species recovery programme.

Phase three: Operational structure (Year eight and on)



Facilities and equipment

All facilities and equipment should be carried over from the eradication equipping and the capital programme. The materials budget for the operations team allows for equipment replacement and maintenance. A full deprecation and replacement programme will need to be put in place after year ten.

Operating and capital costs summary (all phases)

Following is a summary of all costings carried forward from the sub-projects and the assumptions in this paper. The total cost of the project over ten years is calculated at **$41,823,344.**

- All costs are ex-GST. It is assumed that the trust will be GST registered.
- All costs are assessed at 2021 values. No allowance has been made for inflation.
- Inflation and risk are covered by an additional contingency of 15%. The fence contractors have allowed a further 10% contingency in their indicative prices.

Revenue and financial contingency

- It is assumed that from year three the marketing and fund raising undertaken by the marketing co-ordinator will earn more than the equivalent of that person’s cost and budget through memberships, donations, sponsorships, and a modest guided tour programme. This will increase after the eradications as sponsorship opportunities increase and the project’s visibility increases. Revenue has been assessed as $3,400.000 in line with the assumptions included in section 2.4 Social and Economic Value.
- There is a lot of uncertainty in the economy over pricing and inflation. There is also considerable uncertainty regarding the risks of each of the major projects. Most of these uncertainties have cost implications. Therefore, a significant contingency of 15% has been allowed.

Opex												
Team		Years										
	Item	Year one	Year two	Year three	Year Four	Year Five	Year six	Year seven	Year eight	Year nine	Year ten	Totals
Management	Salaries		156,240	312,418	374,976	374,976	374,976	374,976	374,976	374,976	374,976	3,093,490
	Board	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	1,000,000
	Other	200,000	206,000	262,000	62,000	100,000	150,000	150,000	150,000	150,000	150,000	1,380,000
Eradication	labour					1,822,800	1,822,800	1,822,800				5,468,400
	Materials					1,681,963	1,681,963	1,681,963				5,045,889
Field-Fence	Labour								1,374,992	1,374,992	1,374,992	4,124,976
	Materials								610,998	610,998	610,998	1,832,994
Species	labour								93,997	187,994	187,994	469,985
	Other								25,000	225,000	225,000	475,000
Totals		300,000	462,240	674,418	536,976	4,079,739	4,129,739	4,129,739	2,729,963	3,023,960	3,023,960	23,090,734
Capex	Office				625,000							
	field base				375,000							
	road weir	300,000	265,000	1,500,000	1,500,000							
	Fence				3,028,750	6,057,500	3,028,750					
Total		300,000	265,000	1,500,000	5,528,750	6,057,500	3,028,750					16,680,000
Totals		600,000	727,240	2,174,418	6,065,726	10,137,239	7,158,489	4,129,739	2,729,963	3,023,960	3,023,960	39,770,734
Revenue	Donations etc		50,000	250,000	350,000	400,000	400,000	500,000	500,000	500,000	500,000	3,400,000
Net cost												36,370,734
	Contingency 15%											5,452,610
Total cost												**41,823,344**

Risks and contingencies

The major risks for the overall project are seen as follows. Note that specific risks for reach section are identified in the other papers.

Risk	Likely or significant	Prevention	Mitigation if it happens anyway.
Key agencies (DOC, GW, TW) will not take on the lead roles.	Likely and significant	Early discussion on roles and project risks.	May mean abandonment of the project
Base funding cannot be obtained.	Likely and significant	Make bids and cases	May mean abandonment of the project
Core agreements cannot be obtained (GW and Wellington Water).	Unlikely but significant	Continue discussion with Wellington Water. Make the cases.	May mean abandonment of the project
Labour shortages and cost escalation for key personnel.	Likely and significant	Budget realistically. Allow contingency (Done).	Meet the market and raise additional funds.
Resources consents cannot be obtained. Especially around the issues of side-casting on the new road and fish passage.	Unlikely but significant	Early design and discussion with consents people. Make the cases.	May mean abandonment of the project
Delay in key sequential projects effects whole programme timing.	Likely and significant	Allow realistic time frames.	Extend time frames and allow contingencies for delay costs.
Cost escalation and overruns on big items	Likely and significant.	Careful and conservative costing and allow for contingencies.	Raise additional funds
Technical and construction difficulties experienced – especially on the road and weir	Unlikely but significant	Further expert investigation and design. Built into the programme with design costs.	Allow contingency for extra costs.
Eradication fails	Unlikely but significant	Apply a risk minimisation approach to the project design and ensure it is well resourced. (Done)	Rerun the eradication after learning from experience. This will mean extra cost and delay, but the contingency should cover some of this.
Unmanageable incursions occur	Unlikely but significant	Apply a risk minimisation approach to the project design and ensure it is well resourced (Done)	Increase resourcing and biosecurity.
Species do not establish or breed.	Unlikely but significant.	Assess each translocation and manage and resource for success.	Continue trying.

2.2 Iwi and Treaty

The question

The project must work within the provisions of te Tiriti o Waitangi. The questions to be answered or confirmed include.

1. Who is the mana whenua for the catchment?
2. What specific interest do they have in the whenua and the project?
3. What other iwi have interest in the area, including the wider Remutaka?
4. How could this interest be incorporated into the project to best meet the principles of te Tiriti o Waitangi?

Our Findings

1. The mana whenua is **Taranaki Whānui ki te Upoko o te Ika (Taranaki Whānui)** and is represented by the Port Nicholson Block Settlement Trust. (PNBST).
2. The catchment is known as Puketahā by mana whenua. And they confirm the area has great cultural significance for them.
3. They have been involved in developing this idea since its inception and they wish to be involved in the enterprise over the long term.

How we approached the task

In accordance with the principles of te Tiriti o Waitangi, iwi with an interest in the catchment were identified early and discussion and engagement initiated immediately.

The assumption was that **Taranaki Whānui ki te Upoko o te Ika (Taranaki Whānui),** through the Port Nicolson Block Settlement Trust (PNBST) are the mana whenua for the catchment. This has since been confirmed and the trust was first contacted in July 2020. They expressed in writing that they viewed the proposal favourably, and they were interested in a partnership arrangement.

In March 2021, the PNBST were commissioned to provide a Cultural Safety Report to the Steering Group to identify all the iwi, treaty and cultural issues involved. This report has been received and approved by the PNBST[19].

The following has been provisionally confirmed through discussion with the report's author and the Port Nicholson Block Settlement Trust.

- The **mana whenua** for Puketahā (the catchment) is Taranaki Whānui ki te Upoko o te Ika (Taranaki Whānui), represented by the Port Nicholson Block Settlement Trust.
- The iwi is Te Āti Awa and the hapū is Te Matehōu. Waiwhetu and Wainuiomata are the local Marae.

[19] Taranaki Whānui ki te Upoko o te Ika. (2021). Puketahā. Cultural Safety Report. Appendix A

There are a number of specific interests that Taranaki Whānui have in the whenua and the project as follows.

- **Identity and mana**. The establishment of a secure sanctuary at Puketahā will enable Taranaki Whānui to re-establish their mana and reclaim their cultural rights over the whenua.
- **Partnership**. Taranaki Whānui have expressed a desire to be meaningfully involved in and to influence the project as it proceeds. This would mean representation on the governance entity as a partner and co-management. This wish has been incorporated into the proposed governance structure. (See Section 2.1)
- **Te Mana o Te Taiao.** The project will enable Taranaki Whānui to revive their relationship with Te Taiao (nature) and re-establish many lost cultural practices. Note. This and partnership are important elements of the New Zealand Biodiversity Strategy (NZBS) Te Mana o te Taiao.[20]
- **Cultural expression**. Taranaki Whānui have expressed a desire in due course to establish a wharenui at the entrance to the catchment to educate both rangatahi and the public on their role and place in Te Taiao and Puketahā. Note: This is unlikely to be a consideration in stage one (the first ten years) due to timing and the extent of other essential developments (fence, eradication, species releases, etc) but should be considered for stage two.

Iwi with wider interests in the general Wellington and Remutaka area are Ngāti Kahungunu (Wairarapa/Remutaka) and Ngāti Toa (Kapiti/Wellington). These iwi have not been approached for this study but will be informed of progress.

Appendices

The following Appendices have been prepared to support this section

Appendix A. Puketahā. Taranaki Whānui ki te Upoko o te Ika. Cultural Safety Report 2021.

[20] DOC (2020). Aotearoa New Zealand Biodiversity Strategy Te Mana o te Taiao

2.3 Biodiversity Value

The question

The merit of this project is largely based on the added biodiversity value accrued through making the site a predator free zone.

Questions to be answered include.

1. What biodiversity value does Wainuiomata have now?
2. If it were fenced – what species could realistically be re-established in the catchment?

Our Findings

1. A DOC assessment indicates that if fenced, the site has the potential to significantly improve the threat status of three critically endangered or national vulnerable threatened species: kākāpō, rowi kiwi and hihi.

2. There is considerable potential to restore representative forest and freshwater vertebrate species to the site. Ten to twelve are identified as priority species.

How we approached the task

In answering the questions, we carried out the following:

1. Desk research into the representative fauna of the region and catchment, updated with TePapa and GW scientists.
2. Hosted visits to the catchment by DOC recovery group leaders.
3. Prepared an assessment of the catchment's biodiversity potential from a national perspective (DOC).

What is biodiversity value?

A specific site can offer added value to biodiversity nationally or regionally. Value is created by (a) offering safe habitat to species populations or (b) preserving or improving the integrity of ecosystems.

Biodiversity value can also be added by providing ecosystem services through carbon sequestration, and water and soil conservation.

Representative fauna

Representative means 'of the locality'. It is important because generally, only species which were once found in an area should be returned to that place. There are some exceptions to this rule, e.g., if a species is replacing an extinct species, such as South Island Takahe for the extinct North Island takahe. While the Remutaka range has been depleted of indigenous fauna and few threatened species are present, this project offers considerable potential to restore locally extinct representative species translocated from elsewhere in New Zealand.

Following is a summary of the current state of the representative forest fauna for the catchment. See Appendix B Wellington Representative Fauna, for a full assessment[21].

Mammals (bats)	Historically[22] representative species; three (3). Species present in the catchment[23]: nil (0). Extant[24] species locally extinct: two (2). Bats have been recorded in the catchment, but recent searches have not detected them.
Forest birds	Historically representative species; forty-seven (47). Species present in the catchment: seventeen (17). Extant species locally extinct: twelve (12). The catchment contains the best regional populations of most common species with titipounamu/rifleman being the most significant resident.[25]
Reptiles	Historically representative species; sixteen (16). Species (possibly) present in the catchment: five (5). Extant species locally extinct: eleven (11). No recent lizard surveys have been done and data on lizards in the catchment is deficient.
Amphibians	Historically representative species; two (2). Species present in the catchment: nil (0). Extant species locally extinct: one (1).
Freshwater birds	Historically representative species for Wellington; thirty-seven (37). Species present in the catchment: one (1). Extant but absent species for which there may be suitable habitat: perhaps three (3). The forested habitat is limited for freshwater bird species.
Fish	Historically representative species; nineteen (19). Species present in the catchment: twelve (12). Extant but absent species for which there is suitable habitat: five (5). Freshwater fish represent some potential as trout are not fully established. Maintaining fish passage will be important.
Invertebrates	The invertebrates of the catchment are data deficient. Invertebrate surveys need to be done to establish the situation. In the meantime, the catchment has potential to home some forest mega-invertebrates such as Cook Strait giant weta.
Threatened plants.	There is also considerable potential for the catchment to be a safe house for locally threatened plants. See DOC assessment.

[21] Karori Wildlife Sanctuary. (2000 updated 2021). Appendix B. Representative Wellington Fauna.
[22] Historical means ‘living in the area in pre-human times’ circa 1000 AD.
[23] The catchment means the planned fenced area of 3,313 hectares.
[24] Extant means still existing in New Zealand.
[25] GW. (2018/2021). Key Native Ecosystems Operational Plan for Wainuiomata/Orongorongo.

The above indicates that, in addition to the three high priority species identified below, the catchment has the potential to re-establish up to thirty species. In reality it will be much less as the methods to establish some species (e.g., bats) do not exist, some species may not be compatible with the priority species (e.g., weka), the habitat may be marginal or prove to be unsuitable (many freshwater birds) and further lizards and plants may be found or emerge when pests are eradicated. The DOC assessment of ten to twelve priority species is a start point and can be built on in the future.

Threatened species habitat value

The case for predator fencing Wainuiomata rests primarily on its habitat potential for a significant number of critically endangered indigenous species. The unique features of Wainuiomata which make it important for threatened species management is its size and the quality of the habitat.

DOC has assessed the potential of the catchment and has concluded it has value for the following species.[26] They support the proposal in principle, with provisos regarding priorities and their wish for it to not be a call on existing funds.

Kākāpō (*Strigops habroptilus)*[27]. This rare and unusual parrot has been the subject of immense conservation effort since its last survivors were rounded up and placed on secure offshore islands in the 1990's. As at 2021, there are 201 kākāpō in existence. Almost all these birds reside on Whenua Hou, Chalky or Anchor Islands off the southern South Island. A few live on Hauturu/Little Barrier Island in the Hauraki Gulf. The southern islands are at or nearing carrying capacity for kākāpō and new habitat is urgently needed. Kākāpō require predator-free habitat and an abundance of rimu trees for breeding.

Wainuiomata has been assessed by the Kākāpō Recovery Team as being suitable for kākāpō habitat because of its size, (at 3,313 ha Wainuiomata is more than twice the size of Whenua Hou), the quality of habitat (unmodified lowland podocarp forest) and the abundance of mature rimu trees (rimu is the dominant canopy tree over 85% of the catchment). This combination of factors is very rare.

While there is never any guarantee that species will breed in any particular place, Wainuiomata could perhaps provide breeding habitat for up to 150 plus kākāpō.

Ngai Tahu are kaitiaki of kākāpō and Ngai Tahu representatives accompanied the team and expressed verbal support for the venture.

A mainland site near the capital city would also assist with advocacy for the species.

[26] DOC Terrestrial Science. (2021). Appendix C. Assessment of Possible Benefits to Biodiversity.
[27] Conservation status-nationally critical

Kiwi. The indigenous kiwi of Wellington are the little spotted kiwi (*Apteryx owenii)*[28] , and the rowi kiwi *(Apteryx rowi)*[29],Scientific investigation has shown that these two species coexisted in the Wellington region in pre-European times. The largest population of little spotted kiwi is on Kapiti Island near Waikanae (1,200 birds) and eight islands, while Zealandia in Wellington has a small population (circa 150). The total number of little spotted kiwi is less than 2,000 birds. Little spotted kiwi cannot survive in the presence of larger predators.

Rowi are the most threatened kiwi with their total population numbering approximately 650. They are mostly resident in Okarito forest on the West Coast and several small populations on islands. Rowi have proven difficult to manage sustainably on the mainland and the recent encouraging increase in numbers is largely due to Operation Nest Egg which rears chicks past the vulnerable juvenile stage. Rowi do not have a large predator free site available to them.

NI Brown kiwi. In 2006 (before rowi were found to be the kiwi of Wellington) the first six mixed provenance captive reared North Island brown kiwi (*Apteryx mantelli*) were released into the Remutaka under the care of the Remutaka Conservation Trust. After twenty years of trapping and kiwi care, the population has grown to about 250 birds and as many as twenty pairs have found their way into the catchment. The kiwi recovery group will have several decisions to make regarding these kiwi and which of the two indigenous kiwi would be best for reintroduction.

Hihi (Stitchbird, *Notiomystis cincta)*[30]. Hihi are the only member of a deeply endemic NZ family whose closest relations are the NZ wattlebirds. Hihi have only one substantial natural population on Hauturu Island in the Hauraki Gulf. Translocations have established populations on two offshore islands and four fenced sanctuaries, but all these populations are maintained by supplementary feeding.

As Wainuiomata is the same size as Hauturu, and as it is an unmodified lowland forest with very high energy flows, it could offer a substantial re-establishment site for hihi where they wouldn't require supplemental feeding. The site has been assessed by the hihi recovery group and their conclusion is that the site could carry up to 1,500 birds without feeding. Therefore, the site has the potential to materially improve the threat status of hihi.

[28] Conservation status-recovering
[29] Conservation status-nationally vulnerable
[30] Conservation status-nationally vulnerable.

Tieke (North Island saddleback, *Philesturnus rufusater)* [31]. A member of the deeply endemic family of NZ wattlebirds (Callaeidae), tieke were reduced to one natural population on Taranga/Hen Island off Northland. Translocations have established populations on fifteen offshore islands and five fenced sanctuaries. Estimates of the total population suggest that there are more than 8,000 birds and the species prospects are improving. However, there will always be a need for further populations and a site the size and quality of Wainuiomata, based on the carrying capacity of the nearby Zealandia population, could carry up to 2,000 pairs. This would materially improve the status of the species.

North Island Kōkako (*Callaeas wilsoni)* [32]. Another member of the deeply endemic family of NZ wattlebirds (Callaeidae). By the 1990's, Kōkako were reduced to a few scattered population in the North Island. The kōkako population has increased from circa. 330 pairs in 1999 to circa. 1595 in 2017 due to pest control at key sites, and translocation. The largest populations, with more than 100 pairs each, are in Pureora Forest, Hauturu (Little Barrier Island), Te Urewera, Mapara (Waikato), Rotoehu (near Rotorua) and the Hunua Ranges. Other large populations (>50 prs) are at Mataraua/Waima (Northland) and Kaharoa-Onaia near Rotorua, and there are fourteen other smaller populations, including Pūkaha/Mount Bruce. Breeding pairs and unpaired singles defend 4-25 ha territories year-round by singing, which limits density[33].

In 2012 GWRC commissioned Ian Flux to assess the Wainuiomata Catchment for its suitability for kōkako[34]. His conclusion was that the catchment was ideal for kōkako and had ample food and resources for pairs with potential territory sizes of 4-6 ha. This indicates a potential carrying capacity of 500-700 pairs which would substantially improve the security of kōkako nationally. Moreover, kōkako would most likely survive beyond the fence with good management of the surrounding habitat and there is potential to establish a significant regional population.

Other threatened species

There are a number of other at-risk and/or relic species which may benefit from the site, including NI kākā, toutouwai/NI robin, red-crowned kākāriki and Cook Strait giant weta.

Threatened plants which may benefit from the site include members of the Mrytacea family, including Northern rata (*Metrosideros robusta),* ramarama, (*Lophomyrthus bullata*), several rata vines, and swamp mairie (*Syzygium maire)*.

Ecosystem value

The catchment is representative of ecosystem Mf8 kamahi-broadleaf-podocarp forest, not a common ecosystem in the region but well represented (85% remaining). However, examples of the size and condition of Wainuiomata are exceptionally rare.

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[31] Conservation status- at risk, recovering
[32] Conservation status-at risk, recovering
[33] Birds Online (2021). Website.
[34] Flux. IA (2012). A Preliminary Assessment of a Greater Wellington Proposal to Reintroduce North Island Kokako (*Callaeas wilsonii*) to Wainuiomata Mainland Island.

The area is currently well managed by conventional means as it is periodically dressed with 1080 and professionally hunted for ungulates. Predator fencing the catchment will improve the ecosystem by totally excluding browsers such as possums, deer, goats and pigs.

While any improvement in the condition of the forest would be marginal, there would likely be benefit for the water supply through a reduction of drinking water source risk. Predator fencing would remove the need for poison application to one of the main catchments in the water collection area.

Landscape value

The best prospect for ecosystem gain lies in the catchments potential as a kōhanga (nursery) where species can breed safely, establish stable populations and in time provide a source for migration into the wider ecosystem. The Remutaka range is one of the larger intact forested areas in the region with approximately 40,000 ha of protected habitat. There is scope for a wider predator-free style landscape management programme to be shaped around the catchment to improve the prospects of survival outside the fence for species such as kākā, kōkako toutouwai/NI robin, kākāriki and others[35].

Appendices

The following Appendices have been prepared to support this section

Appendix B. Wellington Representative Fauna.

Appendix C. Assessment of Possible Benefits to Biodiversity. DOC Terrestrial Science. October 2021.

[35] See Section 2.13. Managing the Halo.

2.4 Social and Economic Value

The question

The primary purpose and rationale for this project is its national biodiversity value. However, experience has shown that fenced eco-sanctuaries provide opportunities for social engagement and economic development that exceed those of traditional biodiversity programmes.

Questions to be answered include:

1. How do fenced areas benefit the surrounding community?
2. What opportunities are there to engage the community?
3. What economic gains can be realistically expected?

Our Findings

1. An eco-sanctuary at Wainuiomata has considerable potential to add social and economic value in the future.
2. However, this should not be its primary rationale and it should be able to stand alone for its biodiversity value. This is because it must remain an active water supply facility, and it is a large and complex project which will take up to twenty years to reach maturity.
3. Notwithstanding this, sanctuaries are known to add social and economic value to communities through grants and donations, job creation, economic value added to the community through expenditure, the provision of ecosystem services, membership and participation, volunteering, and the provision of added value and commercial services.
4. Wainuiomata has immediate potential to add social value with minimal investment through grants and donations, job creation, economic value added, memberships, and volunteering.
5. Wainuiomata could add as much as $160 million in economic value to the community over the first ten years and create forty-seven shorter term (two year) and sixteen permanent high-quality jobs in a needy socio-economic area.
6. The catchment will continue to provide valuable ecosystem services through clean water, soil conservation and carbon sequestration. A sanctuary operation is unlikely to add materially to the status quo in this area.
7. It is not recommended that Wainuiomata pursues an intensive added value (education) or commercial services (visitor) model in the first ten-year period as this will be incompatible with the water supply function and eradication programmes and would require substantial infrastructure investment. Immediate public demand can be satisfied with a small-scale visitor programme using guided tours similar to what is done now.

How we approached the task

To answer the questions, we undertook the following:

1. Comparison with existing eco-sanctuaries.
2. Research into the social; and economic impact of eco-sanctuaries.
3. An assessment of these as they relate to the Wainuiomata situation and limitations[36].
4. Review by recognised experts.

Appendices

The following Appendices have been prepared to support this section

Appendix D. Social and Economic Value.

Figure 13. Forest and Bird plant nursery at Wainuiomata. Photo Eve Lynch

[36] See appendix D. Social and Economic value.

2.5 The Need for a Fence

The question

We have assumed that a predator proof fence is essential to achieve the expected biodiversity, social and economic gains. Below we test this assumption, as a fence is a large capital investment and long-term commitment. Questions include.

1. How effective is fencing at achieving the primary purpose of keeping the area predator free?
2. How do the biodiversity gains and costs of a fence compare to those of existing management?
3. Is it possible to achieve all or some of the expected outcomes without a fence?

Our findings

1. A fence is required to achieve the primary purpose of habitat for critically endangered species.
2. Precedents show that predator-fencing has been the most effective technology for keeping small parts of the mainland predator-free and providing safe habitat for the most critically endangered species.
3. Without a predator proof fence, the primary rationale of the enterprise, i.e., providing critical safe breeding habitat for kākāpō and hihi, could not be achieved.
4. New technologies have not yet progressed enough to make significant mainland areas reliably predator free for long periods. Wainuiomata will still need to depend on the proven existing technologies for the foreseeable future.
5. Experience from the Wainuiomata mainland island operation is that the current regime will protect the extant forest fauna but will not safely allow the re-introduction of sensitive missing fauna. The grid would have to be considerably tightened and extended to the whole catchment (3,313 ha) to consider this for a limited range of species.
6. An assessment comparing an intensified and extended MI operation shows it is both more outcome effective and cost efficient and has less risks to fence the catchment than to intensify the Mainland Island regime.
7. Note that maintaining an intensified and extended mainland island operation may be impractical as it is unlikely that the species recovery groups would allow sensitive species in the catchment without a fence and the water managers would most likely object to such an intensive regime in an operating water supply area.

How we approached the task

The questions were answered by conducting a comprehensive assessment as follows.

1. Comparing similar situations and experiences from fenced eco-sanctuaries and other projects.
2. Reviewing the needs of the three primary target species (kākāpō, kiwi and hihi and their recovery groups).
3. Reviewing emerging technology with researchers in the field.
4. Reviewing current management and costs and assessing what would be required to achieve the outcomes without a fence.
5. These have been combined into a comprehensive paper on the need for a fence (Appendix E)

Appendices

The following Appendices have been prepared to support this section

Appendix E. The Need for a Fence.

Figure 14. Fenceline at Zealandia. Photo Stephen Fuller

2.6 Land Tenure

The question

The assumption is that the land can be made available for use as a predator-fenced eco-sanctuary.

Questions to be answered include.

1. What are the existing tenure arrangements on the catchment?
2. Would any change of tenure be required for the project to proceed?

Our findings

As sole landowner, Greater Wellington Regional Council has the authority to decide whether or not the catchment can be used for the purpose of an eco-sanctuary.

Land ownership

From enquiries with Greater Wellington, we confirm that the land of interest (3,313 ha) is part of the Wainuiomata/Orongorongo Water Collection Area. The land is owned by GW in multiple parcels and is set aside for the purposes of water supply.

The water supply assets are owned by GW.

The catchment is subject to a service level agreement (SLA) between GW and Wellington Water for the provision of bulk water supplies to the four Wellington cities[37].

There is currently no claim on the land under the Treaty of Waitangi.

[37] GW (2014). Contract for Provision of Management Services Relating to Bulk Water Supply Services.

2.7 Compatibility with the Water Supply Function

The question

The assumption is that the intended use as a premier biodiversity and threatened species site is compatible with the water supply function. Questions include:

1. What advantages are there for water supply if the proposal went ahead?
2. What effects will there be on the water supply and what level of operational and visitor activity can the water supply function accommodate?
3. Are there any costs for the water supply to accommodate the proposal?
4. Can the two purposes be operated together?

Our findings

At the time of submitting this report, the position of Wellington Water in relation to this question was not confirmed. These findings have been reviewed with Wellington Water staff and drinking water advisors but are subject to receiving a response on their position.

1. The two functions (sanctuary and water supply) should be able to function efficiently together at Wainuiomata. It would require goodwill all round, close co-operation, negotiated service level agreements and mutual understanding of each operation's needs.
2. There are significant long-term advantages and benefits for the water supply if the area is managed as a pest free sanctuary, including a cleaner environment, healthier forest, less use of poisons in the long run and improved access. The development will reduce source water risk.
3. The main disadvantage for the water function is a two-year fence and road construction period. This will cause vegetation loss and disturbance, the need to close the catchment and water supply for a one-off aerial toxin operation and greatly increased sanctuary staff activity in the catchment during the grid set-up, fence construction and the eradication. Most of these are shorter term and appear able to be accommodated.
4. Long term (after five years) a pest control/monitoring/incursion response programme and species restoration programme will require significantly increased resourcing and permanent staff activity.
5. The potential of a more extensive visitor programme brings a potentially higher level of impact and will require further discussion as the sanctuary develops. In the early stages the current level of visitor access should be manageable and compatible with the water supply function.

How we approached the task

To answer the questions, we undertook the following:

1. Initial discussions with Wellington Water Ltd through the Operational Manager.
2. The compilation of a view of how the project would be set up and managed through progress of the other projects.
3. An assessment of how this would impact the water function.
4. The preparation of a paper on this topic. (Appendix F.)
5. Review of that paper by the General Manager Catchment Management and the Chief Advisor of the Drinking Water Committee.
6. A request to the Drinking Water Committee to give their view on the question.

Appendices

The following Appendices have been prepared to support this section.

Appendix F. Compatibility with Water Supply Function.

Figure 15. Orongorongo tunnel. Photo Ricky Clarkson

2.8 Fence Route

The question

A key element to fencing the catchment is the availability of a viable fence route. The study assumes that there is a route along which the catchment can be fenced and that the loss of vegetation and other adverse environmental effects along the route is an acceptable trade-off. This assumption was based on a provisional route taken from maps and GWRC staff knowledge.

Questions to be answered include.

1. What is the best route to accommodate a fence?
2. How can we cross the Wainuiomata river?
3. What issues are there with neighbours?
4. What environmental issues, losses and gains come with the proposed fence route?
5. Can a resource consent be obtained for the fence route?
6. What are the costs and risks of the proposed fence line route?

Our findings

1. There is a viable route of 28.8 kilometres for a predator proof fence enclosing 3,313 ha of the Wainuiomata catchment. A new road of 16km length will be required on the forested eastern and southern sections. While there are challenges, the solutions are primarily a matter of design and costs.
2. Crossing and pest-proofing the Wainuiomata River via a weir while retaining fish passage is challenging but feasible. This is subject to detailed design and costings and the granting of a resource consent for the works. There are risks involved with the weir, but the solutions are primarily additional funding, or in the case of the fish passage, good design.
3. The neighbouring landowners who could be contacted are in favour of and support the project. Issues include the road intruding on private property in many places and the need to restrict public access (as is the case now). These issues can be resolved with goodwill backed up with formal agreements.
4. There are adverse environmental effects in building the new road including the loss of nine to ten hectares of primarily beech, kamahi and kanuka forest, risks to the Orongorongo wetland and soil and substrate disturbance. These may require mitigation as conditions of the resource consent.

Continued…

5. Consents will be required from GW and HCC and DOC for the road works and the weir (including fish passage). While specialist advice will be required as part of detailed design, all provisional conditions appear to be able to be accommodated. The key consideration for securing consent for the earthworks will be erosion and sediment control. Methods for immediate stabilisation will be required given the ecological sensitivity of the catchment.
6. Costs for the road, weir and consents are assessed as up to $3,565,000. This includes all design and consent fees, and the dismantling of the existing deer fence.
7. There are significant risks arising from the resource consent requirements, the potential for cost increases and neighbour issues. Most risks appear to be manageable.

How we approached the task

To answer this question, we undertook the following:

1. This question was provisionally addressed with a walk over of the proposed route by Boffa Miskell and BECA volunteer staff in October 2020. To gain further information for indicative pricing of the route and fence and to clarify certain aspects of the route, consulting Ecologists Boffa Miskell and consulting Engineers BECA Ltd generously offered their services (pro-bono) to further survey the route and identify all issues which will affect its construction and the construction of a fence.
2. Boffa Miskell and Beca geology and survey staff undertook further ground surveys and consulted LIDAR and other GW mapping resources to prepare comprehensive reports on the route. Beca supplied a consulting engineer to provide a concept for the river crossing.
3. A construction specification for the cutting of a new sixteen-kilometre route along the eastern and southern boundaries was prepared. This was provided to two well regarded local road contractors (Fulton-Hogan and Agricontracts Ltd) who generously provided indicative prices for the works.
4. The Wainuiomata Park Ranger was asked to provide information on any issues to do with neighbours.
5. The Wainuiomata river is a 20-metre wide, fast flow river which can flood in heavy rain events. No river of this size has been predator-proofed to date. Beca engineers inspected the Wainuiomata river crossing and developed a concept for how the river could be kept secure from pest access. As there is not yet any detailed design, a construction specification could not be developed. The issue of fish passage is still to be resolved. A cost allowance for these works has been included.
6. The results of all these reports were co-ordinated and summarised into a paper which drew the conclusions above. The five sub-ordinate reports are listed below and are attached as Appendices.

Appendices

The following Appendices have been prepared to support this section.

Appendix G. The Fence Route.

Appendix H. Wainuiomata Sanctuary - Geotechnical and Survey Input to Proposed Fenceline. Beca. (June 2021).

Appendix I. Wainuiomata Predator Fence Feasibility Study. Boundary Fenceline. Boff Miskell. (June 2021).

Appendix J. Pest proofing the Wainuiomata river.

Appendix K. Neighbour issues.

Figure 16. 3D image of Wainuiomata Catchment showing proposed fence route. The view is north. Image GW

2.9 Fence Construction

The question

We assume that the chosen route can be fenced to keep out all pests and keep kākāpō in.

Questions to be answered include:

1. What is the best design for the fence?
2. How can we keep kākāpō in the valley?
3. What will it cost to build?
4. What will it cost to maintain?

Our findings

1. It is feasible to construct a predator-proof fence on the surveyed route which will keep out all target pests.
2. Two contractors have provided indicative prices for a 28.8 km fence on the site which will meet our performance specifications.
3. The indicative prices indicate a total price for fence construction of between $11,165,000 and $11,745,000.
4. Neither contractor saw any difficulty in constructing a fence on the site assuming the road has been built to specification.
5. The fence can be secured to contain kākāpō. $350,000 should be allowed for this in addition to the costs above.
6. A number of discreet entry points for pests have been identified, including the Wainuiomata/Orongorongo tunnel and the various water pipes. These can be secured and the sum of $20,000 should be allowed for this.
7. Total costs for fencing and pest proofing are assessed as $12,115,000.

Background

The first all-species predator proof fence was built in 1999 at Zealandia. Predator fencing is now a proven technology which has a twenty-year track record of success. Several contractors specialise in building predator fences.

The Wainuiomata fence would be 28.8 km in length and follow the route and road along the ridgelines. Any fence would need to be secure enough to exclude permanently the eighteen target species: deer, pig, goat, cattle, sheep, dog, cat, ship rat, Norway rat, European and Asian mouse, hedgehog, stoat, ferret, weasel, possum, rabbit, hare.

The Wainuiomata fence will also need to keep kākāpō in.

No fence can be truly predator ‘proof’ as they are subject to wear and tear, damage by weather and outside agents and there is a need to provide access points. A fence should have a lifespan of at least thirty years, have secure gates and no discreet entry points. An alarm and incursion and response system must be in place to quickly detect and remedy any damage. Essentially the fence must act as a perfect and permanent seal around the entire 29 km perimeter.

How we approached the task

With predator fencing an established technology, the following approach to design and costing was selected by the working party, which included DOC staff and consultants from Boffa Miskell and Beca with experience of predator fencing.

1. The working group developed a design and performance specification for the fence.
2. Two companies with a track record and reputation in the field were chosen (Xcluder and Pest Proof Fences Ltd) and were approached to supply indicative prices. Both agreed to participate.
3. Both were supplied with the design specification, the ecologists and geologists report and maps. Both were offered a site visit and one took up the offer. The other opted for a desk-top exercise.
4. The indicative prices were received and have been accepted by the working party as representing realistic costs in the current environment.
5. The Kākāpō Recovery Team were consulted on how to make the fence kākāpō proof. They have been conducting trial with kākāpō.
6. The Park Ranger surveyed the catchment for discreet entries which would need to be pest proofed.
7. The findings were included in a paper which summarises all the issues and conclusions. – see Appendix L.

Appendices

The following Appendices have been prepared to support this section.

Appendix L. The Fence Construction.

2.10 Eradication of Pests

The question

Once the fence is built then the catchment can be cleared of all pests.

Questions to be answered include:

1. Which pests are present in the catchment?
2. Can they be cleared from the fenced area?
3. How much will this cost?

Our findings

1. It is feasible to eradicate all target animals from the fenced area (3,313 ha) apart from mice (see below). There are precedents for a site of this scale and up to date best practice suggests it is challenging but achievable.
2. It is unlikely that mice can be permanently removed from the site. If eradicated they will most likely find their way back in due course. However, attempting their removal is justified given that it will not alter the costs of the multispecies eradication, the associated biological benefits, and the potential for successfully defending the area from mouse re-establishment.
3. Because the site is so large and high-profile species will be on site (kākāpō), we recommend a risk reduction approach and an optimum methodology. This will require additional people and funding above what would typically be allocated to a community-led fenced sanctuary.
4. The recommended method is as follows.
   a. Establish a 75-metre monitoring and incursion response network of tracks and lines across the entire catchment with detection or kill devices at 50 metre intervals on each line. Hunt out ungulates.
   b. Aerial application of toxin.
   c. Complete removal of remnant pests and confirmation of eradication.
5. Costs for the two years are assessed as $10,514,290 which includes all labour and materials and fully equipping and housing a team which at times will number as many as 45 on site (for short periods) and generally will require about 13 permanent staff.
6. There are significant risks in this operation – although the design of the programme is intended to minimise those risks and there are realistic contingencies.

How we approached the task

The process of eradicating pets is now well tested, and the costs are well known so no additional research was required. GWRC has the internal capability needed in the Biosecurity Unit to design and cost a programme and advice from experts such as DOC, research agencies and other sanctuaries was sought.

The method employed was as follows.

1. Reference to precedents and similar operations. These include past eradications and the current operations of other fenced sanctuaries and eradications from islands. There is a large body of work to draw on in this area with established technology.
2. An initial scoping of the task, including a site visit, was conducted by a group of experienced practitioners in the field, including people who know the catchment intimately.
    - Glen Falconer Team Leader Pest Animals-Biosecurity. Greater Wellington (GW).
    - Keith Broome. Terrestrial Science. DOC
    - Helen Nathan. Zero Invasive Predators (ZIP)
    - Kim Broad GW. Wainuiomata Mainland Island Co-ordinator.
    - James Mathews. Operations Ranger. Sanctuary Mountain (Maungatautari)
    - Ricky Clarkson. Park Ranger. Wainuiomata.
3. A draft design, concept plan and costing were prepared by Glen Falconer using current GW and DOC procedures and policies. (Appendix Q.)
4. Review and finalisation of the plan and the eradication paper (Appendix M) with the working group.

Appendices

The following Appendices have been prepared to support this section.

Appendix M. Eradication of pests.

Appendix Q. Wainuiomata eradication method and cost sheet.

Figure 17. GW staff (including Glen Falconer) undertake the eradication at Zealandia 1999. Photo GW

2.11 Maintaining a Pest Free Status

The question

We assume that once the area has been fenced and pests eradicated, it can be kept free of pests.

Questions to be answered include:

1. Can the area be kept free of pests?
2. What other issues are there in managing a pest free zone?
3. What will this cost to operate long term?

Our findings

1. It is feasible to maintain a pest free status in the fenced area. However, to achieve this will require the ongoing operation of a permanent surveillance and response system.
2. This will involve strict biosecurity procedures, ongoing 24/7 fence surveillance and maintenance and the permanent operation of the surveillance network.
3. It is unlikely that mice can be permanently removed from the site. If eradicated they will most likely find their way back in in due course. However, their removal should be attempted and their presence in the catchment should not impede the primary purpose of the site.
4. Other threats, including weeds, pest birds and fish, wasps and security will need to be managed.
5. As with the eradication, and because the site is so large and high-profile species will be on site (kākāpō) the recommendation is for a risk reduction approach and an optimum methodology. This will mean additional resource and cost (without extravagance).
6. Annual operating costs for maintaining a pest free status are assessed as $1,985,910 which includes all labour and materials for eleven permanent staff.
7. There are significant risks in this operation – although the design of the ongoing operation is intended to minimise those risks and there are realistic contingencies.

How we approached the task

This question was considered by the eradication working party as part of their remit

1. Reference to precedents and similar operations. These include past eradications and the current operations of other fenced sanctuaries and eradications from islands. There is a large body of work to draw on in this area with established technology.
2. An initial scoping of the task was conducted by a group of experienced practitioners in the field from a range of agencies, including people who know the catchment intimately.

- Glen Falconer Team Leader Pest Animals-Biosecurity. Greater Wellington (GW).
- Keith Broome. Terrestrial Science. DOC
- Helen Nathan. Zero Invasive Predators (ZIP)
- Kim Broad GW. Wainuiomata Mainland Island Co-ordinator.
- James Mathews. Operations Ranger. Sanctuary Mountain (Maungatautari)
- Ricky Clarkson. Park Ranger. Wainuiomata.

3. A draft design, concept plan and costing were prepared by Glen Falconer using current GW and DOC procedures and policies.
4. The ongoing operation section was broken out and made the subject of a separate paper. (Appendix N)
5. Review and finalisation of the plan and the maintaining pest free status paper with the working group.

Appendices

The following Appendices have been prepared to support this section.

Appendix N. Maintaining a pest free status.

Figure 18. Smallest of the mustelids, weasels have proved to be the most difficult to keep out. Photo DOC

2.12 Restoring Species to the Site

The question

We assume that once the area has been secured, species can be reintroduced.

Questions to be answered include:

1. When and how can species be reintroduced to the catchment?
2. How should these be managed?
3. What will this cost to operate long term?

Our findings

The following conclusions have been drawn from this study.

1. It is feasible to reintroduce a range of sensitive threatened species to the fenced area. Predator fencing is a proven technology which has been operating for 22 years and has allowed the successful reintroduction of even the most threatened species.
2. The catchment has been assessed by DOC Biodiversity and found suitable for three priority species: kākāpō, kiwi and hihi. DOC has determined that establishing populations of these birds in Wainuiomata could significantly change their threat status.
3. The catchment has the potential to allow over time the reintroduction of a further seven to ten species of birds, invertebrates, plus various fish, reptiles and threatened plants.
4. This requires a long-term species recovery plan and programme. Each species requires its own project plan and the approach for each will vary a lot.
5. No reintroductions can be undertaken until the catchment is declared secure and there is confidence in the incursion response system. This is unlikely to be before year eight.
6. Because of the variability amongst species, it is difficult to project resource requirements but a team of one and a half species specialists would be required with an annual project budget. Total costs are assessed as approximately $415K per annum.
7. Risks with species reintroduction vary between species and will be assessed at the time with each species.

Context

We assume that once pests have been eradicated permanently from the catchment, missing extant species can be returned to the site. This process of species reintroductions is also well tested, and the costs are well known.

The question of which species can be restored to the catchment once it has been fenced was dealt with in Section 7, Biodiversity value. This section deals primarily with what operational structure and resource is required to support the establishment of species.

Our approach

1. The establishment of species in fenced sanctuaries has a 20-year history of success so the requirements are now well known and tried. We have drawn on this body of knowledge and experience in assessing what is needed to establish species at Wainuiomata.
2. The DOC translocation recommendations in Section 7 have been used as a guide.

Appendices

The following Appendices have been prepared to support this section.

Appendix O. Restoring species.

Figure 19. Tieke/Saddleback will do well in Wainuiomata. Photo Janice McKenna

2.13 Managing the 'Halo'

The question

Questions to be answered include:

1. What are the likely effects on surrounding habitats and communities?
2. What opportunities are there for partnerships to improve the wider outcomes?

Our findings

The conclusions of this study are as follows.

1. This issue is not an immediate priority and has not been fully investigated.
2. Once the catchment is secure and species are well established, it is likely that many species will migrate from the catchment into the surrounding habitat. This is known as the 'halo effect'.
3. There is approximately 40,000 hectares of potential habitat in the Remutaka Range that could form the migratory 'halo' of the sanctuary.
4. The success of this migration will vary greatly according to each species. Some will establish without further management; some will require management of the surrounding area and others will not survive outside the fence.
5. There is some management being done now in the wider Remutaka, including GW, DOC and several community groups. There is a willingness to integrate this activity and possibly expand it, to capitalise on the Wainuiomata opportunity. Predator Free 2050 Ltd are willing to look at this prospect.
6. Fully investigating this topic falls outside the scope of this study. However, if Wainuiomata proceeds, integrated management of the Remutaka should be fully investigated in association with DOC, GW, the NGO's working in the area and Predator-Free 2050 Ltd.

Context

The assumption is that, with a fence in place species populations will increase to carrying capacity inside the enclosed area, and in time migrate outside the fence into the wider forested landscape. Ideally this wider area should be managed to make it more 'bird safe' and increase populations across the Remutaka ranges. This 'halo' effect is not well understood but is known to occur.

How we approached the question

Discussion was initiated with the parties interested in the management of the surrounding landscape and Remutaka range.

The broad issue was detailed in an accompanying paper. Appendix P. ‘Managing the halo’.

Appendices

The following Appendices have been prepared to support this section.

Appendix P. Managing the ‘halo’.

Figure 20. Kaka could repopulate the Remutaka Range from Wainuiomata. Photo Eve Lynch

2.14 Conclusions

The following conclusions have been drawn from this entire study and carried forward to section 2.1.

1. The project is technically and practically feasible. There are significant risks, but these can be managed.
2. There is an option for a legal entity and governance which could meet the needs of all partners. This is a partner (GW/iwi/DOC) controlled charitable trust. It would need the partners to be willing to participate and a service agreement with GW for joint use of the land with Wellington Water. The partners and settlors of the trust must be decided.
3. The project will go through three phases over the first ten-year period. These are:
   i. Preparatory (three years)
   ii. Development (four years)
   iii. Operations (year eight +)
4. Each phase has been described in terms of its tasks and resource requirements.
5. The total cost has been calculated as $41,823,344 over the ten-year period. This is broken down into OPEX of $23,090,734 over ten years and CAPEX of $16,680,000, plus a 15% contingency allowance. See Operating and Capital Cost Summary, page 37
6. The cost to operate the sanctuary after year seven is calculated as $2,523,960 per annum in current dollars.
7. There are significant risks involved in the project. Four risks could result in abandonment of the project if they occur or cannot be managed and mitigated. The remainder can be managed or mitigated.

This study is submitted to the sponsors for review and discussion.

2.15 Credits

The following people and organisations have generously contributed to this study.

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Chief reviewer. Amanda Cox.

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Note. This list of references does not include references cited in the Appendices. These are included in each appendix.

Part 3

Appendices

Figure 21. Ancient Rata. Photo GW

3.1 List of Appendices

Appendix A. Puketahā. Taranaki Whānui ki te Upoko o te Ika Cultural Safety Report 2021

Appendix B. Wellington Representative Fauna

Appendix C. Assessment of Possible Benefits to Biodiversity. DOC Terrestrial Science

Appendix D. Social and Economic Value

Appendix E. The Need for a Fence

Appendix F. Compatibility with Water Supply Function

Appendix G. The Fence Route

Appendix H. Geotechnical and Survey Input to Proposed Fenceline. Beca

Appendix I. Ecologist report. Boundary Fenceline. Boff Miskell

Appendix J. Pest proofing the Wainuiomata river

Appendix K. Neighbour Issues

Appendix L. Fence Construction

Appendix M. Eradication of Pests

Appendix N. Maintaining a Pest Free Status

Appendix O. Restoring Species to the site

Appendix P. Managing the 'Halo'

Appendix Q. Wainuiomata Eradication method and cost sheet.

APPENDIX A:

Puketahā. Taranaki Whānui ki te Upoko o te Ika
Cultural Safety Report 2021

Puketahā

Taranaki Whänui ki te Upoko o te Ika

Cultural Safety Report

2021

- He Mihi -

Moe ara rä, moe ara rä,
Moe ara rä i tënei pä, moe ara rä i tërä pä
Kii mai nei ngä atua o te pö
Ka tuhi ka rarapa ka uira katoa, te mahuru!
Kiokioki e töia te waka, kiokioki e töia te waka
Ki runga ki te maunga e tü mai nei
Kia whakatakotoria ki ngaro parapara koa
Me he tëtë waka e, me he tëtë waka e, me he pitau whakareia!
Whakarongo mai e te iwi nei, whakarongo mai e te motu nei
Ahakoa whakapiri koe ki a Tauiwi
E kore e taka te ingoa Mäori i runga i a koe
He Mangumangu Taipö nei hoki tätou
Te kupu a Tohu ki ngä iwi e rua
E kore e piri te uku ki te rino
Ka whitingia e te rä ka ngahoro!

Tika tonu ngä kupu körero i whakairohia e Tamanui Wakaneke – "*e kore e taka te ingoa Mäori i runga i a koe*." Tënä, me tü whakahîhî tätou i te ao huri tonu nei, i te mea ai kua tae te wä o te ao Mäori. Nö reira, nö mätou te tino hönore nui i a mätou ano e whakahuatia ënei körero mö tō mātou tupuna pae maunga e kiia nei ko Puketahā, me ōna

Ngä mihi nunui ki ngä tohunga o neherä, nä rätou i kohi, i whakaputa i ngä tuhituhinga mo ngä iwi maha o mua, i noho mai nei i te takiwä – he tapu. Kua whärikihia aua korero ki roto i te tuhinga nei hei mana pütake mo ngä rangi e heke ana. Tënei ka mihi.
E ngä tüpuna, e ngä Ariki-Toa, e ngä Ariki-Tapairu, o ngä koiwi maha o Toi Te Huatahi,
Rätou ki a ratou kua whetürangitia,
Tätou i a tätou ngä uri o Toi Te Huatahi e ora tonu ana
Koia rä e Rongo whakairihia ake ki runga kia tina!
Tina! Hui e!
Täiki e!

- Whakaräpopototanga -

- Executive Summary -

Taranaki Whânui ki Te Upoko o Te Ika are an iwi conglomerate that have maintained the traditional mana and ahikâroa occupation of the tribal takiwä territory – Te Whanganui a Tara me ona takiwä.[1] This area is more commonly known as the Port Nicholson Block (PNB). We are the First Nations Indigenous people of these lands. Having established a partnership with Greater Wellington Regional Council in proposing a predator proof Kākāpō sanctuary for the entire Wainuiomata water supply catchment, this 'cultural safety report' is required to raise awareness of the 'iwi-sphere' within which the water catchment exists from the perspective of the tängata whenua. This aims to ensure the integrity and sanctity of our hapū and whanau, expressed through their identity and history with the area in interest is kept 'safe' – in a condition of being protected from harm or other non-desirable outcomes. This report is not about collating and rehashing the vast information from independent, central and local government publications, instead it simply focuses on who we are as a people and how we state our claim as tangata whenua. Our lands and waterways within the PNB are our ancestral rights and interests, '*demonstrated'* - mai te kähui maunga ki te moana – from the mountains to the sea. Therefore, the natural surroundings of the land and sea – Te Taiao – is of primary importance above all else. We have ancient whakapapa lineage from Taranaki through our early ancestors such as Maru-whakatare, Rua-Taranaki and Tahurangi of Te Kâhui Maunga, and the three waka, Kahutara, Taiköria and Okoki that made landfall in north Taranaki, during the 11th century. Many related tribal groups descended from illustrious ancestors have occupied Te Whanganui a Tara before us – Waitahä, Te Kähui Tipua, Ngäti Mamoe, Ngäi Tara, Rangitäne, Käi Tahu, Ngäti Kahungunu and Ngäti Ira. All of these iwi Mäori also have ancient genealogical ties to our founding tüpuna, Rauru and Awanuiārangi - we are all 'Te Whänau a Toi Te Huatahi'[2]. Other versions of our recorded history express a view that Toi, Rauru and Awanuirangi were themselves Te Kahui Tipua, and were often referred to as the '*early'* tangata whenua, before the arrival of the mythical seven waka fleet that came from 'Hawaiki'. The arrival of the musket in the 19th century induced mass migrations, including five migrations of our own from Taranaki to Te Whanganui a Tara during 1824–1833. Other mass migrations right across Aotearoa would re-shape iwi dynamics forever. Our people that maintain our ahi kaa roa long burning fires of occupation near te wao tapu nui o Wainuiomata (the sacred forest valley of Wainuiomata) reside in Taumairangi (Moores valley), the Wainuiomata valley township and the Wainuiomata valley coast (road) with large areas of Māori land still held by whānau trusts. An important part of these hinterlands is also our whanaunga of Ngāti Wainuiomata, who were formed in the 1960's and built the Wainuiomata marae complex beginning in 1983. Now in 2021, Taranaki Whānui aspirations in seeking a return of Kākāpō and other endangered manu Māori, offers iwi Mäori cultural opportunities perfectly suited for educational training, research, wānanga, noho marae, hunting, pest eradication, gathering Rongoā and raranga weaving materials, recovering fallen rakau, whaioranga wellness retreats, and the active protection of threatened indigenous Māori flora and fauna. Highlighted is also an opportunity to advance the design of a new marae complex at the entrance to the proposed sanctuary where eco-friendly technology is infused with our traditional design art forms through a unique Māori-centric lense.

[1] The iwi that make up our conglomerate are the Âti Awa confederation of Ngâti Tama, Ngâti Mutunga, Ngâti Maru and Te ÂtiAwa - Taranaki - Ngâruahinerangi - Ngâti Ruanui - Ngâ Rauru

[2] This was a view that was expressed by Tā Apirana Ngata after travelling amongst many iwi across the country and learning about their whakapapa. See '*The Origins of Māori Carving'*, an unpublished paper written in two parts by Ngata in 1936

- Ngä Rärangi Upoko –

- Contents –

Ngā tūpuna o mua – ancient ancestors

1. Toi Te Huatahi 1 - c.1150 a.d

Toi Te Huatahi begot Ruarangi. Ruarangi consummated with Rongouerua and begot Rauru. Soon after giving birth to Rauru, Rongouerua was bathing herself in a stream when an atua god-being named Tamarau descended from the sky and consummated with Rongouerua. As he departed, he said to Rongoueroa that if she should fall pregnant with a son, he should be named Awanuiärangi after the great river in the sky from whence he came. Therefore, Rauru and Awanuiärangi were half-brothers. It was theorised by our revered tohunga (learned repository), Te Rangiähuta Broughton of Ngä Rauru, that Rauru and Awanuiärangi were both raised by Toi Te Huatahi 1, as is the custom to be raised and instructed by kaumätua grandparents.

(Te Rangiähuta Broughton of Ngä Rauru)

Toi Te Huatahi 1 (**c.1150 a.d**) **Ao Tatai**
| |
Ruarangi = **Rongoueroa** = **Tamarau**
| |
Rauru **Awanuiärangi 1**

2. Rauru nui a Toi - Te Tini a Awa

Many iwi across Aotearoa are descended from Rauru. Likewise, the descendants of Awanuiärangi multiplied and became known as Te Tini a Awa (the multitudes of Awa). Many of his grandchildren eventually migrated to Northland, Taranaki and Hawkes Bay. Those who went north intermarried with the descendants of Tumutumuwhenua those who migrated west to Taranaki intermarried with the people of Te Kähui Maunga and those who moved southeast to Te Matau a Maui (Hawkes Bay) intermarried with the people of Orotü, Whatumämoe and Mähu. Descendants of Orotü and Whatumämoe would eventually migrate south and name Wellington Harbour, Te Whanganui a Orotü[3] while in occupation there. This was the first known name of our Harbour. Further generation's later descendants of the Northland Ngäti Awa such as Rähiri, took on a new identity by creating Ngä Puhi and forcing their other Ngäti Awa kin out of parts of Northland. These conflicts caused further Ngäti Awa migrations, within Te Tai Tokerau, south to Taranaki, Tämakimakaurau, Tauranga and back to Whakatäne.[4]

3. Toto, Rongorongo and Kuramārōtini

'Toto' was a legendary 'tohunga tärai waka (master canoe builder) who built the two famous waka, Aotea and Matahöurua. He had two daughters, Rongorongo and Kuramārōtini. Kuramārōtini was married with Kupe and her sister Rongorongo was married with Turi. It was through these marriages that Kupe and Turi came into the possession of these famous waka made by their father-in-law. The following whakapapa, one from the east coast (**blue**) and the other from the west coast (**red**) shows these relationships.[5]

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[3] Te Whanganui a Orotu is a transplanted name from Napier Harbour

[4] This narrative of internal Awa migrations from within Aotearoa was researched and discussed by Apirana Ngata in his 1936 unpublished paper, "*The Origins of Maori Carving*". The waka of the fleet - Aotea, Tainui, Te Arawa, Täkitimu, Tokomaru, Mataatua and Kurahaupô – according to Apirana Ngata, probably departed from a place no further than Northland, and at different time periods during the 13th – 15th centuries. These ancient whakapapa lines that link our many iwi together, challenges the seven-waka 'fleet' narrative that is said to have left simultaneously from Hawaiki in East Polynesia around 1350. Toi Te Huatahi 1, Rauru and Awanuiärangi 1 were all born and raised within Aotearoa, ***before*** the so-called fleet that emerged four to seven generations after them.

[5] **Hori Ropiha** of Pörangahau, an early authority on Rangitâne, Ngâti Ira and Ngâti Kahungunu history, **cites the Ngäti Ira whakapapa** that places Kupe four generations down from Awanuiarangi 1. **Hetaraka Tautuhi** of **Ngä Rauru** cites the whakapapa that places Turi four generations down from Rauru

Rauru (c. 1200 a.d) Awanuiärangi I = Wharekura

| |

Räkaumaui Uhenga

| |

Rongotea Poutama

| |

Pureora Toto Whitirangimamao

| __________|___________ |

Turi = Rongorongo (c.1280 a.d.) Kuramārōtini = Kupe

(Aotea) (Matahöurua)

4. Kupe

Te Kupenga o Te Ao (Kupe) was a great great-grandson of Awanuiärangi 1, born and raised in Northland. He set out to circumnavigate Te Ika a Mäui, so he travelled to the eastern side of the island and stayed for some time at different places between Wairoa and Wellington, fathering at least seven children along the way. He is one of the earliest known tupuna to have lived in Te Whanganui a Tara and his name is bestowed on many landmarks on both sides of Te Moana o Raukawa. Eventually he returned to Northland and gave directions for travelling down the west coast of the North Island to his brother in-law, Turi, captain of the Aotea waka. Angela Ballara in her thesis 'The Origins of Ngāti Kahungunu', references other rangatira sources from Ngāti Kahungunu that concur with Hori Rōpiha in relation to the Ngāti Awa origins of Kupe. She states that:

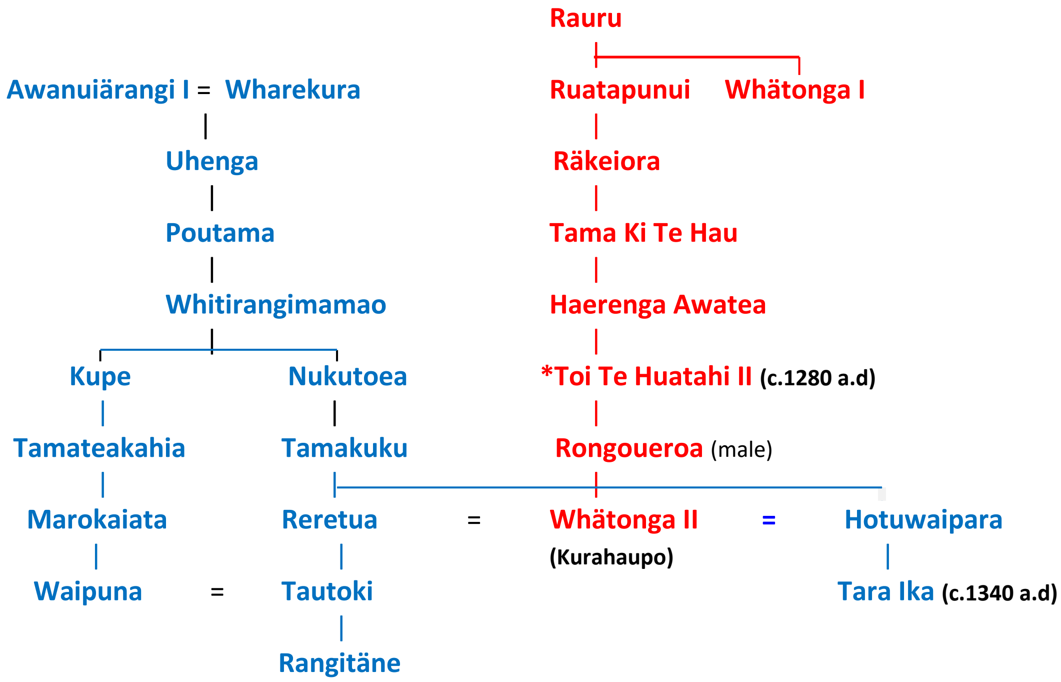
> *"Other descent groups in central Hawke's Bay included the descendants of Kupe's ancestor Awanui-ā-rangi"*[6]

5. Tara-Ika & Rangitāne

When Whätonga II, captain of the Kurahaupö waka travelled to Hawkes Bay and landed at Ahuriri (Napier) he married Hotuwaipara who was of Ngäti Tamakuku, a hapü of the Hawkes Bay Ngäti Awa. These Hawkes Bay Ngäti Awa were the descendants of Kupe and Nukutoea who had migrated earlier from Northland. The first son of Whätonga 11 and Hotuwaipara was Tara –Ika, after whom Te Whanganui a Tara is named. [7] He was so named after Hotuwaipara had pricked her hand on the spine (Tara) of a fish (Ika) while she was pregnant. The following whakapapa shows the relationship between the older branches of Ngāti Awa and descendants of Rauru. They were also descendants of another branch of Ngāti Awa that had migrated from Whakatāne under Koaupari and Maruiwi, who were grandsons of Awanuiārangi 11.

[6] Angela Ballara - Porangahau: THE FORMATION OF AN EIGHTEENTH-CENTURY COMMUNITY IN SOUTHERN HAWKE'S BAY, p.8, referencing Napier 12, p. 19, evidence of Airini Donnolly re Porangahau; Napier 13, p.208, evidence of Maraea Puri re Porangahau

[7] The Awanuiârangi whakapapa line comes from Rangitäne traditions (J McEwen) while the Rauru line to Whätonga 11 comes from Horouta traditions (Rongowhakaata Halbert)



*Toi Te Huatahi 11 lived on Aotea (Great Barrier Island) and was the owner of Horouta and gave it to Paoa and Kiwa to travel to the East Coast

- Rongowhakaata Halbert, *Horouta*

Whätonga 11 would take a second wife, Reretua, sister of Hotuwaipara, and together they had Tautoki. These two half-brothers, Tara and Tautoki, migrated south where Tara occupied Motukairangi (Miramar Peninsula) and Tautoki occupied Parangärahu (Fitzroy Bay). Tautoki married Waipuna, a great granddaughter of Kupe and through them begat Rangitäne, from whom the Rangitäne tribe take their name. We know that when Tara, his wife Te Umuroimata and their migrating Ngäti Awa from Hawkes Bay first occupied Motukairangi, it was an island. It was during the time of Te Aohaeretahi I, great grandson of Tara, when the large 'Haowhenua' quake of 1460 a.d occurred, uplifting the island to create the Hätaitai peninsula. This places Tara and Te Umuroimata, and the building of Te Whetükairangi pä at around 1350 a.d. [8]

6. Tahu Pötiki

Tahu-Pötiki is the naming ancestor of Käi Tahu, arguably the most economically powerful iwi in modern day Aotearoa. His story is one of romance; he was in love with Hamo Te Rangi, the wife of his older brother Porourangi. With a heavy heart he left the East Cape and travelled to Te Wai Pounamu. Upon the death of Porourangi, Tahu-Pötiki returned to the East Cape and married Hamo Te Rangi. Later descendants of Tahu-Pötiki that migrated into Te Whanganui a Tara carried their ancestors name south, occupying Te Mata Ki Kai Poinga pä on Hätaitai (Motukairangi) before moving further south across Raukawa Moana to Te Wai Pounamu. One of the most famous descendants of Tahu Potiki was Tūāhuriri, whose sons Turakautahi and Moki I would migrate further south and go on to found the great iwi of Käi Tahu.

[8] The earthquake time and location based on direction was recorded in China by the ancient seismometer invented in 132 a.d by astronomer, mathematician, engineer and inventor, Zhang Heng

Rauru **(c.1200 a.d)**
|
Whätonga I
|
Apa
|
Rongo Te Whaiao
|
Tuhia Te Tai
|
Ârai Ara
|
Paikea
|
Pouheni
|
Nanaia
|
Porourangi **=** **Hamo Te Rangi** **=Tahu Pötiki** **(c. 1340 a.d)**
(Ngäti Porou) **(Käi Tahu)**

7. Kahungunu

Tai Tokerau traditions say that the Täkitimu people were descendants of the Northland Ngäti Awa and migrated south from Kaitaia in the 14th century. In the late 1800's, Timoti Pühipi of Te Tai Tokerau, an informant of S. Percy Smith told him that:

> *"The group which left from Kaitaia at Rangaunu Bay was led by Kauriwhenua, chief of Ngäti Awa. Tamatea (Pökaiwhenua) was the son of Kauriwhenua and Tamatea was Kahungunu's father"*[9]

The following whakapapa includes a section from Ngäti Kahungunu leader, Hori Tüpaea, and was published in his 1932 petition to the government concerning rights to the former Napier Harbour, Te Whanganui a Orotü, which had uplifted a year before in the Napier earthquake of 1931. He shows his direct line from Awanuiärangi I which concurs with the information from the far north through Timoti Pühipi. This whakapapa also shows that Kahungunu is a famous descendant of Rauru which aligns with an old whakataukî saying:

> *"Ko Rauru te tîpuna tënei o te iwi möhio ki te whakairo, o Ngäti Kahungunu –*
> *Rauru is the ancestor of the tribe learned in carving, of Ngâti Kahungunu".*
> \- Smith 1897 a:28

[9] Smith, S. Percy, 1897. "The Peopling of the North" *Journal of the Polynesian Society*, p. 6 Supplement.

Rauru **(c.1200 a.d)** **Awanuiarangi I**

| |
---|---|---
Whätonga I | **Rauru**
| | |
Tahatiti | **Miru**
| | |
└ = **Rere**

Tata — **Whakatau Pötiki** **(Mähuhu ki Te Rangi)**

(c.1340 a.d) **Tato** [10] — **Pöhurihanga** **(Kurahaupö)**

Rongokäkö = **Muriwhenua**

Tamatea Pökaiwhenua **(Täkitimu)**

Ranginui **(Ngäti Ranginui of Tauranga)** — **Kahungunu** **(c.1400 a.d)**

According to Smith this was a saying of Ngä Puhi, and he said they agreed with East Coast tribes who say Rauru invented the present patterns of classical Mäori carving. Therefore, through his skill as a kaiwhakairo (carver) his descendants carry that '*momo*' or 'trait,' passed down from his ancestor Rauru. Kahungunu was born and raised in Kaitaia to manhood. After falling out with his relatives he left his wife and children and migrated south by land and finally settled in Mähia Peninsula after fathering numerous children amongst many iwi along the way. Kahungunu's grandson from Türanga (Gisborne), Räkaihikuroa, and his son Taräia, migrated south and settled in Ahuriri (Napier) and intermarried with their distant relatives of the Hawkes Bay Ngäti Awa already living there. Generations later descendants of Kahungunu created a new hapü in the Wairarapa and Te Whanganui a Tara under their ancestor Kahukuraawhitia. They were in occupation of Heretaunga (Hutt Valley) when Âti Awa arrived on the Käpiti coast in 1824. Kahungunu is also immortalized in name on the small islet of Mokopuna at the northern end of Mätiu Island where a small cave is called Te Ana a Kahungunu.

8. Ira Türoto

At the time when Kahungunu's descendants (Räkaihikuroa and Taräia) moved from Gisborne to Hawkes Bay, a group of Ngäti Ira (descendants of Ira Türoto from Ûawa - Tolaga Bay) under Te Aomatarahi joined them and also moved south. Horouta waka traditions from the east coast record an interesting whakapapa connection of Ira Türoto back to Âti Awa and Taranaki. Horouta traditions state that Ira Türoto was fathered by Tura, whose father Raumati, was from Taranaki. The following reference comes from Horouta traditions:

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[10] According to Ngä Puhi, Rongokäkö was known as Kauriwhenua in the north. This whakapapa from Hori Tupaea suggests that Tamatea Arikinui may have also been known as Tato. There is also a possibility that Tato is Toto because in some Whakapapa Rongokäkö and Rongorongo are siblings. The **blue line** in this whakapapa from **Awanuiarangi** to **Kahungunu** is taken from the 1932 Hori Tüpaea petition

"The Âti Awa tribe to the North of New Plymouth and Taranaki to the south claim Tamaahua as their chief tribal founder. His son Raumati, by his wife Tauranga (who was also from Tauranga), was responsible for destroying by fire the Te Arawa waka at Maketü. Raumati's grandson, Ira Türoto, became the naming ancestor of Ngäti Ira of Hawkes Bay, Wairarapa and Wellington."

– Rongowhakaata Halbert*, Horouta*

Rauru **(c.1200 a.d)**
|
Tahatiti
|
Ruatapunui
|
Tama Te Huatahi
|
Ngäi Tauira
|
Te Hätauira **(c.1300 a.d)**
|
Tamaahua (Taranaki ancestor associated with the Kurahaupo waka)
|
Raumati
|
Tura
|
Ira-Türoto (Uawa / Tolaga Bay) (c.1380 a.d)

The Ira Türoto traditions from the east coast that are familiar with the doings of Tamaahua living on the west coast suggest's that our ancestors travelled far and wide in ancient times. Tamaahua is a famous Te Kähui Maunga ancestor of the Taranaki west coast, and like Whätonga is also associated with the waka, Kurahaupö. Another version was recorded and published by the famous Ngä-Puhi tohunga, Häre Höngi, husband of Mere Robson[11] of the Te Matehöu hapü of Te Âti Awa. The Häre Höngi version begins with a woman,' Waitaiki' being kidnapped by Poutini from Tühua (Mayor Island). Waitaiki's husband Tamaahua, (originally from Whangamatä, Coromandel) chases Poutini across the island to Taranaki, down the west coast to Te Whanganui a Tara, across Raukawa Moana to Arapaoa Island and further across to Arahura on the west coast. As Tamaahua approached Arahura, Poutini transformed himself and Waitaiki into pounamu at the Arahura River before Tamaahua could catch them. Tamaahua then returns to Taranaki with some pounamu. It is interesting to note that the sacred Toki adze – 'Poutamawhiria' – held in the Pukeariki Museum in New Plymouth was brought to Aotearoa from Hawaiiki on the Tokomaru waka which landed in north Taranaki and affiliates with the Âti Awa confederation. Yet, Poutamawhiria is made of Argillite sourced from Whakatü (Nelson).

[11] Mere Robson was the daughter of Mere Kapa Ngamai II and James Robson who arrived in Aotearoa in 1860 from Northumberland. Mere Kapa Ngamai II was a daughter of Mere Ngamai I and James Harrison, a whaling captain from Nantucket, Massachusetts working on Käpiti Island until his death in 1845, Mere Ngamai I was a daughter of Tapaki-Marae of the Ngäti Rähiri hapü of Te Âti Awa and the famous urukehu (fair-skinned) warrior, Te Motutere of the Te Matehöu hapü of Te Âti Awa

Ahi kaa roa – long burning fires

9. Puketahā

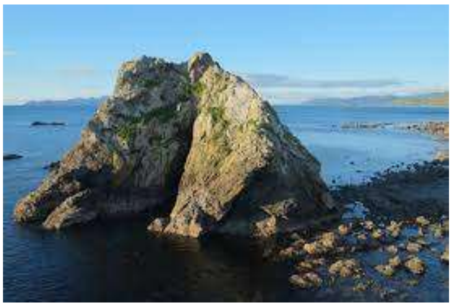
Puketahā (hill of calabashes) is one of our tribal maunga within our takiwā and dominates the Wainuiomata water catchment basin. It is a ‘pae maunga’ (range) approximately three kilometres long, with a series of three peaks at 800, 767, and 791 metres, running south to north respectively in a NE/SW direction. The pae maunga is the central ridgeline that demarcates the Wainuiomata catchment on its western side and the Orongorongo catchment on its eastern side. The NW face of Puketahā is the farthest and highest range that greets you as you drive down the main arterial route into the Wainuiomata township.

Above: The pae maunga of Puketahā on the horizon looking east from Pukeatua. The Wainuiomata township centre is in the bottom right of the frame, above the Wainuiomata High School grounds and Wise Park in the right foreground.

9.1. Te wao tapu - Orongorongo

The Orongorongo Valley is on the eastern side of Puketahā and is named after our ancestress Rongorongo from the 14th century, daughter of Toto who crafted the two famous waka, Aotea and Matahōurua, mentioned earlier. A peak which forms part of the Remutaka Ranges is also named Orongorongo. The western side of the peak of Orongorongo falls into the Orongorongo Valley while the eastern side is the catchment of the Wai-Orongomai stream that flows into Wairarapa moana. One whakapapa tradition records Rongokākö of Takitimu as a brother of Rongorongo. Tai Tokerau traditions refer to Rongokākō as Kauriwhenua. He attended a whare wānanga in Wairarapa which suggests the Orongorongo Valley may have been named then if she was also present in the area at the time, as it abuts the western side of Lake Wairarapa. Many of our people of Taranaki Whänui are direct descendants of Rongorongo, especially the Ngäti Ruanui people of Te Aro pä. The eponymous ancestor Ruanui from which Ngäti Ruanui take their name is a grandson of Rongorongo. Another famous descendant of Rongorongo is her great granddaughter, Wairaka. Despite being married, Wairaka and a lover of hers left the home of her husband Haunui - a - Nanaia (Hau) on the east coast and ran away to her home in south Taranaki. When she reached the west coast, instead of heading to the home of her childhood, she turned south while being pursued by her husband Hau. Hau was a great grandson of Kupe and his wife, Hine Te Apārangi. Hau tracked his wife and her lover from Whanganui to Pukerua Bay, naming all the rivers along the way - his claim to fame. When he caught up with Wairaka at Pukerua Bay he turned her to stone. She is Wairaka rock in Pukerua Bay. Hau then continued-on his way, crossing the Porirua Basin and Te Awakairangi headwaters. When he saw the Remutaka Ranges it presented the image of the täniko hem border (Remu) of a luxurious Kaitaka (Taka) cloak. Rangitäne traditions say that Hau took a rest when he reached the top of the ranges - Remu (buttocks) taka (to rest) - at which point he saw a shining lake and named it Wai (water) Rarapa (flashing).

Rauru **(c. 1200 a.d)** | **Awanuiärangi I** = **Wharekura**
|
Räkaumaui | **Uhenga**
|
Rongotea | **Poutama**
|
Pureora | **Toto** | **Whitirangimamao**
|
Turi **(Aotea)** = **Rongorongo** **(c.1280 a.d.)** | **Kuramārōtini** **(Matahöurua)** = **Kupe** = **Hine Te Apārangi**
|
Taneröroa | **Haunui**
|
Ruanui **(Ngāti Ruanui)** | **Kupe 11** | **Popoto** = **Nanaia**
|
Wairaka ================= **Haunui-a-Nanaia** **(c. 1340 a.d)**


Wairaka, Pukerua Bay, looking north to Waikanae

9.2.1. Ngāti Mutunga - 1825

After migrating from Taranaki the year before in the heke known as 'Niho Puta', Ngāti Mutunga under the leadership of Patukawenga, Pömare, Ngätata i te Rangi, Te Poki, Apitia, Manukonga and others, occupied the western side of Te Whanganui a Tara, while the resident tangata whenua of the time, Ngäti Ira, maintained their villages spread along the eastern side of the harbour. They resided at Waiwhetü (on the eastern side of the Awakairangi estuary), the palisaded pä of Ngutu Ihe (situated on a spur on the Pukeatua Ranges), Oruamotoro (Days Bay), Okiwi (Eastbourne), and Paräoanui (Pencarrow). On the arrival:

> *"Ngäti-Mutunga and others in the "Niho-puta" migration, settled down for a time at Wai-kanae, but not for very long. Rangi-pito says they remained there for about a year and then the whole party moved on to Port Nicholson (Whanga-nui-a-Tara). Many of Âti-Awa, together with Ngäti-Tama, first settled at Ohariu—a place on Cook's Straits directly west of Wellington. From here they moved on to Port Nicholson. On the arrival of the heke they settled down on the shores of the harbour, right in the centre of what is now the city of Wellington, forming a series of villages extending from Te Aro to Kai-wharawhara. The Ngäti-Tama occupied Rau-rimu, which is that part around Fitzherbert Terrace, and their cultivations extended down to the stream Tiaki-wai—that ran down where the Tinakori road now is. The Âti-Awa cultivations also extended over the Otari (Tinakori) hills and beyond, that is, in suitable places, and there were several villages scattered about that part of Thorndon, such as Pa-*

kuao—just where Tinakori road came out to the beach; Kopae-pai-awai, top of Hobson street; Nga-pakoko, near the present Manawatu Railway Station; Kumu-toto at the bottom of Bowen street; Pipitea, a large village fronting the beach, just under Bishops court; besides another large village at Te Aro. The present village of Nga-uranga (the landing places) bears an old Ngati-Ira name. At this time the whole of Thorndon was under cultivation—the Ati-Awa being the first to fell the bush which formerly covered the country.[12]

Left: **Pōmare Ngātata** (? – 1851)

Ngäti Mutunga rangatira who, along with his tuakana, Patukawenga and their band of Ngäti Mutunga warriors fought many battles in Käwhia, Taranaki, the Käpiti Coast, Te Whanganui a Tara and Te Wai Pounamu, before migrating to Rëkohu / the Chatham Islands in 1835. He was only in his early 20's when he led his iwi in the Nihoputa migration from Taranaki in 1824.

Right: carved effigy of **Te Mana** of Ngāti Mutunga.

Te Mana was the son of Te Poki, one of the senior rangatira of Ngāti Mutunga alongside Patukawenga and Pōmare. When Te Poki settled in Te Whanganui a Tara in 1825, he named the Korokoro stream at the western end of Pito One beach, after his son by proclaiming it as '*Te Korokoro o taku tamaiti*' (the throat of my child). The Korokoro stream is known as Te Korokoro o Te Mana (the throat of Te Mana). Te Poki and Te Mana eventually migrated to Rēkohu (Chatham Islands) in 1835 following the desecration of the grave of Te Waka Tiwai, (brother of Pōmare Ngātata) after the Haowhenua war of 1834 on the Kāpiti Coast.

[12] Smith, S. Percy, *History and Traditions of the Taranaki Coast*, pp 406 - 407

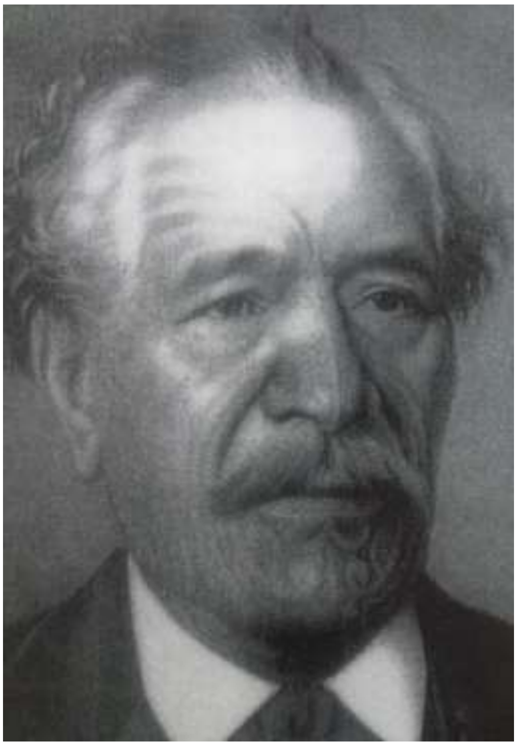
Right: **Ngātata i Te Rangi** (? – 1854)

Rangatira of Ngāti Te Whiti from Ngāmotu (New Plymouth) and Ngāti Mutunga. Ngātata came to te Upoko in 1822, fought at Waiorua Bay, returned to Taranaki, and migrated back to te Upoko in 1824 with his Ngāti Mutunga relatives. Other Te Āti Awa rangatira such as Te Moturoa, Wairarapa, Te Matoha, and Te Pouawhā from the Te Matehōu hapū from Ngāmotu also came in the 1824 'Niho Puta' migration. Ngātata established the kainga of Kumutoto with Pōmare Ngātata of Ngāti Mutunga. He passed away at Otepoti while visiting his daughter Karoraina, who was married to the Kāi Tahu rangatira Taiaroa.

9.2.2. Te Āti Awa - 1832

It was Te Mana of Ngäti Mutunga that first introduced the Orongorongo Valley to our tüpuna of Te Âti Awa from Ngāmotu, and although there are many Te Âti Awa individuals that are referred to in Mäori Land Court hearing records from the late 1800's as having hunted and gathered there, specific individuals such as Hirini Nukutaia, Mohi Puketapu, Hohepa Enoka and Panapa Tuwhare, it was Mätangi of Ngäti Täwhirikura who requested Te Mana show Te Âti Awa the fruits of the Orongorongo Valley.

Carved effigy of Te Matangi, Te Āti Awa entrance, Wainuiomata Valley track to Orongorongo Valley



Manihera Te Toru (1802 – 1884) Son of Te Matangi, Te Āti Awa

9.3. Te wao tapu - Wainuiomata

The east branch of the Wainuiomata headwaters is on the western side of Puketahā. This is the catchment that is the primary 'area of interest' for the proposed Kākāpō sanctuary. The harbour foreshore and Heretaunga Valley provided more than enough land for our people to establish permanent kainga villages. The headwaters of the Wainuiomata Valley, being one hundred metres above sea level, never had any permanent kainga but was extensively used for traditional Māori agriculture.

9.3.1. Te Āti Awa - 1835

Te Âti Awa living in Wairarapa under Te Wharepöuri and others were ambushed by a war party of Ngäti Kahungunu under Nuku-Pewapewa and Ngäi Te Upokoiri under Hoeroa. Nuku came down from Mähia Peninsula to see if Âti Awa were still in occupation of Wairarapa. At night he saw the many fires of occupation but noticed that one fire was bigger than the others. This was Tauwharerata, the village of Te Wharepöuri near modern day Featherston. Te Wharepöuri was engaged in building a house at the time of the attack:

> *"The attacking party attempted to spear him by thrusting their long spears through the sides of the house; but he climbed up to the roof, and there held on to the rafters until help came from his own party by way of diverting the enemy's attention, and he was released from his awkward position, and so escaped. Nuku was anxious to save Te Whare-pouri in order that peace might be made between the two tribes and that when the latter escaped from the house Nuku and two fleet runners pursued him in order to catch him. But Te Whare-pouri was too quick for them; he flew into the forest, and finally jumped over a cliff and escaped, his pursuers not daring to follow him. But Ngati-Kahungunu did not go back empty-handed, for they captured and took away to Nuku-taurua with them Wharawhara-i-terangi, a daughter or niece of Te Whare-pouri's."*[13]

Te Wharepōuri (? – 1842)

[13] Ibid, p. 457

While running the traditional forest trail that crosses west / east along the headwaters of the Orongorongo and Wainuiomata catchments Te Wharepouri was distraught, grieving and crying for what he thought would be the certain death of his wife, daughter and other whanaunga and likened the great waters (**wai-nui**) streaming down his face (**mata**) to the Wainuiomata catchment. The trail continues across to the Pukeatua Ranges and down into Waiwhetü. Upon hearing the news of this tragedy, the kuia elders occupying Te Whanganui a Tara also mourned what they believed was the loss of Te Uamairangi, Te Kakapi and others. Te Uamairangi was eventually released soon after and allowed to return to Te Whanganui a Tara but Te Kakapi was taken back to Mähia by Nuku Pewapewa. Te Wharepöuri was elated when his wife returned which motivated him to seek peace with Nuku Pewapewa and Ngäti Kahungunu and to negotiate the return of Te Kakapi. Despite the uneasy state of affairs at the time, our people still ventured into Orongorongo regularly. Emeritus Professor Alan Ward records how:

> *"Orongorongo was used by Te Atiawa. These were mainly Te Matehou according to Ihaia Porutu in 1868. According to one witness, a group also came to Pipitea from Arapaoa (island) a short time **before** Col. Wakefield's arrival: Hone Waitere, Wi Rangiawhio and Hemi Te Whiro, joining a sister, Te Rahiri. They became permanent residents, worked in Pipitea's cultivations and went to Orongorongo to fish, collect karaka berries and make canoes."*[14]
> *…. Mohi Puketapu was another of these early Te Atiawa claimants who were still at Waiwhetu and visiting Orongorongo when Te Matehou came back from the Wairarapa and 'took possession'. Mohi continued to get fish and berries and bring them back to Pipitea.* [15]

9.3.2. Te Āti Awa guide Heaphy and Dieffenbach across Wainuiomata / Orongorongo - 1839

Charles Heaphy was the NZ Company draughtsman at the time of the Tory making its maiden voyage into Te Whanganui a Tara in September 1839. Ernst Dieffenbach was a German, also employed by the NZ Company, but as a '*naturalist*'. Despite only being in Aotearoa for a few weeks, they both ventured into the eastern interior hinterland of Te Whanganui a Tara to 'collect' specimens of indigenous Māori flora and fauna, in particular, the now extinct Huia. Heaphy recorded how:

> *"The Huia (Heteralocha acutirostris) was then to be found in the ranges between Wainuiomata and Palliser Bay. Dr. Dieffenbach, the naturalist, was anxious to obtain some, and I accompanied him, making sketches, to the high range that overlooks Palliser Bay… **two boys readily went with us as guides** … we struck in from near Lowry Bay (Whiorau), and reached the source of the Orongo (Orongorongo) stream before night … the natives were afraid of the Wairarapa people against whom they had lately fought, and while we slept with our feet near the fire, they sat crouched with **our guns in their hands**, listening to detect any possibly approaching footsteps, for they were on the debateable land of the two tribes. The only sound worth noticing was the beautiful melody, towards morning, of the bell-birds. Thousands of these were singing together, and, probably by some auricular delusion, the sound seemed to arrange itself into scales, like peals of bells running down octaves. As the sun rose this music ceased altogether. From the top of the range we had a fine view of Palliser Bay and the Wairarapa Lakes. **On our way homeward the natives suddenly stopped**; they heard in the distance the peculiar cry of the huia. Imitating this, and adding a peculiar croak of their own, which they said was very attractive, our guides soon brought two birds - a male and female - within shooting distance. We abstained from firing for a moment, admiring the elegant movements of these birds as they leaped from tree to tree, peering inquisitively at us, and gradually coming nearer. We now fired with light charges and*

[14] P.97
[15] P.168

> *brought each a bird down.* ***Our natives were annoyed at our "griffinism**." They had intended, by a further allurement of a peculiar gutteral croak, to have brought the birds so near as to capture them with a common slip-knot at the end of a stick - a process which we saw subsequently performed with entire success. As we descended the spur near the mouth of the Hutt River, a whale and its calf were tumbling about between Lowry Bay. and Somes' Island." [16]*

The interesting part about their adventure into the Wainuiomata – Orongorongo forests was that they were guided by two Te Āti Awa *boys* who *"readily went*" into the hills of the Wainuiomata / Orongorongo hinterlands, despite being "*afraid*". We can only surmise that these two un-named boys were teenagers and were both capable, and fully aware of the risks of the time. It is also interesting in that the two *boys* were even permitted to guide their two clients into the hinterland despite the danger of potentially coming face to face with seasoned adult warriors from Wairarapa. Clearly, these boys chose to face that fear, albeit with a shotgun in hand at night by the fire. This eye-witness account from Heaphy describing the intimate knowledge of the two Te Āti Awa boys in imitating the calls of the Huia which suggests that they may have been specifically sought after for their particular skillset in calling the Huia, or, that the skill of bird calling was widespread among iwi Māori where everyone was good at it. Before peace was firmly established in 1840, parties of our people and our whanaunga elatives from Totaranui (Queen Charlotte Sound) made full use of the Orongorongo valley. Emeritus Professor Alan Ward records how:

> *"Orongorongo was used by Te Atiawa. These were mainly Te Matehou according to Ihaia Porutu in 1868. According to one witness, a group also came to Pipitea from Arapaoa (island) a short time before Col. Wakefield's arrival: Hone Waitere, Wi Rangiawhio and Hemi Te Whiro, joining a sister, Te Rahiri. They became permanent residents, worked in Pipitea's cultivations and went to Orongorongo to fish, collect karaka berries and make canoes."[17]*
> *…. Mohi Puketapu was another of these early Te Atiawa claimants who were still at Waiwhetu and visiting Orongorongo when Te Matehou came back from the Wairarapa and 'took possession'. Mohi continued to get fish and berries and bring them back to Pipitea. [18]*

9.3.3. Te Tatau Pounamu – the greenstone door of peace - 1840

After preparing and raising the required utu (payment) for the return of Te Kakapi, Te Wharepöuri sailed north to Mähia Peninsula to negotiate peace arrangements. Unfortunately upon arrival he would learn that he had recently died in an accident (at the mouth of the Whakakî Lagoon where a capsized waka struck him on the head) at which point he sung a poetic song of mourning for the great warrior chief, Nuku Pewapewa, reputed to be a giant of a man:

He Waiata Tangi mō Nuku Pewapewa
Nā Te Wharepōuri o Te Āti Awa

1Tera Tariao ka kokiri kai runga,	*1 LoTariao has sprung up on high,*
Ko te rite i ahau e whakawhetu nei,	*In like case am I with the stars above.*
3Te hua i te puku e kai momotu nei.	*3 Cherished memories within do tug and tear.*
Wairua i tahakura nou nei e Nuku;	*The spirit that comes to me in dreams is yours, O Nuku';*
5 Kei te whakaara koe i taku nei moe,	*5 Awakening me from my slumbers,*
Kia tohu ake au ko to tinana tonu.	*Verily, me thought 'twas you in the flesh.*
Me he wai wharawhara te tuturu i aku kamo.	*Like the dripping wharawhara leaves, my tear-*

[16] Major Charles Heaphy, Notes on Port Nicholson and the Natives in 1839.(Art. III) [Read before the Wellington Philosophical Society, 11th October, 1879. Published in Transactions and Proceedings of the New Zealand Institute, 1879. Vol XII.]
[17] P.97
[18] P.168

	dimmed eyes.
E tangi, e manu, kia mohio roto.	*Sing on, O bird, to give me peace of mind.*
Ma te hau tonga e whiu i ahau	*Let the wind from the south hurl me forth*
10 Nga puke iri mai o Rangitoto i waho;	*10 To the elevated peak of Rangitoto out yonder;*
Kia whaia atu ka wehe i ahau.	*So that I might pursue the absent one*
Tera pea koe ka iria he maunga,	*Peradventure you are lingering on the mountain top,*
Nga tai tangi mai o Manukau i raro;	*With the tides of Manukau lamenting below;*
14 Ki Nga-Puhi ra ia, ki Wainukumamao,	*14 or with Ngapuhi afar (thou art), at Wainukumamao,*
15 Ki Morianuku; te huri rawa mai	*15 or at Morianuku; where you will backward gaze*
To wairua ora ki au ki konei.	*and present your spirit, as if in life, to me here.*

Then the cousin of Nuku, Tû Te Pâkihi Rangi, took over proceedings and travelled to Te Whanganui a Tara with an entourage of 30 warrior chiefs. En route to Te Upoko o Te Ika, Te Wharepöuri agreed to remain with Te Hapuku of Ngäti Te Whatuiapiti at his residence on the Heretaunga plains at Te Hauke as a diplomatic prisoner while the entourage of Ngäti Kahungunu continued to Te Whanganui a Tara. Before the arrival of Ngäti Kahungunu in Te Whanganui a Tara, a raiding war party of Ngäti Moe from Wairarapa attacked and killed Te Pühäkawa[19], chief of the Te Matehöu hapü of Te Âti Awa of Waiwhetü, while he was tending to his gardens in Whiorau (Lowry Bay). The Ngäti Kahungunu entourage arrived in Te Whanganui a Tara during June of 1840 where at a formal hui at Pito One, Tü Te Pakihirangi established our eastern boundary as part of peace proceedings:

> *"Live, all of you, on this side of the bounding mountains (Remutaka to Turakirae) you on this side, I on the other. I will call those mountains our shoulders; the streams that fall down on this side will be for you to drink, on the other side for us."*

To seal the peace arrangements with the Wairarapa people, Te Kakapi o Te Rangi was married with Ihaka Ngähiwi of Wairarapa while Ngä Whäwhä, a granddaughter of Tamairangi (Ariki Tapairu/female lord of Ngäti Ira) was married with Wî Tako Ngätata of Âti Awa.

Takarangi = **Raumahora**
|
Rongoueroa = **Te Whiti o Rongomai I** = **Tarawhakauta**
| |
Aniwaniwa **Kara ki Te Rangi**
| |
Te Whiti o Rongomai II **Pakanga** **Tamairangi** = **Whanake**
| | |
Te Wharepöuri **Ngātata i Te Rangi** **Whakaangi**
| | |
Te Kakapi = **Ihaka Ngahiwi** **Wi Tako Ngātata** = **Ngāwhāwhā**
(Te Âti Awa) **(Ngäti Kahungunu)** **(Te Âti Awa)** **(Ngäti Ira)**

Whilst our people no longer harvest indigenous Māori flora and fauna such as Karaka and Kereru, we actively maintain the harvesting of ngā tamariki a Tāne Mahuta that sustains our traditional spiritual, medicinal, weaving, carving and storytelling transfer of knowledge. Naturally, we have adopted the harvesting traditions of introduced species (deer, pigs etc) and have made them our own.

[19] Te Pūhākawa was decapitated and his head taken back to Wairarapa.

9.4. Kāi Tahu

The iwi of Kāi Tahu were former occupants of Te Whanganui a Tara alongside Ngāi Tara and Ngāti Kahungunu during the 16th century, predominantly centred on Motukairangi (Miramar Peninsula), known then as Hataitai. The four-hundred-year-old pā site of Te Mata ki Kai Poinga on the west side of Matai Moana (Mt Crawford) is where the great Kāi Tahu rangatira, Tūāhuriri once resided before his descendants moved across Raukawa Moana to Te Wai Pounamu. Up until 2012, Kāi Tahu were the last Kaitiaki of Kākāpō when they made the first hekenga migration from the deep south, into the takiwā of Ngāti Manuhiri of Te Moana o Tikapa (Hauraki Gulf), re-introducing Kākāpō to Te Hauturu o Toi (Little Barrier Island). We are aware of the enormous commitment required in caring for Kākāpō, should Kāi Tahu permit the hekenga migration of Kākāpō to Puketahā.

9.4.1. Tuakana - teina

Tāne Davis (Kāi Tahu) and Estelle Learsk (Kāi Tahu, Ngāti Ruanui) were welcomed to the Wainuiomata Recreational Reserve in late 2020. In the context of this Kaupapa, they are our tuakana (senior) as they hold the mana authority, and the matauranga knowledge. Therefore, they are no longer waewae tapu (sacred feet) and have no restrictions in our takiwā that relate to the kaupapa purpose of establishing a sanctuary. Our knowledge of Kākāpō is non-existent and was lost more than a hundred years ago with the extinction of the local Kākāpō population. Effectively, the proposed sanctuary cannot happen without the permission and knowledge transfer from our Kāi Tahu tuakana. The assessment they gave of the quality of the Rimu and Rātā podacarp forest in the Wainuiomata water catchment was resoundingly positive.

Above: Kaitiaki Tāne Davis (Kāi Tahu) and Fiona McKenzie (Ngāti Manuhiri) releasing Kākāpō on Te Hauturu o Toi Island, Te Moana o Tikapa (Hauraki Gulf). This hekenga migration of Kākāpō from Rakiura to Hauraki was the first in our history since their disappearance from the mainland. A safe haven for up to 23 kakapo which was close to 50% of the remaining kakapo from 1982 to 1999, most of them moved up from Stewart Island to protect them from cat predation. Kakapo were removed prior to kiore (rat) eradication in the early-2000s and were re-introduced in 2012.

10.Taranaki Whānui - Ahi Kaa Roa

Te Āti Awa families from Waiwhetū and Te Tatau o te Pō have maintained ahi kaa roa in the Wainuiomata Valley, Taumairangi Valley and Parangārahu (Fitzroy Bay) from the mid 1800's. The kainga of Okakaho in Parangārahu was occupied right up until the mid-1900's until the last remaining whanau relocated to the Wainuiomata township. The area where the current Wainuiomata township is, was often referred to as part of the back-hills of Whiorau (Lowry Bay). This gave rise to the name of the Lowry Bay block, part of which was returned to the iwi as cultural redress land under the Taranaki Whānui – Port Nicholson Block Settlement Act. The Whiorau / Lowry Bay block (1) today covers Wainuiomata marae, Wise Park, the Fire Station and the old Wainuiomata Intermediate and High Schools. After World War II suburban development was the new social order of the day coupled with large scale manufacturing development at the foothills of both sides of Pukeatua. Many Te Āti Awa families moved from Waiwhetū and Te Tatau o Te Pō over to Wainuiomata and almost immediately intermarried with many other Māori that migrated to the city from the four winds of ngā hau e whā. Under the Port Nicholson Block Taranaki Whānui ki te Upoko o te Ika Settlement Act 2009, our statutory rights to the Wainuiomata Reserve Area and Remutaka Forest Park are acknowledged by the Crown. These high country and coastal valleys are all interconnected with the ngāhere providing kai, timber, raranga material and rongoā medicines, farmland for stock, freshwater kai such as Tuna and Inanga, and takutai coastal waters for Mataitai seafood.

10.1. Wainuiomata – coast road valley

Before the Wainuiomata township was created it was swampy terrain, parts of which were used by our tūpuna of the Te Matehōu hapū from Waiwhetū as ngakinga gardens. In contrast to the township, the '*coast road'* is still rural farmland on the doorsteps of the neighbouring Orongorongo valley. Indeed, uri descendants of Wikitoria Randall (nee Puketapu) still live on Māori freehold land adjacent to the entrance of the Remutaka Forest Park. The Te One Jones whanau, also from the Te Matehoū hapū have farmed the valley since reserve lands were arranged for our people. The iconic Wainuiomata Rugby Union Club fields – William Jones Park – is associated with the whanau of William Wiri Te One Nukutaia Jones.

(R) William Wiri Te One Nukutaia Jones with his wife Hanna Jones (nee Burrow) holding Wiremu jnr, 1908

Whakapapa: Te Āti Awa whanau of Wainuiomata coast and Taumairangi

Rauru c. 1200 a.d
|
Tahatiti
|
Ruatapu
|
Tamatea Huatahi
|
Ngaitauira
|
Te Hatauira
|
Tamaahua Tamateahurumangamanga (*Te Kāhui Tū*)
| |
Raumati Te Moungaroa (Kurahaupo waka) Poutini (Tokomaru waka) c. 1350 a.d
| | |
Uru Te Kakara = Ngarue (Ngahue) Pouwhenua
| |
Wharematangi Pouwānanga
| |
Tairi Poukōrero
| |
Taihawea Poutea
| |
Turipariaha Hine Tawaki
| |
Marupoto Hape ki Tuarangi
| |
Maruwhiuwhiu = Tukoutehe Patiki Moeroa
| |
Tupatukorehe Rangipatito
| |
Te Hekengatao Ngātarapuku
| |
Takawhakione Ngāwhete
| |
Haeamaiterangi ======= Whitiaua (Whakairitaua)
|
Te Rangiapitirua Te Rangi Puaheihei = Hinetaitu
|
Raumahora = Takarangi = Kanaiterangi Taihuru
| | |
Te Wehenga Rongouaroa Punatoto = Raepakoko Te Manutoheroa
|
Te Matoha Te Moturoa Wairarapa Kautarewa = Nukutaia = Takawaru Te Rīrā Pōrutu = Te Awa
| | | |
Hera Tipene William Jones = Keti Kautarewa Mohi Puketapu ============ Harata Pōrutu
(b. Wales, 1809)
| | |
Hera Piko ============================== *Pero Te One Hapi Tutua Puketapu
| |
^ Wiri Te One Jones Ihaia Pōrutu Puketapu

Eric Keti Wiremu Ken Ray Heni* Pai Turi Henry Betty Ihakara Te Rīrā Erenora = Rangi Hetet Wikitoria

Wainuiomata coast whanau | Taumairangi whanau | Wainuiomata marae Tohunga | Wainuiomata coast whanau

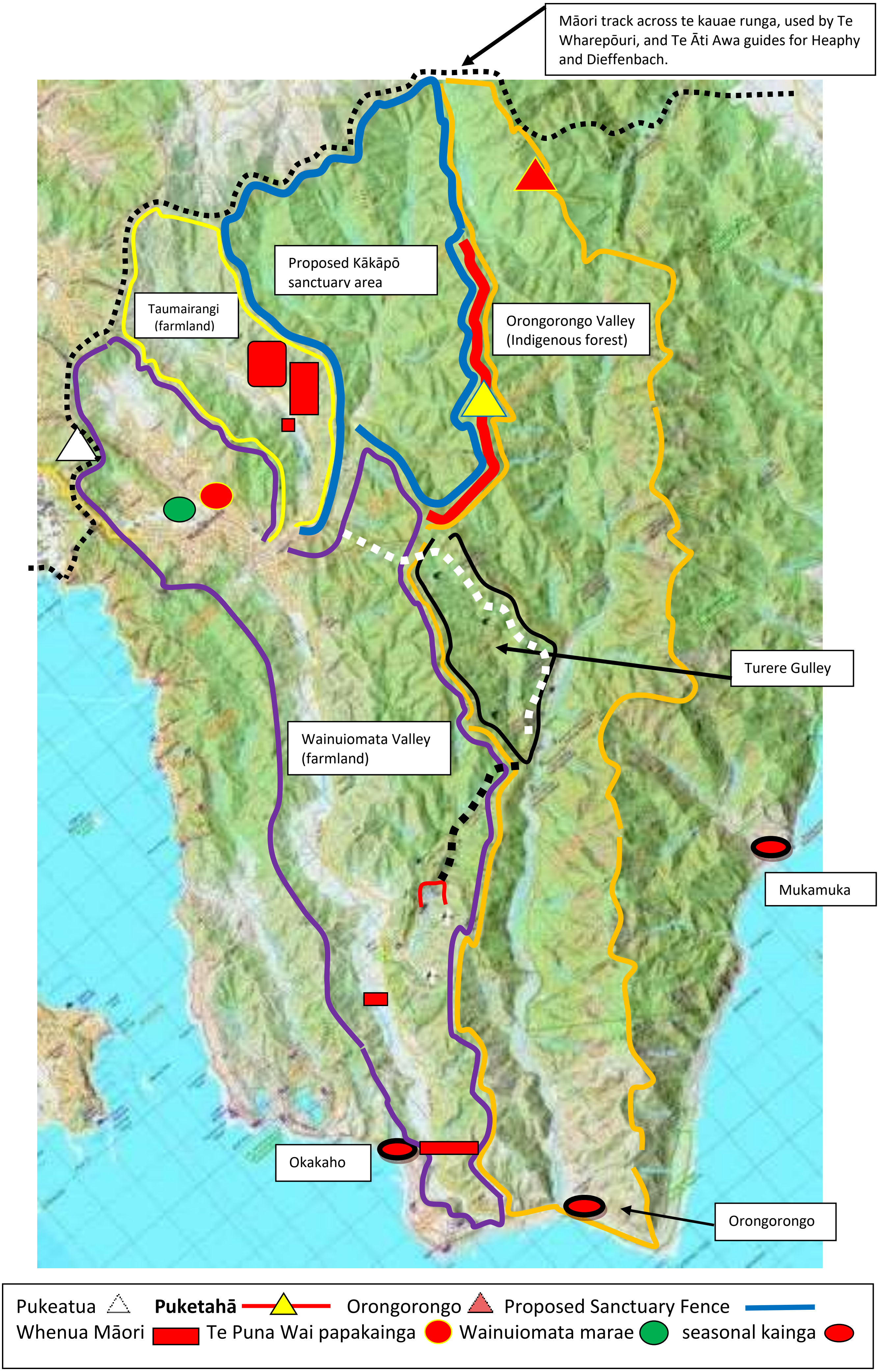
Note: William Jones was born in Wales, 1809 and died in New Plymouth in 1898. *Pero Te One was also known as William Nukutaia Jones, and ^ Wiri Te One Jones was also known as William Wiri Te One Nukutaia Jones


Left: Manu Jones (4), 1914 **Right**: Heni (Nin), Pai and Ken (Brown) Jones, Wainuiomata School, 1924

Living down the 'Wainui coast' - before the post-World War II urban development - with a mix of pasture and large forested hills and valleys, farm produce and wild game provided the bulk of the kai that large whanau needed to keep them strong and healthy. Wiri Te One Nukutaia Jones, his wife Hanna and their ten children is one example. He had other siblings that also had large families with many descendants that live in Waiwhetū and across Wainuiomata. At the turn of the century, the Influenza and Smallpox epidemics decimated our people, so these early images of his whanau portray the strong survivors of that time. Their strength is a reflection of the environment that they lived in, where the land provided kai and resources. The national Māori population reached an all-time low of approximately 40,000 by 1900, and then the fight to recover began. In 2021 the Māori population has grown to 850,000. In 1850, a census of the local `population of the 'Port Nicholson natives' had our numbers at 711 people. Today our iwi register sits at approximately 19,000 registered iwi members, with as many as 6,000 iwi members living locally within the takiwā.

Below: Peter Reweti, grandson of Heni (Nin) Gordon (nee Te One Jones). Iwi kaitiaki as Chairman of the Te Āti Awa Fisheries Trust.

Above: Pai, Ray and Ken (Brown) Te One Jones – Wainuiomata/Orongorongo, 1939
Te whanau o Te One / Jones, Te Matehōu te hapū, Te Āti Awa



Māori track across te kauae runga, used by Te Wharepōuri, and Te Āti Awa guides for Heaphy and Dieffenbach.
Proposed Kākāpō sanctuary area
Taumairangi (farmland)
Orongorongo Valley (Indigenous forest)
Turere Gulley
Wainuiomata Valley (farmland)
Mukamuka
Okakaho
Orongorongo
Pukeatua
Puketahā
Orongorongo
Proposed Sanctuary Fence
Whenua Māori
Te Puna Wai papakainga
Wainuiomata marae
seasonal kainga

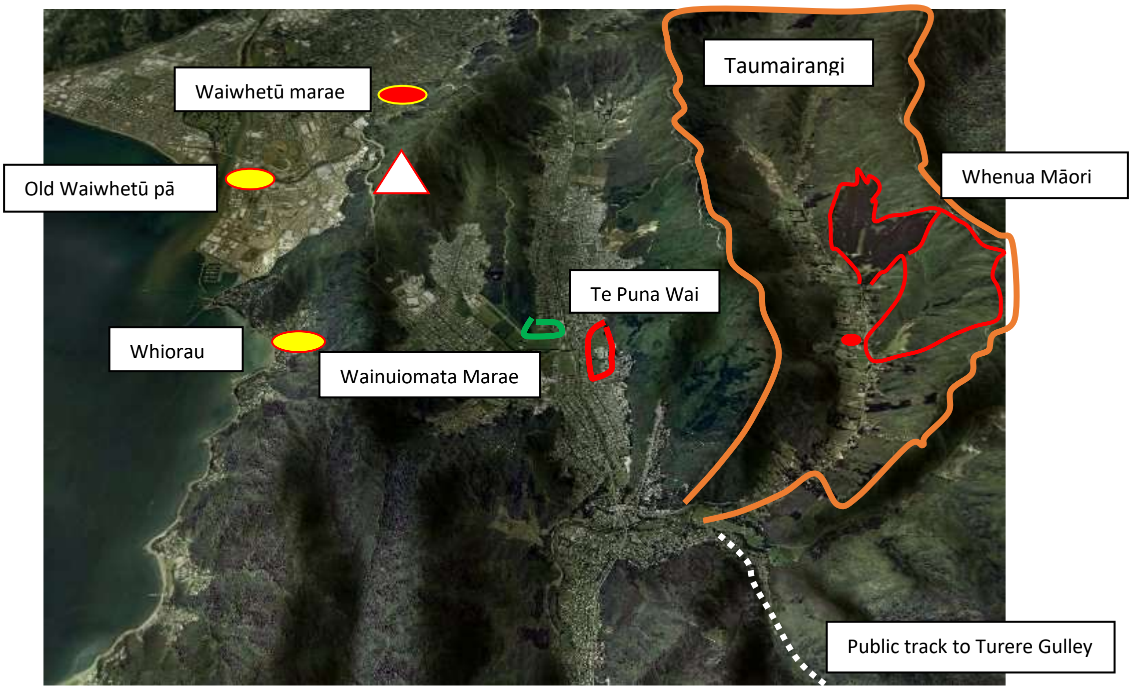
Today, Wainuiomata coast road whanau maintain their role in kaitiakitanga projects that focus’ on Kotahitanga unity in the whanau, hapū, iwi, local authorities and wider community. The uri descendants of Wikitoria Randall (nee Puketapu) maintain their ahi kaa roa down the coast road opposite the entrance to the Remutaka Forest Park, which is the southern *public* access point into the Orongorongo valley. Hunting and gathering from the ngāhere and the moana of the local Wainuiomata and Orongorongo catchments and coastlines are a major mainstay for her children, grandchildren and, and great grandchildren. Kaitiakitanga is a natural part of their daily lives, being involved with local Tai Ao initiatives such as the Kiwi Recovery Programme in the Orongorongo valley, hunting, pest management, and fisheries compliance management.

Left: Te Āti Awa kuia, Wikitoria Randall (nee Puketapu), about to pick up her mokopuna grandchild in the centre, with her son Anania at Wainuiomata marae, welcoming new Kiwi before being transferred to Turere gulley in the Orongorongo valley. **Right**: Renee, son of Wikitoria, former Fishery Officer, currently working as a kaitiaki for Maritime NZ. Renee was instrumental in leading negotiations for the handover of the de-commissioned Landcare Research facility.

The integrity and cultural safety of our local whanau down the Wainuiomata coast road valley – expressed in their identity and history with the area in interest - is integral for the future management of our Orongorongo forest pā. They are the whanau that occupy the connecting gateway into Orongorongo, with multiple kaupapa projects across many disciplines – rongoā, raranga, whakairo, pest management, hunting, rakau extraction and wairua sustenance.

10.2. Taumairangi Valley

Taumairangi is more commonly known as Moores valley. Whanau from the Te Matehoū hapū still maintain the ahi kaa roa in Taumairangi across three blocks of whanau land, two of which are significant, relative to the valley. The uri descendants of Te Āti Awa kaumatua Ihakara (Kara) Puketapu (87) have strong whenua holdings in the valley, and on a smaller scale, the uri descendants of his teina, Te Rīrā Puketapu (82). Taumairangi is a highland haven of the Te Āti Awa heartlands where the children, grandchildren and great grandchildren of the resident whanau continue to thrive in a rural environment that has staved off urban intensification. The whanau living down the Taumairangi valley, like the whanau down the Wainuiomata coast road valley maintain deep connections to te wao tapu nui a Tāne. Access to the Orongorongo catchment from Taumairangi is a short walk over the southern end of Puketahā, which takes you in to the headwaters of the Tūrere gulley (see map below).



Co-existing side by side with our ngāhere is our traditional Māori art forms that are predominantly inspired by nature. These art forms are entirely dependent on Māori flora and fauna in terms of the mauri life force that is transformed from a living entity to a living art form that takes on a new mauri life force. Uncle Kara was instrumental in taking these art forms to the world through the Te Māori exhibition, alongside other rangatira such as Hirini Moko Mead from Ngāti Awa and Piri Sciascia from Ngāti Kahungunu. Ahi kaa roa in Taumairangi for spiritual, mental and physical sustenance plays a significant role in staying connected to the land. Again, the integrity and cultural safety of our local whanau down Taumairangi – expressed in their identity and history with the area in interest - is integral for the future management of the Orongorongo forest pā.

Te Māori exhibition – New York Metropolitan Museum, 1984. He kawai rangatira – (**L – R**) Taranaki Tohunga Te Rangiāhuta Ruka Broughton and Taniwharau Te Hoe Manuka Sonny Waru, Dr Kara Puketapu, Tā Paora Reeves, Tā Kingi Ihaka, Tainui Tohunga Henare Tūwhangai, Tā Hemi Henare, Dr Bruce Gregory, Hon Koro Wetere

Left: kaumatua, Te Rīrā Puketapu (82)

Pictured here in the 1960's taking a rest while pig hunting in Wainuiomata - Orongorongo. A small land-owner relative to his tuakana, uri descendants of Te Rīrā maintain the ahi kaa roa in Taumairangi alongside their tuakana. Combined, the children, grandchildren, and great grandchildren uri descendants from these whanau, including the adult partners that come from many iwi and other ethnic backgrounds are regarded as a section of the Te Matehōu hapū in their own right. Their assistance to manaaki those of our people that are wanting to reconnect with Orongorongo will be a useful way to also connect whanau with whanau.

10.3. Te Puna Wai - papakainga

Ko Pukeatua te Maunga
Ko Wainuiomata te Awa
Ko Taranaki Whānui te karanga maha
Te Matehöu te hapü
Ko Te Âti Awa no runga i te rangi

Built on 'returned' Mäori land reserved for Te Âti Awa from Waiwhetü, Te Puna Wai is the latest papakäinga that will help fulfil the urgent need to house our people from the wider people of Taranaki Whänui. Te Puna Wai officially opened in 2019 by the Hon Nanaia Mähuta, MP for Tainui and Minister of Mäori Development. Currently, Te Âti Awa Nui Tonu Köhanga Reo operates on site with approximately 100 tamariki, and there are plans to build a full marae complex to meet the cultural needs typical of a traditional papakäinga community. Whanau currently occupy nineteen homes with a further eighteen sections ready to be built on. The Parihaka prophet's Te Whiti o Rongamai and Tohu Kakahi stand sentinel 'back to back' at the main entrance to the papakäinga while opposite is Te Mauri o Te Puna Wai, the papakäinga mauri stone sourced from Maunga Taranaki. Above right is Minister of Māori Development Nanaia Mahuta making a symbolic planting of a native tree on the official opening of the Te Puna Wai papakainga.

11. Ngāti Wainuiomata – ahi kaa roa

Ko Pukeatua te maunga
Ko Wainuiomata te awa
Ko Pukeatua te wharenui
Ko Te Puna o te Ora te wharekai
Ko Wainuiomata te marae
Ko Ngāti Wainuiomata e ngunguru nei!

Following the end of World War II, there was an increase in rural iwi Māori moving into the cities to look for employment as the manufacturing sector exploded. Many iwi from the four winds are represented in Wainuiomata such as Ngāti Porou, Ngāti Kahungunu, Ngā Puhi, Tainui and others. Taranaki Whānui gave their full support towards the building of the marae complex - carvers and weavers under Te Rangi and Erenora Hetet, and tradesmen under the Mäori Affairs Trade Training scheme. Many of the migrating Mäori to Wainuiomata would marry into many of the families of Taranaki Whānui, further strengthening inter-iwi relationships. Sixty thousand Māori live within the Wellington Region, more than half of which (36,000) live in our takiwā. Lower Hutt city has the largest Māori population in the lower North Island at over sixteen thousand. Six thousand of the sixteen thousand Lower Hutt Māori live in Wainuiomata.

11.1. Wainuiomata marae

Part of the original Whiorau (Lowry Bay) land blocks, in what is now the central township of Wainuiomata, was taken out of the hands of the Te Matehōu hapū of Waiwhetū by Governor Grey in 1847. One of these blocks was wrongfully placed under the tenure of the Lower Hutt City Council as a reserve. Te Āti Awa led by Kara Puketapu advocated for this reserve to be gifted to Ngāti Wainuiomata and placed in the tenure of a new Wainuiomata marae organisation. Wainuiomata Marae was first registered as an incorporated society on the 4th April 1973. The marae has been the focal point for local whānau, hapū and iwi in Wainuiomata for over three decades.

Above: Opening of the Wharekai, Te Puna o te Ora, 15 October 1983 by the late great Tohunga of Ngā Rauru, Te Rangiāhuta 'Ruka' Broughton (foreground). Erenora Puketapu-Hetet is front-left supported by Jean Puketapu. Secretary of Māori Affairs, Ihakara (Kara) Puketapu is centre. Right of centre with flowing white hair is Taranaki elder and Tohunga, Taniwharau Te Hoe Manuka Sonny Waru

Below: Linda Olsen (nee Williams) Ruahine (manager) of Wainuiomata marae. An uri descendant of Taranaki Whānui, and raised in Taranaki, Linda is the face of the marae community.

Above: Ko Pukeatua te Wharenui - opened on Saturday, 10th September 1988 by the late Anglican Bishop of Aotearoa, the right reverand Whakahuihui Vercoe of Ngāti Awa

Above: Wainuiomata marae complex and adjoining land, formerly part of Lowry Bay block (1) owned by the Te Matehōu hapū (of Te Āti Awa) from Waiwhetū and Pipitea

Left: **Te Rangikaiamokura Wirihana Hetet** of Ngāti Tuwharetoa and Ngāti Maniapoto (b. 1937) with daughter Veranoa. At 84 years of age, Uncle Rangi Hetet is the oldest tohunga in Aotearoa and as such, is regarded as a living taonga. He succeeded his tohunga, Hone Taiapa of Ngāti Porou, as Master Carver of the NZ Māori Arts and Crafts Institute upon his retirement in the late 1970's, before becoming a fully independent artisan from the early 1980's. Uncle Rangi was the resident Tohunga master carver of Wainuiomata marae, teaching many young men across many iwi, and currently resides in Wainuiomata.

Tāne te punanga – Tāne the sanctuary

12. Invasion of introduced species – the response

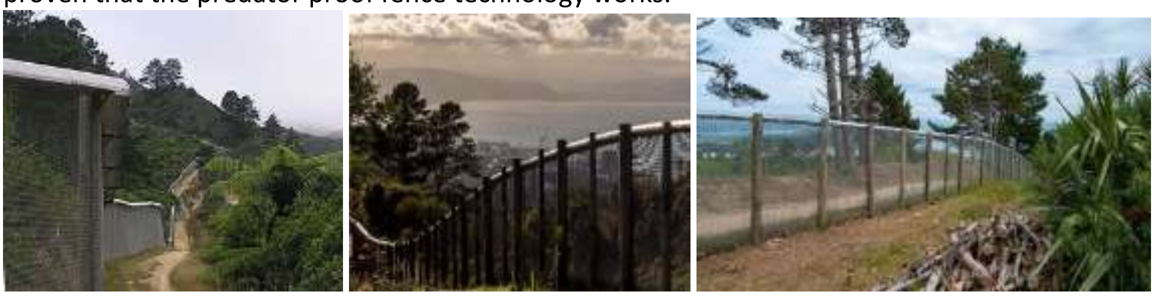
When our first founding tūpuna came to these shores from East Polynesia, they left an environment where the largest islands such as Otahiti (the main island of Tahiti) and Tumu Te Varovaru (the main island of Rarotonga) can easily fit inside Lake Taupo. Witnessing the far bigger islands of Aotearoa would have left them awestruck, especially after an arduous journey across 3,000 miles of the south pacific ocean. Having no knowledge of the local fauna and flora, and the seasonal changes of a temperate climate, the processs of trial and error resulted in the overhunting of as many as 36 species of large manu such as Moa and Pouakai, and the once widespread Kekeno. To their credit, our tūpuna *corrected* their mistakes, as ***tikanga*** – *the correct way of doing things* – were formulated. The law of *tapu* enforced strict environmental practices. Trangressions were met with swift, strict repurcussions. Seasonal hunting and gathering, alongside a greater importance dedicated to kumara agriculture dictated by real time Moon phases, ushered in the transformation of our tūpuna '*becoming Māori'*, becoming naturalised, becoming indigenous. Despite introducing Kiore (Polynesian Rat) to Aotearoa, they were a welcome addition as a food source with tribal 'rat runs' jealously defended. The introduction of large and small mammals, Mustelids and the Australian Brushtail Possum brought greater complex problems that remain to this day.

12.1. Remutaka Conservation Trust Kiwi Project

The success of this project is a reflection of the strength of the Wainuiomata community. Sixteen years on since its conception, and with 130 North island Brown Kiwi roaming the Tūrere and neighbouring Whakanui gulleys, this community-wide effort has made an astonishing achievement. Much like the experience of our founding tūpuna, this is the same process of correcting those early mistakes made by our early European ancestors that had no knowledge of indigenous Māori flora and fauna. In the modern age of fast evolving technology we acknowledge Pākēha culture becoming naturalised, becoming indigenous, in its own right. Te whanau a Wikitoria Randall maintain their involvement with the project as a natural extension of living adjacent to the Remutaka Forest Park entrance. We acknowledge that the North Island Brown Kiwi was not formerly endemic to our local forests, and that the distribution of Kiwi when it was at its lowest numbers required alternative measures to ensure their survival.

12.2. Predator proof fencing

The Zealandia experience has shown the world what can be done when drastic measures are required to curb the threat of extinction of our endangered species. We acknowledge the tenacity of Jim Lynch and team, they who dared to dream and went about utilising all of their problem solving skills to achieve an end goal. Zealandia has been a success story that has resulted in Wellington witnessing the return of Kākā and other manu close to the city. The global acclaim that Zealandia has enjoyed in recent years is now a huge source of pride for our city, and the nation. Zealandia has proven that the predator proof fence technology works.



Above: Three sections of the Zealandia predator proof fence

12.3. Kākāpō – developing whakapapa

Kākāpō enjoyed millenia without having to deal with any predators. Human contact and introduced predators, combined with habitat loss through deforestation for pasture on a wide scale brought about their extinction on the mainland. We have learnt that the Kākāpō recovery efforts from Kāi Tahu and DoC have heralded an increase in population from 52 birds in the mid – 1990's at the lowest point, to 212 birds today. To stave off in-breeding in such a small population base an artificial insemination programme was created by the recovery team which aims to provide a greater level of gene diversity. The first artificial insemination of Kākāpō was in 2008 - 2009 and at the time it was the first successful artificial insemination of a wild bird species in the world. Further artificial inseminations in 2011, 2014, and again in 2016 were unfortunately unsuccessful. Then in 2019 there was a breakthrough with two successful hatched chicks through artificial insemination, one of which was an uri descendant of an important Kākāpō known as Sinbad, who carries a rare 'Ira' (gene) from the Kākāpō of Te Whakataka-Kārehu-a-Tamatea (Fiordland). Sinbad is now twenty-three years old, and is himself an uri descendant of Richard Henry, the last Kākāpō from Te Whakataka Kārehu a Tamatea that died in 2010 at approximately 80+ years old.

> *"The existing Kākāpō population has a very limited stream of whakapapa to produce off-spring from. The joining of Matauranga and western science perspectives are needed to maintain the Kākāpō population, and ultimately, enhances the Mauri of Kākāpō."*[20]

- Tāne Davis, Ngāi Tahu Kākāpō Recovery Team

Left: *Sinbad*, an important taonga of the Kākāpō population due to the gene's he carries from Te Whakataka-Kārehu-a-Tamatea (Fiordland). Kākāpō are protected on three main predator-free islands – Whenua Hou (Codfish Island) off Stewart Island, Anchor Island in Dusky Sound, Fiordland and on Little Te Hauturu a Toi (Little Barrier Island)).

Right: *Sirocco*, the official ambassador of the Kākāpō recovery movement, pictured here with British actor and comedian, Stephen Fry. Sirocco enjoys an international profile making him the first manu Māori celebrity from Aotearoa. Although Sirocco travels the country at times as part of his duties, all known kākāpō wear smart transmitters so they can be rigorously monitored. This provides information about their location and which females have mated, when and with whom.

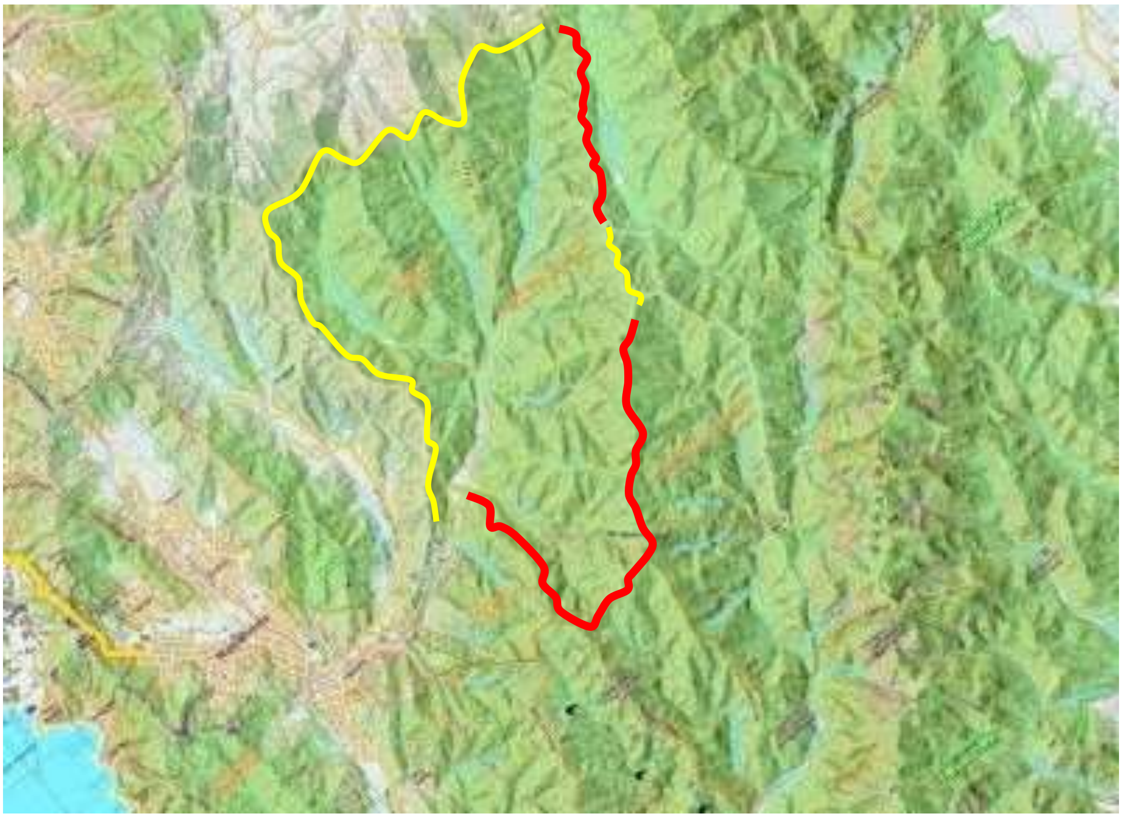
[20] https://www.stuff.co.nz/southland-times/114295023/first-successful-artificial-insemination-of-kkp-in-a-decade

12.4. Te utu – the cost

Utu is a customary concept that can be interpreted as revenge, vengeance, retaliation, payback, retribution, cost, price, wage, fee, payment, salary, and reciprocity. In the context of the proposed sanctuary, the utu that comes with having to build a predator proof fence is the loss of forest habitat on the eastern ridgeline, and the increased level of safety and protection for our endangered manu Māori like Kākāpō. The process of 'taking' from Tāne Mahuta and removing his children is an act of aggression if the result derives no reciprocal benefits back to Tāne. Ideally, we do not want to be felling any trees in an old growth forest where the mauri of Tāne Mahuta is undefiled and in a pristine state. However, in the context of the proposed sanctuary, the multiple reciprocal benefits back to Tāne Mahuta are clear, and therefore utu is reconciled.

12.4.1. Ridgeline corridor

The ten-metre-wide, fifteen-kilometre-long stretch of ridgeline forest that would need to be felled, to our understanding, is integral to the integrity of the fence technology – simply put, a wide berth is required to keep predators from getting over the fence. Issues of visual pollution of the current deer fence that runs along the Taumairangi (eastern Moores Valley) ridge, and northern ridge across both Wainuiomata and Orongorongo catchments, are non-existent. Indeed, the western and northern 4wd track and deer fence is largely unknown to the general population, even to some Department of Conservation staff. You simply can't see it, unless you are up on top of the highest points of the ridges. Along many sections of the ridgeline the forest either side of a ten-metre-wide corridor would still be higher than the ridge itself, making the track not unlike the current 4wd tracks inside the water catchment area. Along other sections of the ridgeline, the forest is scarce, which reflects the diversity of species and habitat at different altitudes.



current track ----------------------- proposed track --------------------

12.4.2. Ridgeline species

The dominant species along the forested areas of the highest altitudes of the ridgeline is Tawhai (Silver Beech) – Tawhairauriki (Black/Mountain Beech), and Tawhairaunui (Hard/Red Beech). The aforementioned species are of *specific* interest as we reciprocate the utu for their removal. The Tawhai species are known to us as suitable for carving. This provides us with an opportunity to utilise the Tawhai for carved whare whakairo ancestral houses and associated whare that form a marae complex. It is a cultural imperative to create a marae complex at the entrance to the proposed Kākāpō sanctuary, to express an interpretation of the unique identity of our indigenous flora and fauna, that are also Māori, in name and story. These carved, woven and painted creations of traditional Māori art, honour their 'Mauri' life principle by transforming them into representations of living ancestors, and whakataukī proverbs that guide us. A stockpile of seasoned Tawhai (and other species harvested from the ridgeline corridor) for the coming decades will be carefully managed for cultural purposes pursuant to tikanga Māori.


Above: variations along the southern end of the Puketahā range with Tawhai dominated areas, and open areas of Wharariki (mountain flax))

12.4.3. Multiple endangered species

Having the ability to re-introduce a multitude of manu Māori to our ngahere and increase the numbers of re-emerging manu such as Kākā is extremely exciting. Equally, having the opportunity to be active kaitiaki, defending the fenceline and re-establishing a relationship with our manu Māori that our tūpuna once had, is akin to getting a second chance at something that was once never thought possible. Imagining a return of Rowi, Kōkako and Hihi, and increasing numbers of Tieke, Kākā, Kākāriki, Korimako, Kawekaweā, Pīpīwharauroa, Tui, Riroriro and Kereru gives exponential value to a sanctuary designed primarily for those species that have extremely low populations, such as Kākāpō, and are unable to defend themselves against sustained attacks from Mustelids, Rats and Possums. This wider spectrum of species preservation also widens the awareness of the drastic measures that are now required to avert the extinction of those most at threat. It can be argued that even without Kākāpō there would still be a need for a predator proof fence to increase the populations and expand the gene diversity of the other aforementioned species. To further develop a deeper understanding of our manu Māori, there are research opportunities to delve into the '*culture'* of each of our manu Māori species as it develops in real time from the time of re-introduction into Puketahā. This development of manu Māori culture leads to an understanding of their own specific '*traditions*'. Our tūpuna give us clues of the 'culture and traditions' of our manu Māori through the pūrākau stories interwoven into our oral literature and art forms. This is a realm of mātauranga Māori that has much to be uncovered for further development.

12.4.4. Improved pest management accessibility

The eastern ridgeline of the Wainuiomata water catchment is also the western ridgeline of the Orongorongo catchment, therefore the creation of a ridgeline corridor presents an even greater opportunity for improved pest management along all of the gulleys on the western side of the Orongorongo valley north of the Turere gulley. The population of North Island Brown Kiwi in the Turere and Whakanui Gulleys is an amazing example of what can be achieved when dedicated community members. Gaining easier access to the Little Huia and Big Huia gulleys north of the Whakanui Gulley, and the headwaters of the Orongorongo via a new access track along the ridgeline corridor gives kaitiaki in the iwi and wider community a better chance at emulating the intensive pest eradication efforts in the Turere gulley. Connecting with the current track at the headwaters of the Wainuiomata and Orongorongo catchments provides us with a large loop route beginning and ending at the water treatment facility.

13. Marae

It would be a cultural imperative to create a marae complex at the entrance to the proposed sanctuary, to express an interpretation of the unique identity of our indigenous flora and fauna, that are also Māori, in name and story. These carved, woven and painted creations of traditional Māori art, honour their 'Mauri' life principle by transforming them into representations of living ancestors, and whakataukī proverbs that guide us. A stockpile of seasoned Tawhai (and other species harvested from the ridgeline corridor) for the coming decades will be carefully managed for cultural purposes pursuant to tikanga Māori. We understand the amount of trees felled along the ridgeline corridor will be significant, therefore it would make economic sense to sell some of the trees to help offset the financial cost of the fence. A typical marae complex is made up of;

- Marae atea (proper) – the open courtyard plaza in front of the wharenui
- Wharenui – the main building dominating the marae atea. Also referred to as a whare tupuna (ancestral house) and a whare whakairo (adorned house)
- Wharepuni – an additional sleeping house
- Wharekai – the dining room
- Kauta – cooking house, often incorporated into the rear of the wharekai
- Wharepaku – ablution block

13.1. Whare wānanga, mātauranga Māori – houses of learning, Māori knowledge

The term Māori means '*natural*'. Science (from the Latin word scientia, meaning "**knowledge**") is a systematic enterprise that builds and organizes knowledge in the form of testable explanations and predictions about the universe. The earliest roots of science can be traced to Ancient Egypt and Mesopotamia in around 3000 to 1200 BCE. [21] Our matauranga Māori, in part, is a culmination of corrections after making typical mistakes of a human culture entering a new and unknown environment, not unlike the interpretation above. After these corrections were formulated, and knowledge of Aotearoa developed, environmental management and society in general operated in sync with nature dominated by a lunar calendar that acknowledges real time in a thirteen-month lunar cycle. This concept of real time in a lunar calendar dictated every imaginable part of our daily lives from fishing to agriculture, harvesting wild foods and medicinal flora, fowling, and moving among seasonal camps within the local takiwā territory. This knowledge system guided tohunga experts in making decisions largely related to, among other things, food supply and security, the weather, and natural phenomenon occurrences. Merging modern science applications and

[21] https://en.wikipedia.org/wiki/Science

technology with matauranga Māori is not new. Yet there is still a wide spectrum of research and knowledge seeking to be had, and having a punanga sanctuary makes for easier activation of applications such as (but not limited to):

- Educational training – hui, wānanga, noho marae, rostered kaitiaki in residence
- Contract hunting of overpopulated game animals – Deer, Pigs etc
- Pest eradication including removal of carcasses and mustering Goats out of the forest
- Raranga material gathering for weaving and natural dyes – Kiekie, Toi, Neinei, Tānekaha, Raurekau etc
- Whai oranga wellness retreat/noho marae
- Rongoā gathering and oil production – Manuka, Hinau, Titoki, Taraire, Rewharewha etc
- Retention and milling of fallen rakau
- Active protection of threatened indigenous Māori flora and fauna

13.2. Whare kōhanga

It was mentioned earlier (point 12.3) that the Kākāpō Recovery Team conduct the artificial inseminating of Kākāpō to increase the diversification of their DNA to avoid in-breeding and ensure a healthy population moving in to the future. A purpose built whare kōhanga (nesting house) could be a good option with which to conduct the artificial insemination process of Kākāpō. It can also offer a place not unlike an avian hospital to care for sick or injured manu (adults and chicks). The obvious benefit of having a whare kōhanga in a marae complex at the entrance to the sanctuary is not having to transport the manu over long distances, instead only needing to stay within the immediate area. Another important benefit of a whare kōhanga is having the opportunity to train kaitiaki that will be caring for our manu, so they are being constantly up-skilled, when and where needed. A whare kohanga can also act as a visitor centre where visitors can come and still interact with Kākāpō and other manu Māori, when poor weather dictates having to stay out of the sanctuary.

13.3. Kaitiaki guardians

Working in partnership with Greater Wellington will build on an already positive relationship. Kaitiaki from Taranaki Whānui have an iwi-centric worldview with the knowledge and experience of our tribal landscape and traditions where connection to the whenua is grounded in the four levels of hierachy of our traditional society where kaitiaki guardians operate at all four levels :

- Iwi (***bones***) represents the base structure of the people as a '*tribal'* unit. Examples include PNBST and the Wellington Tenths Trust. Developing from the bones are the:
- Hapū (***to be pregnant***) units representing our people as '*sub-tribal'* units. Examples include Waiwhetū Marae Trust representing the Te Matehōu hapū, and Te Tatau o Te Pō Marae Trust representing the hapū of Ngāti Te Whiti and Ngāti Tawhirikura. Developing further from the hapū are the:
- whānau (***to give birth***) units representing our people in '*family'* units. There are many whanau units that act independently from hapū and iwi through their own Whanau Trusts. Whānau members are:
- tāngata, hunga, wāhine, tāne (**people, women and men**)

We are proud of our whanau that have maintained the spiritual connection to te wao tapu nui a Tāne, as kaitiaki, exercising the rights of our ***whakapapa*** - which literally means '*to be of the earth'*.

14. Renewable energy technology

All forms of renewable energy that can be harnessed should be harnessed where possible for a forest pā to function at its full potential. Energy storage battery systems can be linked with individual powerwall battery systems where all systems support each other providing greater energy security in the event of a fault to an individual unit.

Left: The Tesla Powerwall is a battery that stores energy, detects outages and automatically becomes the pā's energy source if part of the pā's grid goes down. Unlike diesel generators, Powerwall keeps your power on without using liquid fuel - or the noise of a generator.

If our forest pā can harness enough energy to successfully cater for all its needs, a significant financial cost to its infrastructure can be erased. Tikanga dictates a zero-pollution policy in a pristine forest.

14.1. Micro wind

Pā tuwatawata fencing around part of the perimeter of the pā can provide additional space for micro wind capacity. Traditionally, the pā tuwatawata has intervals of primary posts called 'ngare' (symbolizing a whanau member). These ngare have a 'head' that can have small individual helix generators attached on the top and all can be connected as a single unit. Below left is one example of a small Helix generator (retail at $44), and on the right, a 'ngare' primary post of a pā tuwatawata palisaded fence.

14.2. Anaerobic Digestion – Home Biogas

Anaerobic digestion is a collection of processes by which microorganisms break down biodegradable material in the absence of oxygen. The process is used for industrial or domestic purposes to manage sewerage and produce methane gas. The collected methane can be used for cooking on gas hobs and / or heating. These systems solve a fundamental problem for the sustainability of the local ecosystem. The Homebiogas toilet unit below retails for NZ$1,750, and includes a custom-made toilet, sewage/gas collectors and stove hob. This unit can easily replace the septic tank and the two flush toilets in the main building.

14.3. Human Traction

A small room can be set up to house a dual-purpose exercise space utilizing cycling and rowing power generators to generate electricity. Kaitiaki will be required to contribute a daily exercise and energy conversion session. This transfer of human energy into electricity, not only boosts the energy supply, but equally as important, it will improve the health and well-being of kaitiaki. The bicycle generator below left can provide electricity to a house for 24 hours as a result of one hour of human traction input energy. Below right is the latest in rowing machine power generators.

14.4. Micro-Hydro

Immediately behind the pā is a small stream. This offers an opportunity to harness its energy from a series of micro-hydroelectric systems that are small, compact, portable and only need a small flow of water to operate. Other small gulley's close by may also offer opportunities to use additional micro-hydro systems.

14.5. Solar

The north facing side of the roof of the living quarters gets ample daylight sun. This is an obvious choice for a solar water heating system, and solar panels. Increasingly the market has improved in the solar industry over the last two decades. The example below has the dimensions 1.52 m x 68 cm and produces up to 700 watts. The complete system is affordable at NZ$540.00. The north facing side of the living quarters can easily accommodate five of this size.

14.6. Eliminating the habit of wasting electricity

The national grid puts the consumer in a position of dependency at a household level, therefore people are generally not overly aware of their day to day power use. An Energy Efficiency and Conservation Authority (EECA) survey in 2012 found that New Zealanders waste over $100 million a year leaving appliances on standby instead of turning them off at the wall. That was nine years ago. The Electricity Authority's survey found one in every 10 Kiwi households don't know how much they spend on power. They highlighted typical human behaviour:

> *"It's kind of an inconvenience if you have to go and turn everything off at the wall once you've finished with it. No one does it. It's not something you think about. There are many appliances that we only use for a short period of time, yet we leave them on for long periods of time - DVDs, speakers on our computers, printers. So, over a year they end up using more power than what we actually use when we're using them. Total energy wasted like this nationwide is enough to power the city of Nelson all year."*[22]

Having your own power generators that you manage *yourself* brings a heightened awareness of how much power is being produced, and how much power is being used. This culture shift will be our greatest tool to use our energy efficiently so that it is conserved better. A zero-waste policy will ensure a greater sense of energy security and offer further research opportunities into energy supply and demand of an off-grid power system, as a formulated guideline for small forest pā.

[22] EECA products manager Terry Collins - https://www.newshub.co.nz/nznews/100-million-of-power-wasted-each-year-2012062717

Appendix

Native Population of Port Nicholson 1842

Conducted by Edmund Halswell, Protector of Aborigines for the southern district

1. Native Population of the Pa Waiwetu 1st July 1842

Men 23 Ngahenga, Papawero, Wiremu Kingi, Mataiwi, Hoani, Tariki, Tewaitapu, Tetakua, Taukari, Ngatai, Huki, Tehua, Teronga, Te Pateke, Aopehi, Waha, Ngakerikeri, Ngangarahu, Tauroto, Hopiri, Tehuka, Koperu, Tamati
Women 22 Te Raru, Ngakaru, Wahie, Kauamo, Takatua, Tupua, Taupoki, Para, Wahine, Ngaone, Tekauwaka, Kaikawa, Kokoroti, Ngawaka, Waia, Moki, Hoe, Tewera, Ngapuke, Ngapake, Pukeariki, Purua
Boys 13 Tenakihi, Tierui, Teputaki, Teawa, Kunga, Te Ngawere, Wakahata, Tikanga, Tepura, Ngauri, Tekamau, Kari, Tawai
Girl 1 Tuhipo
Total 59 (Te Matehöu of Te Āti Awa)

2. Native Population of the Pa Pitone 1st July 1842

Men 47 Te Puni, Pani, Tuhoto, Tangihia, Mahau, Henare, Moka, Teuku, Mirimatua, Tuari, Huta, Motutahi, Ngaroto, Tauware, Warekeri, Teawio, Witiki, Taura, Pitooni, Putai, Ngaweka, Hamana, Purema, Mu, Ngahohoanga, Tengatoro, Tekurutai, Te Ra, Tepohi, Tehana, Wakarewa, Ngorongoro, Ngapake, Teaparua, Ngaware, Ngahau, Hakiwaiti, Mitikakau, Kopuri, Haerewaho, Rakei, Takau, Ngaure, Tepuku, Te Ao, Pakewa, Tewareware
Women 39 Takahi, Teamohou, Titahi, Taku, Mere, Ngapuhi, Kori, Pari, Pua, Ngapuhi, Takahuaringhi, Pito, Terohi, Kokiri, Ngao, Ngangahu, Tekakapi, Patutu, Ngapipo, Tariao, Te Raroa, Taunoka, Kahi, Teraro, Wareunga, Muri, Te Manu, Ngahina, Para, Ruaatuna, Ngarerenga, Poiriri, Wahanga, Teke, Tarata, Pikiwana, Turanganei, Ngarue, Wakatapu
Boys 5 Pohiaki, Tawatahi, Ngahurai, Warewati, Teware
Girls 6 Mahi, Kino, Makamoana, Tawai, Parani, Matawa
Total 97 (Ngāti Te Whiti & Ngāti Tawhirikura of Te Āti Awa)

3. Native Population of the Pa Ngauranga 1st July 1842

Men 18 Te Warepore, Watene, Kupe, Tetoru, Taiata, Waikanae, Kikipa, Tame, Wakatoru, Humea, Kopeta, Oka, Taupiki, Matangi, Waitara, Mataipu, Unuka, Ketu
Women 22 Kawa, Mutu, Puke, Puikui, Kuratope, Kongaipia, Temoe, Tenguru, Tewara, Kuraiti, Tekotomotu, Ngapukapuka, Takanewa, Taura, Ponamu, Wakarato, Tekura, Tepuki, Maweu, Mapurangi, Te uru, Rawea
Boys 7 Waimarama, Kowau, Wahatanapu, Konari, Peri, Te Muru, Tainui
Girl 1 Mapuna
Total 48 (Ngāti Tawhirikura of Te Āti Awa)

4. Native Population of the Pa Kaiwarawara 1st July 1842

Men 31 Taringakuri, Rerewa, Kopeka, Tekapunia, Teiwi, Wetu, Wahipe, Tarikarau, Kaipuka, Neapari, Tekawenga, Tau, Tewiroro, Paipa, Kuwi, Tewakakiko, Pakirikiri, Pehi, Tumutake, Ngaupari, Tokitahi, Tekoti, Terena, Piroa, Teipu, Tumeke, Tehaukoti, Ramu, Teriri, Tekapa, Tehumaturo

Women 22 Riweri, Wero, Pareteho, Kape, Waikura, Tewairero, Tawaki, Manai, Kohikiko, Henenui, Warekohu, Tuaia, Taiawio, Tekapu, Kino, Tenaihi, Hinekura, Wakahike, Tewaitungia, Kino, Kongorongoro, Tenoti
Boys 5 Rakeiora, Makeri, Pae, Terangi, Ngaripa
Girls 2 Teheranga, Te Ahi
Total 60 (Ngāti Tama)

5. Native Population of the Pa Pipitea 1st July 1842

Men 59 Moturoa, Wairarapa, Mangatuku, Ngaukaka, Ngapuna, Kuaha, Papa, Pukekura, Roriki, Kopiri, Mere, Pamu, Hoera, Ngapaka, Panapa, Tetute, Puketapu, Motutawa, Ingo, Otaki, Porutu, Ngaro, Patu, Tematewai, Rawiri, Enoka, Reupene, Warepapa, Warepore, Ngakete, Tohuora, Ewiu, Rangikapuoho, Emapo, Etui, Kaea, Wahanui, Tehau, Terakekatoa, Awakite, Eana, Temata, Keretu, Ngake, Hikoikoi, Hore, Maru, Mau, Kahi, Pipi, Parei, Kotuku, Tupara, Area, Wata, Huka, Ngatuihe, Tame, Reihana Reiwiti – Richard Davis, Missionary Native
Women 43 Mata, Ehina, Pete, Ngawai, Karoraina, Takawaru, Taraiti, Pukere, Ati, Wakatau, Tupeka, Roa, Pawa, Rapu, Pokai, Moko, Eha, Tekopi, Kauterewa, Kuhu, Warenui, Kahi, Hinikura, Tuhi, Poitete, Piri, Here, Penakoti, Teteratoihau, Matarawa, Terewanga, Hinirangi, Paku, Motero, Puhoro, Teapukau, Tunewa, Ngeru, Wahanui, Mahia, Maro, Pare, Kurakau
Boys 13 Tekahapu, Tapurangi, Tupuna, Piti, Tenene, Reihana, Tame, Tenane, Ngaporoporo, Ngauru, Kamau, Ngau, Raro
Girls 19 Ngawaka, Ponaka, Ataahua, Tetoru, Ngamotu, Tetirawahe, Hineawa, Puhi, Tureikura, Kahura, Terurunga, Makere, Karoraina, Arihia, Kuhu, Hinirangi, Paku, Matatatara, Paro
Total 134 (Te Matehöu of Te Āti Awa)

6. Native Population of the Pa Kumutoto 1st July 1842

Men 9 E Toko, E Pakou, E Waru, E Gnogno, E Toni, E Tera, E Koaramo, E Upa, E Manu
Women 5 E Poaka, E Meri, E Pe, E Otaki, E Weto
Boy 1 E Tako
Total 15 (Ngāti Te Whiti of Te Āti Awa)

7. Native Population of the Pa Te Aro 1st July 1842

Taranaki Tribe (Ngāti Haupoto and Ngāti Haumia)
Men 50 Tamati Wirimu, Ko Tamati Waka, Ko Hoani, Ko Rihiri, Ko Mihi, Ko Akaraiha, Ko Paora, Ko Timoti, Ko Rewiri, Ko Raneira, Ko Ihaia, Hamuera, Ko Weininu Tamati, Ko Piripi, Ko Weminu Patana, Ko Puhi, Ko te Kawau, Ko Poniki, Ko te Manu, Ko Humene, Ko Taraia, Ko te Wata, Ko te Raro, Ko Makuki, Ko Taku, Ko Paraia, Ko Kawena, Ko Porera, Ko Moa, Ko Hiro, Ko te Poho, Ko Timo, Ko te Awitu, Ko Taranga, Ko Hautoke, Ko Waikanae, Ko Poporo, Ko Tuwhahanui, Ko Hakopa, Ko Pakuahi, Ko Rakeimoko, Ko te Wero, Ko te Kanakana, Ko Pipi, Ko Pakehere, Ko te Rangi I waho, Ko Remu, Ko Tiito, Ko te Pai, Ko Nga Kitikiri
Women 30 Ko Hera, Ko Mata, Ko Meri, Ko Herahana, Ko Ripeka, Ko Riria, Ko Meriana, Ko Kataraina, Ko Hareta, Ko Haro, Ko Arapiti, Ko te Aro, Ko Rakei, Ko Pakinga, Ko Ngarongo, Ko Rahi, Ko Hineuma, Ko Wanga, Ko Maroaitu, Ko te Hau, Ko Kuma, Ko Rongonaroa, Ko te Hoe, Ko Mihi, Ko te Waituku, Ko Puarito, Ko Matangi, Ko Nuku, Ko Kawa, Ko Nga Ki
Children 13 Ko te Mounga, Ko Taku, Ko Ngatitamana, Ko Tunai, Ko te Ui, Ko Aumatau, Ko te Wata, Ko Neteuru, Ko Taupiri, Ko te Kai, Ko te Wiuwiu, Ko te Puhi, Ko te Waiwa
Total 93

Ngati Ruanui Tribe (Ngāti Tupaia)
Men 16 Ko Kotuku, Ko te Tawero, Ko Puihi, Ko Pukaku, Ko Haukotiri, Ko te Kawarau, Ko te Tihi, Ko Pakuahi, Ko te Wehi, Ko Rikipoai, Ko Marangi, Ko Toko, Ko Puhi, Ko Nikere, Ko Taiaha, Ko Tami
Women 8 Ko Wareroa, Ko te Wehikore, Ko te Kata, Ko te Raku, Ko te Waiwokapuki, Ko Uruhaea, Ko te Rape, Ko Hinemoko
Children 11 Ko Hera, Ko te Wakainu, Ko Takua, Ko Tupaia, Ko Nga Nance, Ko Turua, Ko Hineteuru, Ko Tuaiwa, Ko Wiuwiu, Ko te Raro, Ko Tapuere
Total 35

Total (Taranaki and Ngāti Ruanui**) 128**

TOTAL TARANAKI WHĀNUI – 541

Note: This census did not survey the west coast pā at Ohariu, Ohaua, Te Ika Maru and Ohau, and the south coast pā at Oterongo, Waiariki, Opuawe and Kārori. Another census in 1850 included these west and south coast pā which resulted in a count of 711 Taranaki Whānui.

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APPENDIX B:

Wellington Representative Fauna

Wellington Representative Fauna

Note. These lists were originally compiled for the Karori Sanctuary Restoration Strategy. Lynch et al. 2000. It has been updated 2021 with information supplied by Colin Miskelly (Te Papa) and P. Crisp (GWRC).

Latin Name	Common Name	Present in the valley.	Missing but extant	Notes
Mammals				
Chalinolobus tuberculatus	Long-tailed bat/ Pekapeka	No	Yes	Search undertaken – no sign.
Mystacina robusta	Greater short-tailed bat/ Pekapeka	No	No	Extinct – congener to be released
Mystacina tuberculata tuberculata	Southern short-tailed bat/ Pekapeka	No	Yes	Search undertaken- no sign.
Birds				
Acanthisitta chloris granti	NI rifleman/titipounamu	Yes	NA	
Aegotheles novaezealandiae	New Zealand owlet-nightjar	No	No	Extinct – analogue – Australian owlet-nightjar
Anomalopteryx didiformis?	Little bush Moa	No	No	?
Anthornis melanura	Bellbird/korimako	Yes	NA	
Anthus novaeseelandiae	Pipit/pīhoihoi	No	Yes	Habitat not appropriate.
Apteryx owenii	Little spotted kiwi/kiwi pukupuku	No	Yes	
Apteryx rowi	Rowi kiwi	No	Yes	
Aptornis otidiformis	NI Adzebill	No	No	Extinct -no analogue available
Bowdleria punctata vealeae	NI fernbird/mātātā	No	Yes	
Callaeas wilsoni	NI kōkako	No	Yes	
Capellirallus karamu	Snipe rail	No	No	Extinct – no analogue available
Chrysococcyx lucidus lucidus	Shining cuckoo/pīpīwharauroa	Yes	NA	
Circus approximans	Australasian harrier/kāhu	Yes	NA	
Circus eylesi	NZ harrier	No	No	Extinct – Congener present
Coenocorypha barrierensis	NI snipe/tutukiwi	No	No	Extinct –analogue – Chatham Island snipe
Corvus moriorum	NZ raven	No	No	Extinct –analogue – *Corvus* sp (Australia)
Coturnix novaeseelandiae novaeseelandiae	NZ quail/koreke	No	No	Extinct –analogue – stubble quail (Australia)
Cyanoramphus auriceps auriceps	Yellow-crowned parakeet/kākāriki	Yes	NA	
Cyanoramphus novaezelandiae novaezelandiae	Red-crowned parakeet/ kākāriki	No	Yes	Vagrants from Matiu/Somes island present?
Dinornis novaezealandiae	North Island giant moa	No	No	
Eudynamus taitensis	Long-tailed cuckoo/koekoeā	Yes	NA	
Euryapteryx curtus	Coastal moa	No	No	
Euryapteryx gravis	Stout-legged moa	No	No	
Falco novaeseelandiae	NZ falcon/kārearea	Yes	NA	
Gallirallus australis greyi	NI weka	No	Yes	
Gerygone igata	Grey warbler/riroriro	Yes	NA	
Hemiphaga novaeseelandiae	NZ pigeon/kererū	Yes	NA	
Heteralocha acutirostris	Huia	No	No	Extinct – no analogue available

Latin Name	Common Name	Present in the valley.	Missing but extant	Notes
Hirundo neoxena	Welcome swallow/warou	Yes	NA	
Mohoua albicilla	Whitehead/pōpokatea	Yes	NA	
Nestor meridionalis septentrionalis	NI kākā	No	Yes	Vagrants present.
Ninox albifacies rufifacies	NI laughing owl/whēkau	No	No	Extinct – no analogue available
Ninox novaeseelandiae	Morepork/ruru	Yes	NA	
Notiomystis cincta	Stitchbird/hihi	No	Yes	
Pachyornis geranoides?	Mantell's moa	No	No	
Petroica longipes	NI robin/toutouwai	No	Yes	Released 2016 but not survived
Petroica macrocephala toitoi	NI Tomtit/miromiro	Yes	NA	
Philesturnus rufusater	NI saddleback/tīeke	No	Yes	
Porphyrio mantelli	NI takahē	No	No	Extinct – analogue – SI takahe
Prosthemadera novaeseelandiae novaeseelandiae	Tui	Yes	NA	
Rhipidura fulginosa placabilis	NI Fantail/piwakawaka	Yes	NA	
Strigops habroptilus	Kākāpō	No	Yes	
Todiramphus sancta vagans	NZ kingfisher/kōtare	Yes	NA	
Turnagra tanagra	NI thrush/piopio	No	No	Extinct –no analogue available
Xenicus jagmi	NI stout-legged wren	No	No	Extinct – no analogue available
Xenicus longipes stokesii	NI bush wren	No	No	Extinct –analogue – rock wren
Zosterops lateralis lateralis	Silvereye/tauhou	Yes	NA	
Reptiles & tuatara				
Dactylocnemis pacificus	Pacific gecko	No	Yes	
Hoplodactylus duvaucelii	Duvaucel's gecko	No	Yes	
Mokopirirakau southern NI	Ngahere gecko	Yes	No	
Naultinus punctatus	Wellington barking gecko	Yes?	NA	Not recorded but thought to be present.
Oligosoma aeneum	Copper skink	Yes	NA	
Oligosoma alani	Robust skink	No	Yes	
Oligosoma infrapunctatum	Speckled skink	No	Yes	
Oligosoma kokowai	Northern spotted skink	No	Yes	
Oligosoma macgregori	McGregor's skink	No	Yes	
Oligosoma ornatum	Ornate skink	No	Yes	
Oligosoma polychroma	Northern grass skink	Yes	NA	
Oligosoma whitakeri	Whitaker's skink	No	Yes	
Oligosoma zelandicum	Glossy brown skink	No	Yes	
Sphenodon punctatus	Cook Strait tuatara	No	Yes	
Woodworthia chrysosiretica	Gold-striped gecko	No	Yes	
Woodworthia maculata	Raukawa gecko	Yes	NA	
Amphibians				
Leiopelma hamiltoni	Hamilton's frog	No	Yes	
Leiopelma waitomoensis		No	No	Extinct – congener will be released

Species List – Wellington Representative Freshwater Vertebrates

Latin Name	Common Name	Present in the valley	Missing but extant	Notes
Birds				
Anas chlorotis	Brown teal/pāteke	No	Yes	Habitat suitable
Anas gracilis	Grey teal/tētē	No	Yes	Habitat limited
Anas rhynchotis	Australasian shoveler/kuruwhengi	No	Yes	Habitat limited
Anas superciliosa superciliosa	Grey duck/pārera	No	Yes	Habitat limited
Ardea alba modesta	White heron/kōtuku	No	Yes	Habitat limited
Aythya novaeseelandiae	NZ scaup/pāpango	No	Yes	Habitat limited
Biziura delautori	NZ musk duck	No	No	Extinct – analogue – Australian musk duck
Botaurus poiciloptilus	Australasian bittern/ matuku hūrepo	No	Yes	Habitat limited
Chenonetta finschi	Finsch's duck	No	No	Extinct - same genus as Australian Wood duck which is breeding in Tasman Bay.
Cnemiornis gracilis	North Island goose	No	No	Extinct – analogue – Cape Barren goose?
Cygnus sumnerensis	New Zealand swan	No	No	Habitat limited
Egretta novaehollandiae novaehollandiae	White-faced heron/ matuku	No	Yes	Habitat limited
Fulica atra	Australian coot	No	Yes	Habitat limited
Fulica chathamensis	NZ coot	No	No	Extinct – analogue – Australian coot
Himantopus novaezelandiae	Pied stilt/poaka	No	Yes	Habitat unsuitable
Hymenolaimus malacorhynchos	Blue duck/whio	No	Yes	Habitat suitable
Ixobrychus novaezelandiae	NZ little bittern	No	No	Extinct – analogue – Australian little bittern
Malacorhynchus membranacea	NZ pink-eared duck	No	No	Extinct – analogue – pink eared duck (Australia)
Mergus australis	NZ merganser	No	No	Extinct – analogue – Common merganser, (China)
Microcarbo melanoleucos brevirostris	Little shag/kawaupaka	No	Yes	Habitat unsuitable
Oxyura vantetsi	Blue-billed duck	No	No	Extinct –
Phalacrocorax carbo	Black shag/kawau pango	No	Yes	Habitat unsuitable
Phalacrocorax sulcirostris	Little black shag/kawau tūī	No	Yes	Habitat unsuitable
Phalacrocorax varius	Pied shag/kawau	No	Yes	Habitat unsuitable
Poliocephalus rufopectus	NZ dabchick/weweia	No	Yes	Habitat limited
Porphyrio porphyrio melanotus	Pukeko	No	Yes	Habitat limited
Porzana pusilla affinis	Marsh crake/koitareke	No	Yes	Habitat limited
Porzana tabuensis plumbea	Spotless crake/pūweto	No	Yes	Habitat limited
Rallus philippensis assimilis	Banded rail/mioweka	No	Yes	Habitat suitable

Latin Name	Common Name	Present in the valley	Missing but extant	Notes
Tachybaptus novaehollandiae novaehollandiae	Australian little grebe	No	Yes	Habitat limited
Tadorna variegata	Paradise shelduck/pūtangitangi	Yes	NA	Habitat limited.
Tribonyx hodgenorum	Hodgens' waterhen	No	No	Extinct – analogue – Tasmanian native-hen?
Amphibians				
Leiopelma hochstetteri	Hochstetter's frog	N	Yes	
Leiopelma markhami		N	No	Extinct.
Fish				
Anguilla australis	Short-finned eel	Yes	NA	
Anguilla dieffenbachii	Long-finned eel	Yes	NA	
Cheimarrichthys forsteri	Torrent fish	No	Yes	
Galaxias argenteus	Giant kokopu	Yes	NA	
Galaxias brevipinnis	Koaro	Yes	NA	
Galaxias divergens	Dwarf galaxias	Yes	NA	
Galaxias fasciatus	Banded kokopu	Yes	NA	
Galaxias maculatus	Inanga	Yes	NA	
Galaxias postvectis	Short-jawed kokopu	Yes	NA	
Geotria australis	Lamprey	Yes	NA	
Gobiomorphus basalis	Cran's bully	No	Yes	
Gobiomorphus breviceps	Upland bully	No	Yes	
Gobiomorphus cotidianus	Common bully	Yes	No	
Gobiomorphus gobioides	Giant bully	No	Yes	
Gobiomorphus hubbsi	Blue-gilled bully	Yes	No	
Gobiomorphus huttoni	Red-finned bully	Yes	No	
Neochanna apoda	Brown mudfish	No	Yes	
Prototroctes oxyrhynchus	Grayling	No	No	Extinct
Retropinna retropinna	Common smelt	No	Yes	Habitat limited

APPENDIX C:

Assessment of Possible Benefits to Biodiversity

DOC Terrestrial Science

Appendix C

Wainuiomata Fenced Sanctuary Proposal

Assessment of Possible Benefits to Biodiversity

Completed by the Terrestrial Science Unit in Biodiversity Group, Department of Conservation, September 2021

Department of Conservation
Te Papa Atawhai

New Zealand Government

Material within this report was provided by various team members from within the Department of Conservation. Recovery Groups provided information to support the species specific information that has been included.

Maps were provided by Jim Lynch, Project Lead for the Wainuiomata Sanctuary proposal.

Collated and Written by Nikki Pindur
Northern Terrestrial Science Manager,
Terrestrial Science unit, Biodiversity Group

Approved by Mark Fitzpatrick –
Director Terrestrial Science Unit,
Biodiversity Group

Cover: Vegetation from within the site. *Photo: Jim Lynch*

DOC - 681459

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CONTENTS

1 Detailed Assessment of the Proposal - Benefits to Species'' Recovery.

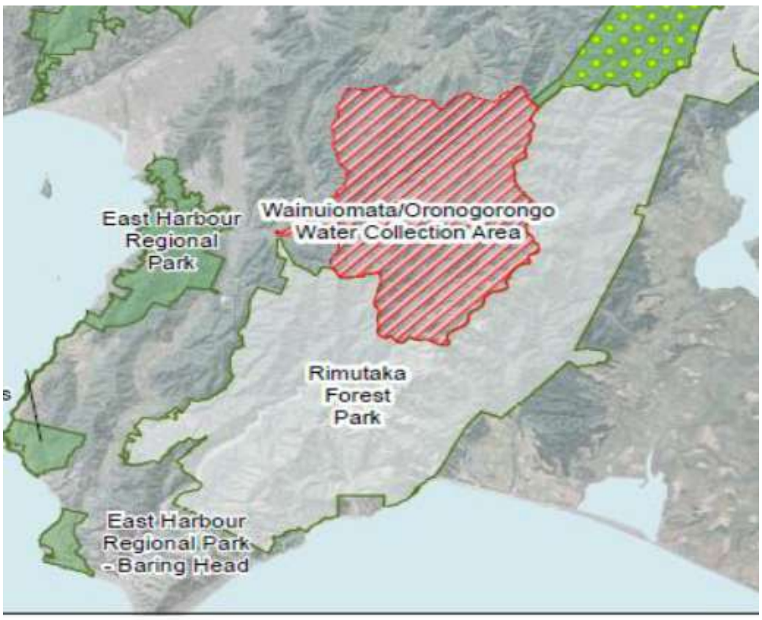
1.1 The Site

1.1.1 The Wainuiomata water catchment is located two kilometres east of Wainuiomata township (part of Lower Hutt City). It is the headwaters of the Wainuiomata River. The water catchment consists of the west and east branches of the river with many tributary streams including Sinclair's Creek and Georges Creek. It is the western section of the 7,373-hectare Wainuiomata/Orongorongo Water Collection Area which includes the headwaters of the neighbouring Orongorongo River.

1.1.2 The Water Collection Area is part of a major complex of protected natural areas totalling approximately 40.000 ha which includes the neighbouring Wainuiomata/Lower Hutt City and private reserves, the East Harbour Regional Park (2,250 ha), Pakuratahi Forest (8,000 ha) and Remutaka Forest park (23,000 ha).

1.1.3 The site is roughly triangular and is approximately 3,350 hectares in size. It is enclosed by ridges separating it from three neighbouring valleys to the west (Moore's valley), north (Whiteman's Valley) and east (Orongorongo valley). The Wainuiomata Recreation Area, from where the catchment is accessed via Whitcher Grove and Reservoir Road, is immediately to the south.

1.1.4 The Remutaka Forest Park, which is adjacent to the site is managed by DOC. Greater Wellington Regional Council (GWRC) manages the Wainuiomata water catchment as part of Wellington's water supply infrastructure and the public has limited access to a small portion for recreational purposes. GWRC's investment at this site is significant, including control of ungulates, mustelids, rats, and possums to low levels across the Catchment.



1.2 Benefits to Fauna

1.2.1 The site supports a full range of more common native species such as NI rifleman, bellbird, shining cuckoo, Australian harrier, yellow-crowned parakeet, long-tailed cuckoo, NZ falcon, grey warbler, kereru, welcome swallow, whitehead, morepork, pied tit, tui, NI fantail, NZ kingfisher, and silvereye.

1.2.2 It is proposed to introduce rarer species such as hihi, rowi and kākāpō, once the fence is built.

1.2.3 Table one shows an analysis of all the species that have been proposed within the Wainuiomata Project Document. We have assessed if a fence is required for each species to be translocated, the potential change (if any) of the threat status over time, and if the site is required for persistence.

1.2.4 The current recommendation for three species; rowi, kakapo, and hihi are that they are put into fenced sanctuaries or offshore islands to ensure they are not predated. It is likely that if translocations of rowi and hihi are successful and the populations establish at this site, the threat status of these species would improve over time.

Table 1. Species that could be translocated into the Wainuiomata Proposed Site							
Species	**Current NZTCS Status**	**a) Is site suitable for a viable population?**	**b) Is a pest fence essential?**	**c) Required for persistence?**	**d) Lead to NZTCS status improvement?**	**No of pairs or individuals***	**Comments**
Kakapo	Threatened- Nationally critical	Yes	Yes	Yes	Yes, a change over time to Nationally Vulnerable	150 individuals	The Wainuiomata Catchment meets the criteria for a kākāpō breeding site in terms of size, habitat quality, lek display areas and, most importantly, the presence of large areas of rimu dominant forest, which is essential for successful breeding.
Rowi kiwi	Threatened – Nationally Vulnerable	Yes	Yes, at this stage as no other proven management prescription	Yes	Yes, once a population I secure and breeding	Site will hold 70-100 pairs, but NI brown kiwi must be removed first	Currently do not have a proven in-situ predator management prescription for this species, so a fenced sanctuary offers a good opportunity for growing the population until a proven management prescription is in place.
Hihi	Threatened – Nationally Vulnerable	Likely	Yes	Yes, but dependent on a large population establishing, which has some uncertainty associated	Yes, potential to move into relict (from Threatened to At Risk)	100-2000 individuals	Waiting on report from expert assessment which will give a better assessment of the site's potential.
NI Kokako	At Risk- recovering	Yes	No	No	No	420 pairs	Already recovering
NI Saddleback	At Risk- Recovering	Yes	Yes	No	No	Hundreds-low thousands of individuals, but dispersal post translocation is a risk	Already recovering and likely to be assessed as relict in next assessment.
NI kaka	At Risk - Recovering	Yes	No	No	No	Hundreds-low thousands of individuals	Already recovering, but unlikely this project alone would put in relict.
NI Robin	At Risk- Declining	Likely, but previous translocation failed, possibly due to dispersal	No	No	No	0-9000 pairs. Previous translocation failed so this depends if another is successful	Large population declining NZTCS status. This project could help but would be unlikely alone to make enough difference. Also, establishment uncertainty because of dispersal.
Red crown parakeets	Relict	Likely	Yes	No	No	Hundreds to low thousands but may not introduce due to competition with yellow crowns	Red-crowned = relict

Table 1 cont. Species that could be translocated into the Wainuiomata Proposed Site							
Species	**Current NZTCS Status**	**a) Is site suitable for a viable population?**	**b) Is a pest fence essential?**	**c) Required for persistence?**	**d) Lead to NZTCS status improvement?**	**No of pairs or individuals***	**Comments**
Giant weta (Cook Strait)	At Risk-Relict	Likely	Yes	No	No	Unknown, but estimate low thousands	We have other mainland sanctuary options for this species.
Fernbird	At Risk-Declining	Uncertain	No	No	No	Uncertain	Large population declining NZTCS status. This project might help but would be unlikely alone to make enough difference.
Brown teal	At Risk-Recovering	Uncertain	No	No	No	Uncertain	Not much wetland to provide suitable habitat
Blue duck	Threatened – nationally Vulnerable	Unlikely - uncertain how much of the catchment contained within the planned fence is suitable.	No	No	No	Uncertain – no technique for translocation	No technique for translocating whio to new sites unless highly isolated
Bittern	Threatened-Nationally Critical	Unlikely – too small, but could contribute a small amount of protected habitat for a highly mobile species	No	No	No	1 intermittent pair	
Banded rail	At Risk - Declining	Unlikely – too small	No	No		Uncertain	
Hamilton’s frog	Threatened – Nationally Vulnerable		?	?		Uncertain	This species very likely requires mouse control
Takahe	Threatened-Nationally Vulnerable	No	Yes	No	No	1 or 2 pairs as ambassador birds only	Ambassador birds could go there only – habitat unsuitable
Yellow crown	Not threatened	Natural population present	No	No	No	Hundreds-low thousands	Yellow crowned+ not threatened

*These figures are an estimate only.

1.3 Kākāpō Recovery

1.3.1 There are currently 208 kākāpō, held on predator free, offshore islands. The species urgently requires more breeding habitat and returning birds to large areas of their former natural range is of highest priority. DOC and Ngāi Tahu's shared vision is to restore the mauri of the kākāpō. Rakiura and mainland Fiordland are preferred reintroduction sites, due to the whakapapa links of today's kākāpō population to these areas. Until these are ready for kākāpō, other sites are needed to grow the population.

1.3.2 Based on an initial site visit and information supplied, the Wainuiomata catchment meets the criteria for a kākāpō breeding site in terms of size, habitat quality, lek display areas and, most importantly, the presence of large areas of rimu-dominant forest, which is essential for successful breeding. If the catchment had a suitable predator-proof fence that kept kākāpō contained, it may prove to be an excellent site for kākāpō breeding. Wainuiomata could house up to 150 kākāpō.

1.3.3 DOC and Ngāi Tahu recognise that potential breeding sites of the quality that Wainuiomata offers are extremely rare. However, suitability of the site for kākāpō can only be determined with certainty by moving birds to the location. It would take many years to truly establish the site's potential. So, its suitability for kākāpō should be subject to ongoing assessment if the proposal progresses.

1.4 Rowi Recovery

1.4.1 Rowi are one of the most threatened kiwi taxa. The population estimate is at around 600 birds across two sites in New Zealand (Blumine Island and Mana Island; 2018-2028 Kiwi Recovery Plan).

1.4.2 The site could support 70-100 pairs of rowi. Currently do not have any other sites we can put rowi that provide security to the species by being pest free. One of the benefits of this site is that it falls within the historic known range of rowi. A predator free site of this size that is secured with a fence is currently not available for rowi and could provide significant benefits for the species.

1.4.3 Within the footprint of the site there could be some north island brown kiwi that would need to be removed from the site to stop them intermixing.

1.5 Hihi Recovery

1.5.1 The Hihi Recovery Group aims to increase the number of self-sustaining hihi populations to five, by establishing populations at new sites through translocation. If a successful translocation were to occur, and a population of hihi established, the result would be an improvement in the threat status of hihi.

1.5.2 The Hihi Recovery Group has completed a site visit on 15 July. They have informally said that the site is looking really promising for hihi and will be able to provide more information on the benefits to hihi in the near future. Their preliminary view is that the site does have potential and is of interest.

1.5.3 If Hihi were to be translocated into the site, there is no clear mechanism to fund their management, which would need to be planned. Hihi require supplementary feeding in nearly every site they are in. At this stage advice form the Recovery Group is that supplementary feeding would be required for the first 5 years after a translocation is completed. One of the benefits of supplementary feeding is that it does provide a mechanism for monitoring.

1.5.4 Supplementary feeding is currently carried out by the community groups that have raised money for the translocations to occur in the different locations in the north island where this has taken place. Feeders need to be changed every two days to reduce the chance of diseases

1.5.5 The recovery group estimates that the site could hold around 1500 hihi.

1.5.6 The Wainuiomata proposal provides a fenced site that is at a scale with habitat quality that we currently don't have for hihi populations.

1.6 Costs and management of species moved to the site

1.6.1 DOC will need to maintain oversight and management of kākāpō populations that are moved into the area. The kākāpō team have confirmed they are able to support and fund any work on the ground that is specific to kākāpō.

1.6.2 Hihi will require supplementary feeding at the site for at least 5 years after they are translocated into the site. Currently, supplementary feeding (changing nectar every two days) is run by the community groups, or sanctuaries that have received hihi. There is not funding that sits alongside hihi recovery that could be used to pay personal if hihi are moved to this site.

1.6.3 Rowi populations could be monitored once moved into the site, but do not require specialised support, other than pest free status being maintained at the site.

1.6.4 All species would be vulnerable to pest incursions, so maintenance and checking of the fence becomes a core expectation of translocations and management of this site.

1.7 Benefits to Flora

1.7.1 The catchment is part of the Tararua Ecological district and consists primarily of lowland rimurata/tawa-kamahi forest. This is typical of central and southern North Island lowland forest on better soils. While it is not a particularly threatened forest type at a national level, it has been substantially depleted by land clearance (19% remaining) and a lot of the remaining area has been degraded by logging, fire and browsing (Manaaki Whenua/Landcare -2004).

1.7.2 Rimu and kahikatea dominate in the valley bottoms and rimu/miro on higher ground. Matai is scattered throughout, and silver and red beech predominate on the highest perimeter ridgetops. The canopy consists primarily of hinau, tawa and kamahi. (O. Spearpoint 2020 see vegetation map at end). This forest type was once the dominant vegetation in the Wainuiomata and Hutt lowlands and valleys and the Wellington peninsula.

1.7.3 The Wainuiomata catchment represents a unique remnant outlier of this almost lost rimu/rata lowland ecosystem.

1.7.4 A feature of the forest is the extent of rimu which covers about 85% of the site and dominates the canopy with numerous emergent rata, which needs rimu as its primary host. The forest structure (emergents, canopy, subcanopy, shrub, lianes, floor) is largely intact except for parts of the shrub and floor layers which have been damaged by historical herbivore browsing.

1.7.5 21. Table 2 summarises different flora species that are known to be within the proposal site. There are both some potential risks (e.g., myrtle rust spread that would be considered during the Resource Consent stage) as well as benefits of the proposal to the flora in the area.

1.7.6 There has not been a botanical assessment completed at the site to determine what plants would benefit from complete removal of mammalian pests. However, based on knowledge of some team members we have been able to complete a high-level assessment on the benefits of the site.

1.7.7 We expect the understory to continue to regenerate with the permanent removal of goats, deer, and possums. This will provide food for invertebrates and birds within the area.

Table 2. Assessment of flora		
Species	**Description**	**Significance to DOC**

Species of the **Myrtaceae** family **CONSERVATION STATUS:** 'Threatened-Nationally Vulnerable' (de Lange et al. 2018) due to their vulnerability to myrtle rust	· There is a healthy population of ramarama (*Lophomyrthus bullata*) · The forest is dominated by northern rata (*Metrosideros robusta*) · Rata vine is also abundant (e.g., *Metrosideros perforata*) · A few swamp maire (*Syzygium maire*) is present and significant as this species is uncommon in the Wellington region. DOC and Otari Wilton Bush are researching ways to conserve seeds of this species (seed banking project). · Kanuka (*Kunzea robusta*?) and manuka (*Leptospernum scoparium*) are present.	· DOC should consider the protection and vulnerability of these species. · The building of fence and infrastructure could threaten these populations by spreading Myrtle rust in the area (see additional risk below).
Brachyglottis kirkii* var. *kirkii **CONSERVATION STATUS:** 'Threatened-Nationally Vulnerable' (de Lange et al. 2018) Regionally 'Endangered' (Crisp 2020)	· Wainuiomata catchment is a strong hold for this species. · GWRC is currently working with Otari Wilton Bush nursery in conserving and propagating this species. · This species could benefit from removal of grazers (deer and possum)	· This species is currently not managed by DOC
Mistletoe species *Korthalsella salicornioides* **CONSERVATION STATUS:** 'Threatened-Nationally Critical' (de Lange et al. 2018) *Tupeia antarctica* **CONSERVATION STATUS:** 'At Risk-Declining' (de Lange et al. 2018) *Ileostylus micranthus*	· The three suggested species are suitable for the area. · Suitable habitat for these species might currently be limited and planting of host tree/shrub species might be needed prior to translocation. · *Peraxilla* species were not included in the list as there might not be good beech habitat within the proposed fence boundaries.	· Translocation of threatened species of mistletoe in Wainuiomata is not a priority for DOC. · Conservation efforts should focus on the natural populations on DOC land in the Wellington regional region (e.g., Kapiti Island). o These populations are not monitored due to lack of resources. o It is however critical to ensure the genetic diversity of the species.

CONSERVATION STATUS: 'Not Threatened' (de Lange et al. 2018)		

1.8 The Halo

1.8.1 The proposal suggests regular pest control in a 'halo' around the fenced site. The long-term goal is stated as "to have 10,000 hectares surrounding the area that is under sustained pest control".

1.8.2 The proposal estimates $1.5 million is required for the first year of management, with $1 million required annually to maintain the halo. The halo provides more security for any species that leave the fenced sites as they would be moving into an area that is receiving pest control.

1.8.3 It is not clear who would be expected to fund or execute this management, however large portions of it are PCL thus it may fall to DOC. This would be an additional deviation of funding allocation, from that determined through current prioritisation processes.

1.9 Relationships Considerations

1.9.1 In discussions with the Sanctuaries of New Zealand Chair, feedback was that while there is not necessarily a relationship risk for DOC if this bid is supported, or funding provided, other sanctuaries could ask us to provide technical support for their restoration plans and translocations in the same way we provide support to Wainuiomata. This is not something DOC currently resources, and such work would require a reprioritisation of technical advice.

1.9.2 There is already some public interest, and interest from Ministers in this proposal progressing. There are likely to be reputational risks if DOC doesn't support a proposal where three species would see their threat status change over time with the establishment of populations at this site.

1.9.3 Mana Whenua Taranaki Whānui ki te Upoko o te Ika strongly support the project. They have a close working relationship with GWRC as the land manager and have been engaged to complete a Cultural Impact Assessment by the Project Lead.

1.10 Alignment to other DOC work programmes.

Te Mana o te Taiao

1.10.1 The proposal aligns with four of the outcomes within Te Mana o te Taiao.

1.10.2 Outcome 1 "Ecosystems from mountain tops to the ocean depths are thriving

1.10.3 Outcome 2 "Indigenous species are their habitats across Aotearoa New Zealand and beyond are thriving."

1.10.4 Outcome 3 "People's lives are enriched through their connection with nature."

1.10.5 Outcome 4 Treaty partners, whanau, hapu and iwi are exercising their full role as Rangatira and kaitiaki

1.10.6 While the implementation plan for Te Mana o te Taiao is still being developed it is easy to see that projects that are looking to provide protection the native flora and fauna align to this kaupapapa.

Optimised Landscape Scale Projects

1.10.7 Doc has an Optimised Landscape Scale Portfolio Work (OLSP) programme where sites are assessed and prioritised for management. The fenced area proposal for Wainuiomata did not rank in the top 10 sites for management. The site is also not an existing EMU (ecosystem management unit) that DOC is managing.

1.10.8 What this means is that the OLSP work programme would not be an appropriate source of funding for this project as the site did not fall within the top ten sites that are being progressed. It is not uncommon for sanctuaries to site alongside the work of DOC, and to not necessarily align directly with our work priorities. This is because the proposals are often community led and have a community of interest that sites behind it.

DOC's use of fences

1.10.9 DOC does use fences to protect different species in specific locations. Some examples include where we may have fenced a peninsula to protect some sea birds; a fence for a particular population of invertebrates, for instance snails; fences for populations of lizards.   This is done on a case-by-case basis and is most commonly done to protect a population or species. Therefore, this proposal does align with other management DOC has put in place, and proposals from community groups that DOC may have supported in the past.

1.11 Conclusion

1.11.1 The proposal is highly likely to have a positive benefit to the threat status of at least three species of birds, as well as plants, invertebrates, and reptiles.

1.11.2 The close proximity to a large urban centre could help in raising the funds necessary to build and run the facility, as well as volunteers that may be required for different aspects of operating the site.

1.11.3 There would be significant de-investment in current conservation projects if DOC was to fund this proposal.

1.11.4 Such de-investment could see some species which are already threatened decline to the detriment of their current threat status.

1.11.5 Therefore, the recommendation is that DOC provide in-kind technical support for this proposal only.

APPENDIX D:

Social and Economic Value

Wainuiomata Sanctuary Feasibility Study

Paper No:	**Appendix D**
Title:	**Social and Economic Value**
Date:	**14th September 2021**
Author:	**James Lynch** Project Advisor
Reviewed by:	**Thomas Nash** GW Councillor**; Amanda Cox** GW

1. Introduction

The primary purpose and rationale for this project is its national biodiversity value. However, experience has shown that fenced eco-sanctuaries provide opportunities for social engagement and economic development that can exceed those of traditional biodiversity programmes.

Note. Considerable cultural value will accrue from Wainuiomata. This is covered in section 2.2 Iwi and Treaty.

2. Limitations

This study has chosen not to explore this issue fully at this stage for the following reasons.

1. The catchment is and will remain an important operating water supply area for the region. This imposes many limitations on social engagement and economic activity if an acceptable level of risk to source water quality is to be maintained.

2. Many GW councillors, staff and associates believe that the project should be able to stand alone on its biodiversity merits and be independent of public support or commercial activity, both of which will be limited by the water function.

3. It will take a long time to establish the sanctuary infrastructure (ten years) and for the species to build up in the catchment to numbers which will be an attraction (twenty or more years). This study reviews the first ten years only (stage one). Major decisions about economic development can be safely left to the second and even third stages.

4. In Zealandia, the region already has an eco-sanctuary based on a high-volume retail tourism and education model where people can easily access a rich indigenous experience. It would not be necessary to duplicate this in the short term.

However, certain aspects which are relatively cost neutral, beneficial, and compatible with the above have been included for the following reasons.

1. There will be a high and immediate interest from the public and demand for the opportunity for engagement. This will be generated by the presence of high-profile iconic species such as kākāpō and kōkako and a unique, previously inaccessible, old growth forest. Registrations of interest are being received now.

2. Taranaki Whānui have registered their particular interest in the cultural/educational area and the future potential economic opportunities.

Note that there has been considerable research regarding the social and economic impact of eco-sanctuaries, and some has relevance to Wainuiomata. A number of research publications were consulted during the preparation of this paper and a selection is listed in the references.[1][2][3][4][5]

3. What is social and economic value?

According to Social Value UK[6], social value is the quantification of the relative importance that people place on something. This can be through a financial or time commitment and can be expressed by way of a contribution of some sort.

According to Wikipedia[7], economic value is a measure of the benefit provided by goods or services to an economic agent, in our case the sanctuary governing body and/or the regional community.

4. How do fenced areas create social and economic value?

Fenced eco-sanctuaries create social and economic value through the following avenues. These values are listed in order of their relevance to Wainuiomata.

1. **Donations and grants**. The opportunity for individuals, philanthropic institutions, and businesses to provide direct financial support. This provides an alternative revenue stream and access to alternative sources of value, e.g., pro-bono services.

2. **Job creation**. Sanctuaries can be rich in permanent 'green' jobs which provide a rewarding career path.

3. **Economic value in the community**. Sanctuaries create economic activity and additional jobs in the wider community through direct expenditure on goods and services to local businesses and individuals.

4. **Ecosystem services**. Sanctuaries contribute to the provision of clean water, soil conservation, and carbon sequestration within their managed areas.

5. **Membership.** The ability of individuals, businesses or families to join or associate with the corporate body and participate directly in the enterprise, usually for a small annual fee. Membership often confers benefits and participation in governance processes. This can also be expressed as 'Friends of…" support groups.

6. **Volunteering**. The ability of individuals or businesses to offer their labour or services, usually without-charge, confers benefits of connection, fulfilment, and improved mental and physical wellbeing.[8]

7. **Added value services**. The provision of services by sanctuaries to customers, usually for a fee or through funded grants for such activities as educational experiences and research activities.

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[1] Campbell-Hunt D. Freeman C. (2010) Community-Based Entrepreneurship and Wildlife Sanctuaries: case studies from New Zealand

[2] Maseyk, F Dr et al. (2021) Social and Ecological Outcomes from Community-Led conservation

[3] Campbell-Hunt D, (2002) Developing a Sanctuary. The karori Experience.

[4] Campbell-Hunt D, (2008) Ecotourism and sustainability in community-driven ecological restoration: case studies from New Zealand.

[5] Campbell-Hunt D and C, (2013). Ecosanctuaries

[6] Social Value UK. Website https://socialvalueuk.org/what-is-social-value/

[7] Wikipedia Economics. Website https://en.wikipedia.org/wiki/Value_(economics)

[8] Volunteering and its surprising benefits Volunteering and its Surprising Benefits - HelpGuide.org

8. **Retail services**. The provision of commercial retail services (e.g., entry to managed areas, nature experiences, cafes, shops, etc) for visitor interest and enjoyment.

Following is an assessment of how each may apply at Wainuiomata in phase one, given the limitations covered above. Each is also assessed for precedents amongst three eco-sanctuaries: Zealandia in Wellington city (225 ha trust established 1995), Maungatautari near Cambridge (3,400 ha 2006) and Orokonui near Dunedin (300 ha 2008).

5. Donations and grants

Donations and grants from individuals, businesses and philanthropic agencies is an important part of revenue for most community sanctuaries. Many depend on these for both capital and the major part of their operating funds. Grants and donations can come from private individuals and families, businesses (often from pro-bono services), philanthropic trusts and public grant bodies such as the lottery board. The Wellington Region is well served by these sources of funding.

Zealandia received approximately $700,000 pa (2019 and 2020) from non-capital grants and donations and also receives periodic capital grants for specific projects. Maungatautari[9] received $1,385,086 in 2020 for LTA operating grants and donations and Orokonui received $451.090 in 2020. Except for Zealandia's fence (funded by a loan), the major capital items for all three sanctuaries (fence, eradications, visitor centres) were all funded by grants and donations. Grants and donations depend on how much effort the organisation invests in solicitation and large donors generally require an after-care process to maintain goodwill. This usually requires the services of a fundraiser, and such a person should be able to pay for themselves many times over. An organisation must have charitable status to attract serious grant funding.

Wainuiomata is too big, nationally important and complex an operation to have to depend on community sourced philanthropic grants and donations. However, there is no reason why this sector cannot be asked to supplement base funding and provide another layer of contingency and financial 'insurance'. Wainuiomata will be particularly attractive for people wanting to support high profile species recovery programmes such as kākāpō and kōkako. Several substantial offers of donations have already been informally made by private philanthropists.

6. Job creation

Sanctuaries can be rich in permanent 'green' jobs which provide a rewarding career path. These jobs run from governance (chair and trustees), management, biodiversity operational staff and specialists such as administration, marketing, education and research. Many more jobs are created during the construction phase. These jobs will have added value as Wainuiomata is a generally low socio-economic area and more local employment would be welcomed.

The detailed cost estimates for the establishment and operation of the Wainuiomata Sanctuary project show that the enterprise will create the following number of jobs (see section 2.1).

1. Capital works (office, field base, road, weir, fence). Twenty-five FTE for three years.

2. Eradication. Twenty-two FTE for three years.

3. Board, management, and administration support. Four permanent FTE from year two.

4. Ongoing operations from year seven (excluding education, research, and visitors). Twelve permanent FTE.

[9] Sanctuary Mountain-Maungatautari. 2019-20 Annual Report.

5. Education research, visitor engagement. Not assessed and won't reach maturity until the second ten-year stage.

7. Economic value in the community

Sanctuaries create economic activity and additional jobs in the wider community through direct expenditure on goods and services to local businesses and payment of salaries and wages to individuals. In 2019/20, it was assessed that Zealandia contributed close to $30 million per annum of economic value to the Wellington region through capital investment, job creation, training and other local spending.[10]

Generally, the equation for assessing economic value-added to a locality is a multiplier of four times the capital and operating expenditure. This means that Wainuiomata will add $160-180 million of economic value to the region over the next ten years – an average of $20 million a year. Much of this additional expenditure will benefit the Wainuiomata and Lower Hutt communities directly.

8. Ecosystem services

Sanctuaries strengthen natural infrastructure by contributing to the provision of clean water, soil conservation, and carbon sequestration within their managed areas. The catchment already fulfils a major function in providing these ecosystem services to the region.

The water supply will continue to provide approximately 10% of the regions water. The sanctuary will reduce source water risk by eliminating wild animal contamination from rats, possums and ungulates but this may be partly offset by additional populations of birds and mice.

The risk to source water will be reduced by the need to use less poison in the long run but this will be partly offset by the increased activity required to maintain the catchment operations.

The catchment already serves to preserve soil as it is largely forested. This may improve somewhat when large, bodied herbivores and pigs are eliminated, and the understory recovers but this is difficult to calculate.

The catchment is a climax indigenous forest which stores as much carbon as it is likely to be able to hold. Climax forests are generally neutral as far as carbon sequestration goes i.e., they emit (through decay) as much as they accumulate (through added biomass from growth). The elimination of browsing animals may improve carbon sequestration, but this is not well researched or well understood. It can be assumed therefore that the catchment will remain largely carbon neutral.

In summary, the catchment will continue to provide a range of important ecosystem services, but the establishment of a pest free sanctuary will not add materially to that function.

9. Memberships

Membership of the governing body is generally the primary mode of direct public participation in sanctuaries. Members pay an annual subscription varying from $30 pa to $90 pa. Membership is often a vehicle for the public to offer a token of support to the enterprise and be kept informed of progress by way of various media. Memberships are also an efficient vehicle for soliciting volunteers and small donations. Most memberships also include free visitor entry and discounts for goods and services. Seeking memberships involves costs for recruitment, registrations and renewals, database management, news services, and enquiry handling.

[10] Zealandia-Te Mara a Tane. Annual report 2019/20 Page 44.

Zealandia has approximately 14,000 individual members which earns subscription revenue of $382,000 pa (2020 Annual Report). Maungatautari does not employ this direct membership model. Orokonui has 700 members[11]. The volume of memberships appears to co-relate with the size of the local population and the amount of effort the enterprise puts into recruiting and maintaining membership.

For Wainuiomata, memberships would be an ideal way to build public participation and a support group and solicit volunteers and small donations. The Wellington and Hutt City area has a large, educated population (400,000) with a history of supporting community enterprises and nature and Wainuiomata is close enough to Wellington City and the Hutt Valley to encourage this support.

Visitation and discounts for services could not be offered in the first phase as benefits (see later) and accordingly the cost of membership would need to be kept low. Due to the costs of servicing, membership would initially most likely be revenue and cost neutral. A revenue stream for Wainuiomata from memberships should not be relied upon in the first ten-year phase but could be developed over time as the public profile for the enterprise increased.

10. Volunteering

Volunteering is a way for the public to directly participate in and support an enterprise by providing opportunities for the public to offer their labour. Volunteering can involve businesses and individuals and can be integrated into an enterprise's operations from governance to professional services to office administration and visitor management through to field operations. Most sanctuaries have an active volunteer base, and some depend on volunteers for much of their labour. Volunteers are generally those who wish to have a close and active relationship with the enterprise.[12]

Zealandia has 450 registered volunteers, Maungatautari 292, and Orokonui 300. The extent and value of volunteering depends on how much an enterprise invests in volunteering through recruitment, training, supervision, and care. There are significant costs, both in time and financial investment, to maintaining a competent and useful volunteer force.

For Wainuiomata, volunteering would have value but would also have limitations. Professional pro-bono services will be welcomed. However, most of the work in the first five years would be specialised and require professional and trained staff. The catchment is some distance from the larger population centres, is very large and rugged and the weather is often cold and wet. The experience of the GW Mainland Island staff is that volunteers don't function well in this difficult environment. Entry to the catchment would be restricted for health reasons and teams of volunteers require a lot of management. Volunteers have not been factored into the eradication or incursion response plans because of this. However, they could be employed on administrative and support tasks and for taking guided tours. When the species recovery programme begins after five years, they could be usefully employed on monitoring, feeding and species care tasks.

Accordingly, volunteering can be accommodated in certain areas but should not be a major focus of the first phase and no work programmes should be dependent on them.

11. Added value services

Some eco-sanctuaries provide services such as educational experiences and research activities. Educational and research activities tend to be funded through grants or donations from funders who support such aims and are generally fiscally neutral.

[11] Orokonui Eco-sanctuary Website. https://orokonui.nz/About/The-Trust.
[12] Bell K. (2003) Assessing the Benefits for Conservation of Volunteer Involvement in Conservation Activities (DOC)

There will most likely be a demand for educational visits very early. However, it is not recommended that a structured programme be considered until at least phase two and a dedicated programme may not be needed at all. Education programmes require professional personnel and facilities, are costly to run and do not earn surplus revenue. It may be that an education programme can be contracted out to iwi or a provider at a later date.

Research programmes are similar and need to be fiscally neutral. Research needs can be met by forming partnerships with research institutions such as crown agencies and universities.

12. Retail services

Some eco-sanctuaries provide commercial services such as visits and nature experiences for public interest and enjoyment. Visitor programmes range from small scale with donation entry to sophisticated structured programmes, with retail facilities (cafes and shops), which access the national and international tourism market.

GW runs a limited number of public guided tours in the catchment every year. These are popular and it is likely that when the project gets underway, public interest will be high and there will be a commensurate demand for visits to the catchment. The catchment offers a tall forest experience (although this is also available at Kaitoke and the Catchpool Valley in Remutaka Forest Park). The historic water infrastructure provides added interest.

It is not recommended that a major visitor programme be developed (at least in the first ten-year phase) for the following reasons.

1. The water supply function would preclude unrestricted public access for health reasons. Health screening would be required of all visitors.

2. A large number of visitors would require toilets and many miles of expensive well graded walking tracks which would be difficult to accommodate without adding to source water risk. Large numbers of visitors would require a purpose-built visitor centre as the existing centre is far too small and may have to be commandeered for staff offices.

3. There will be intensive pest eradication and species reintroduction programmes in the first ten years which don’t lend themselves to accommodating high visitor numbers.

4. The catchment is huge and wild, and it is easy for unguided visitors to underestimate the forest and get lost. Unguided access is not desirable.

5. The weather is generally inclement (average 180 wet days per annum), and a visitor programme could have a lot of enforced downtime.

6. It will take up to fifteen years for the reintroduced fauna to establish and form visible populations. An area of this size will take a long time to reach carrying capacity for most reintroduced birds. Moreover, small, well camouflaged birds are not easy to spot in a tall forest and are often high in the canopy and spread out.

To accommodate the immediate public interest in the project and encourage membership and support, guided tours could be undertaken along the Georges Creek Road, primarily on weekends. The road is hardened and easily accessed and has numerous points of interest with a genuine tall forest feel and is close to toilet facilities. A small-scale programme of this nature in this locality could accommodate up to 5-8,000 visitors per annum, satisfy public curiosity and interest, be easily run by volunteers (or iwi franchise), and could provide a small but significant revenue stream. It would not disrupt or put at risk the water services, or the sanctuary operation and would not require any additional facilities.

The expansion of such a programme can be reassessed as the organisation matures and demand is better known. Taranaki Whānui have indicated an interest in constructing a wharenui at the entrance which could interpret their history and provide for visitors. This could be reviewed for feasibility in the second ten-year phase.

13. Conclusions

The conclusions are as follows.

1. An eco-sanctuary at Wainuiomata has considerable potential to add social and economic value in the future.

2. However, this should not be its primary rationale and it should be able to stand alone for its biodiversity value. This is because it must remain an active water supply facility, and it is a large and complex project which will take up to twenty years to reach maturity.

3. Notwithstanding this, sanctuaries are known to add social and economic value to communities through grants and donations, job creation, economic value added to the community through expenditure, the provision of ecosystem services, membership and participation, volunteering, and the provision of added value and commercial services.

4. Wainuiomata has immediate potential to add social value with minimal investment through grants and donations, job creation, economic value added, memberships, and volunteering.

5. Wainuiomata could add as much as $160 million in economic value to the community over the first ten years and create forty-seven shorter term (two year) and sixteen permanent high-quality jobs in a needy socio-economic area.

6. The catchment will continue to provide valuable ecosystem services through clean water, soil conservation and carbon sequestration. A sanctuary operation is unlikely to add materially to the status quo in this area.

7. It is not recommended that Wainuiomata pursues an intensive added value (education) or commercial services (visitor) model in the first ten-year period as this will be incompatible with the water supply function and eradication programmes and would require substantial infrastructure investment. Immediate public demand can be satisfied with a small-scale visitor programme using guided tours similar to what is done now.

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14. References

Bell K. (2003) Assessing the Benefits for Conservation of Volunteer Involvement in Conservation Activities (DOC)

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APPENDIX E:

The Need for a Fence

Wainuiomata Sanctuary Feasibility Study

Paper No:	**Appendix E**
Title:	**The Need for a Fence**
Date:	**17th September 2021**
Author:	**James Lynch** Project Advisor
Reviewed by:	**Paul Jansen** DOC; **Kim Broad** GW MI Co-ordinator. **Helen Nathan** ZIP

1. Introduction

We have assumed that a predator proof fence is essential to achieve the expected biodiversity, social and economic gains. Below we test this assumption, as a fence is a large capital investment and long-term commitment.

Questions include

1. How effective is fencing at achieving the primary purpose of keeping the area predator free?
2. How do the biodiversity gains and costs of a fence compare to those of existing management?
3. Is it possible to achieve all or some of the expected outcomes without a fence?

2. Background and precedents

Many of the endemic species of Aotearoa have become extinct or are perilously threatened primarily due to the depredation by introduced predators. In the 1980's DOC succeeded in eradicating rodents and other small mammals from offshore islands. Ever larger islands were cleared of pests and there are now forty-four islands which are mammal free with Campbell Island (15,000 ha) being the largest of these. These island eradications have significantly added to the security of many forest birds and reptiles. Islands are very effective and cost efficient for threatened species management.

However, the island programme is reaching its optimum and the very large islands such as Great Barrier and Stewart Island have the same problems of scale as predator control on the mainland. Without the technology to remove exotic pests from these large islands, critical habitat for the recovery of endangered species is severely restricted. This is now stalling recovery and putting long term survival of these species at risk.

In the early 1990's DOC initiated the 'Mainland Island' programme, starting with Mapara Forest (1,000 ha) near Te Kuiti and resulting in five projects which were to be experimental research units. (Boundary Stream, Rotoiti, Trounson, Paengaroa, Te Uruwera). These projects used conventional methods of toxins, traps and hunting in a systematic and permanent process to control pests to very low levels.

As a result of their success, many other intensively managed 'mainland islands' were set up around the nation. These have been successful in recovering in-situ populations of at-risk species such as kiwi, kōkako, and kākā and improving the general health of the forest ecosystem. Attempts to translocate more sensitive species such as tīeke and hihi to mainland islands have not succeeded.

In 1999 Zealandia built the first multi-species predator proof fence in New Zealand[1]. Since then, fourteen significant fences of similar design have been constructed for a mixture of private, NGO and TA eco-sanctuaries. The largest of these ring-fenced eco-sanctuaries is Maungatautari at 3,400 ha which is the same scale as Wainuiomata. Seven of these are ring fenced and seven are peninsula fences. The ring-fenced sanctuaries have been spectacularly successful in enabling the return of extremely sensitive fauna such as tīeke, hihi, kiwi pukupuku, tuatara and giant weta.[2]

In Zealandia, research has shown that the fence has enabled the return of sixteen nationally or regionally endangered fauna species. Over time the population structure of forest birds has altered dramatically in favour of the deeply endemic species and is strongly tracking towards that which exists on nearby predator free Kapiti Island (1,910 ha). Some species (kākā and kākāriki) have re-established in the surrounding suburbs[3].

From the above precedents, it can be concluded that predator-proof fencing has been the most effective technology for keeping small parts of the mainland predator-free and providing safe habitat for the most critically endangered species.

3. Target species

The primary rationale for predator fencing the proposed Wainuiomata Sanctuary is to create safe habitat for several nationally critically endangered species, especially kākāpō, rowi/Okarito brown kiwi or kiwi pukupuku/little spotted kiwi and hihi/stitchbird. Tīeke/saddleback, kōkako and tuatara are other favoured highly important species. (See DOC report).

The Project Leader for the Kākāpō Recovery Group confirms that kākāpō require habitat free of cats, mustelids and rats for the species to survive and breed. A translocation of kākāpō to a mainland island habitat without a predator proof fence and a robust incursion response system in place would not be permitted. The leader of the hihi recovery group has confirmed the same thing for hihi. Tīeke and tuatara are other key target species for Wainuiomata which also require habitat entirely free of cats, rats and mustelids.

The conclusion is that without a predator proof fence, the primary rationale of the enterprise could not be achieved.

4. Future technology prospects

If existing technology cannot keep significant areas predator free, then what of developments in the research pipeline?

The Predator-Free NZ campaign was launched in 2012 with Sir Paul Callaghan's 'Vision for a Predator-free NZ' speech sponsored by Zealandia and Victoria University[4].

Since then, a research programme driven by Zero Invasive Predators (ZIP) has been investigating future technologies, including field trials in the 12,000 ha Perth River Valley in South Westland. ZIP has participated in the eradication investigation for this project.

ZIP has confirmed that, although their technologies prove promising, there is no immediate or medium-term prospect of emerging or existing technologies being able to eradicate and keep

[1] Campbell-Hunt D and C, 2013. Ecosanctuaries
[2] Innes J, et al. (2019). New Zealand ecosanctuaries: types, attributes and outcomes, Journal of the Royal Society of New Zealand.
[3] Miskelly C, (2015) Changes in the forest bird community of an urban sanctuary in response to pest mammal eradications and endemic bird reintroductions. OSNZ
[4] Callaghan Sir Paul, (2012) 'Vision for a Predator-free NZ' You tube.

permanently free of invasive species an area with the characteristics of Wainuiomata without a fence. The two primary reasons are that 1) there are no strong natural barriers (such as large rivers or alpine ranges) protecting the site from reinvasion, and 2) given that the site is a water collection area, the ability to respond to reinvasion events using toxins will be limited.

We conclude that new technologies have not yet progressed enough to make significant mainland island areas reliably predator free for long periods without the need to response to reinvasion. Wainuiomata will still need to depend on the proven existing technologies for the foreseeable future.

5. History of Wainuiomata Catchment management

As noted in part One the biodiversity management in the catchment was patchy until 1999 when GW designated the Wainuiomata Catchment a key Native Ecosystem (KNE). At that time, GW began aerial 1080 toxin applications to control possums, established professional hunting of ungulates and pigs and appointed a ranger.

In 2004 a comprehensive ‘Mainland Island’ style bait station and trapping operation was set up in a portion of the Wainuiomata River headwaters covering 1,200 hectares. The programme targets rodents and mustelids with a 150m X 100m management grid and has been operating ever since. The graph below shows a summary of the results of that programme on the rat population in the mainland island. In 2005 a sixteen-kilometre deer fence was constructed along the western and northern boundaries to reduce the migration of deer, goats and pigs into the catchment.

The results of these programmes have been variable with pest numbers spiking in mast years in the mainland island, despite the control (see graph below). Monitoring has shown that rat numbers are usually extremely high in areas adjacent to the mainland island, meaning incursions of rats are likely to be continual and significant. 1080 operations undertaken in the adjacent areas have reduced rat numbers but only temporarily. Deer and pigs still invade from the east and need regular operations to keep them down.

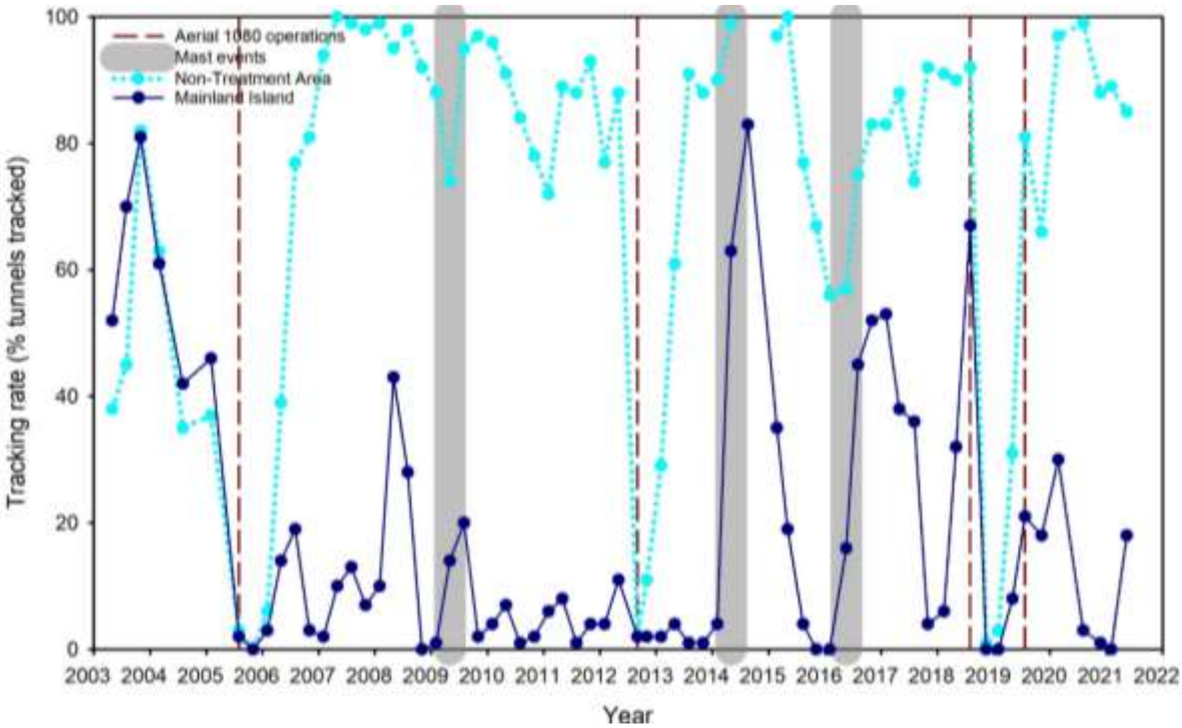

Figure 1 pest control at Wainuiomata. Graphic GW.

GWRC spends approximately $200,000 pa to maintain these programmes.

This management regime has materially improved the mainland island forest condition. The predator control has resulted in an increase in resident birds such as tui, korimako/bellbird, kereru, pōpokotea/whitehead and titipounamu/rifleman. However, further biodiversity gains are severely hampered by the limitations of the current management regime.

With the establishment of the mainland island, it was intended to release missing but extant species in the catchment with toutouwai/NI robin and NI kōkako being the first targets, as the habitat was suitable for both these species. In 2012 and 2013, 120 North Island robin were transferred into the mainland island from Kapiti Island. There was successful breeding and fledging from at least six pairs but dispersal out of the safe site was high and meant a low establishment rate. Had the mainland island been three times its size (the size of the proposed fenced sanctuary) the prospect of the robins anchoring within the managed area and establishing a sustainable population would have been far greater.

A subsequent feasibility study on the prospect of re-introducing NI kōkako into the mainland island found that the mainland island didn't encompass sufficient ridgeline nesting habitat for kōkako and that the current rat control wasn't sufficiently sustained. The study recommended increasing the size of the mainland island to incorporate more ridges and intensifying the predator control.

The conclusion from the Wainuiomata and other mainland island experience is that the current regime will protect the extant forest fauna but is compromised when reintroducing missing fauna. The grid would have to be considerably tightened and extended to the whole catchment (3,313 ha) to consider this. However, without the benefit of a predator proof fence, the eradication of predators and an increase in size, the mainland island cannot provide safe refuge for the endangered species listed earlier for which suitable habitat is now severely restricted.

6. What would it take to make the catchment predator-free?

If the current Mainland Island regime is not adequate for the task, could the area be made safe for sensitive species by strengthening the management regime?

The following analysis is based on costs assessed for this project and assumes the following management regime for the 3,313-ha managed area.

1. A management grid doubled in intensity (75m X 50m) over the current MI grid (150m X 100m) and extended to the whole catchment (1200 ha to 3,330 ha).

2. The same eradication process would be used but substituting brodifacoum with 1080. This would technically be a 'knockdown' as it is impossible to eradicate everything from the area without a fence.

3. The post-operation regime as designed and costed would need to be extended to the whole catchment and be maintained permanently. This would be augmented by annual hunting for ungulates and aerial 1080 operations for mast years, (every 2-5 years).

4. With a fence, the post-op monitoring procedures can be reduced by up to 50% after 3-5 years when there is confidence in the fence and incursion response systems, and staff can be deployed on species and other work. In time the central grid may be able to be scaled back when confidence in the fence and biosecurity procedures has been established.

Following is a broad comparative analysis for the two methods over a 30-year fence lifespan.

The conclusion is that, with existing technology, it is both more outcome effective and cost efficient and has less risks to fence the catchment than to intensify the Mainland Island regime. Note that maintaining an intensified and extended mainland island operation is impractical as it is unlikely that the species recovery groups would allow sensitive species in the catchment without a fence and the water managers would most likely object to such an intensive regime in an operating water supply area.

Comparative analysis

Method	Calculation of operational costs	Outcomes (at 30 years as added value VA)
Scenario 1. Intensified MI operation Managed 3,350 ha. 75 X 50 grid. Traps, poison. Continuously maintained. Annual ungulate and pig hunting 1080 aerial for knockdown and again in extreme mast years (two to five yearly) Possum (0%), rat (0%), mustelids (0%), ungulates (0%), hedgehogs (1%), cats (0%). Mice (3%)	1st 3 years incl. knockdown. $10,000,000 Next 27yrs @ $2.25m pa $60,750,000 Total $70,750,000 Estimates include deer fence maintenance and replacement over time. Annual hunting and three yearly 1080 operations. Note. Pest control costs only. Does not show species management and other operational costs. It is assumed these costs are the same between scenarios.	**Biodiversity Value Added:** Forest health greatly improved. Increase in most resident bird spp over whole site. Some migration beyond the fence. RC kākāriki and kākā self-introduce over time. New reintroductions: toutouwai, kōkako, pāteke, rowi, whio. Few populations at full potential carrying capacity. Increased reptiles due to mice reduction. **Risks.** Toxin accumulation and persistence. Trap and poison shy residual populations. Increased source water risk. Mast years occasionally overwhelm the system. Social and water managers reaction to intensive and continuous poison use in water supply area.
Scenario 2. Pest-proof fence 29 km fence with maintenance and 30-year replacement programme encloses 3.313 ha. 75 X 50 monitoring and incursion response programme. Grid maintained but servicing reduced 50% when confidence in fence established (3years after fence built). Grid may be scaled back over time. No mice management. Possum (0%), rat (0%), mustelids (0%), ungulates (0%), hedgehogs (0%), cats (0%). Mice (60%)	Fence & road $15,750,000 1st three years incl. eradication $10,000,000 Fence mtce. & mon. 27 years @ $1.25 m pa $33,750,000 Total $59,500,000 The marginal saving of 11 million over 30 years would allow the fence to be partly replaced if needed through a depreciation and upgrade programme.	**Biodiversity Value Added:** Forest health at optimum. All resident spp at carrying capacity and migrating beyond the fence. Twelve fauna reintroductions, many migrating beyond the fence. kākāpō, rowi kiwi, hihi, tīeke, kōkako, tuatara (nationally significant spp) established. Lizards not greatly improved. **Risks**. Mice are abundant. Toxin use greatly reduced. Source water risk reduced. Social and water management risk low. Control methods still effective.

7. Summary and conclusions

The conclusion is that a fence is required to achieve the primary purpose.

1. Precedents show that predator-fencing has been the most effective technology for keeping small parts of the mainland predator-free and providing safe habitat for the most critically endangered species.

2. Without a predator proof fence, the primary rationale of the enterprise, i.e., providing critical safe breeding habitat for kākāpō and hihi, could not be achieved.

3. New technologies have not yet progressed enough to make significant mainland areas reliably predator free for long periods. Wainuiomata will still need to depend on the proven existing technologies for the foreseeable future.

4. Experience from the current Wainuiomata mainland island operation is that the current regime will protect the extant forest fauna but will not safely allow the re-introduction of sensitive missing fauna. The grid would have to be considerably tightened and extended to the whole catchment (3,313 ha) to consider this for a limited range of species.

5. An assessment comparing an intensified and extended MI operation shows it is both more outcome effective and cost efficient and has less risks to fence the catchment than to intensify the Mainland Island regime.

6. Note that maintaining an intensified and extended mainland island operation may be impractical as it is unlikely that the species recovery groups would allow sensitive species in the catchment without a fence and the water managers would most likely object to such an intensive regime in an operating water supply area.

James R. Lynch
Project Advisor

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Miskelly C, (2015) Changes in the forest bird community of an urban sanctuary in response to pest mammal eradications and endemic bird reintroductions

APPENDIX F:

Compatibility with Water Supply Function

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16 November 2021

Wayne O'Donnell
General Manager, Catchment Management Group
Greater Wellington Regional Council
PO Box 41
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35-37 Chapel Street
Masterton

Dear Wayne

Proposed Wainiuomata water catchment eco-sanctuary

Thank you for your letter of 29 October 2021 in relation to the proposal to predator fence 3,313 hectares of the Wainuiomata water catchment to establish a secure eco-sanctuary.

We believe the proposal has significant merit and is highly compatible with protection of the water supply catchment, and therefore support the proposal subject to careful management of the following issues:

1) The primary purpose of the catchment is to protect water for public consumption, and as such its primary function should remain as a water supply catchment in perpetuity. Proposed recreational interests must not conflict with this, now or in the future, and remain complimentary.
2) Restriction of access and limiting visitor numbers to avoid fouling/pollution/degradation of the catchment. The eco-sanctuary should therefore avoid becoming a commercial enterprise.
3) Safety of vehicles and people accessing what is currently a remote and relatively inaccessible area.
4) Ensuring water supply operational personnel have free unobstructed access to the intakes as/when required in the future.
5) Provision of services infrastructure for current and future needs, including appropriate wastewater treatment and disposal that minimises risk to the source water.
6) Sufficient operational resource being made available during implementation to ensure risks are managed, for example erosion and sediment control, oil/chemical spills, sufficient construction monitoring etc.

7) Revenue generation proposals should not adversely impact pest control and other catchment management activities outside of the proposed sanctuary (for example in the Orongorongo Valley etc.)
8) Access to the immediate vicinity around the water supply intakes should be restricted to protect the drinking water supply.

We are happy to discuss the proposal further if required.

Yours sincerely

L. Edwards

Laurence Edwards
Chief Advisor Drinking Water, Wellington Water

Wainuiomata Sanctuary Feasibility Study

Paper No:	**Appendix F**
Title:	**Compatibility with Water Supply Function**
Date:	**4th October 2021**
Author:	**James R. Lynch QSM.** Project Advisor.
Reviewed by:	**Gillian Woodward** Wellington Water; **Wayne O'Donnell** GW.

1. Introduction

See the proposal to predator fence the Wainuiomata Catchment and manage it as a premier national threatened species site.

A question to resolve with the potential establishment of a fenced sanctuary at Wainuiomata Catchment is "Can a sanctuary be run in conjunction with the existing and future water supply function?"

Note that the area of interest is the headwaters of the Wainuiomata River only (3,313 hectares). The Orongorongo catchment (4,043 hectares) is not included in the proposal.

An assumption of the proposal is that the water supply function will be able to continue largely unaffected. This paper sets out all the issues identified so far in relation to the water supply which will need to be resolved before a decision to proceed.

Questions to be answered include:

1. What advantages are there for water supply if the proposal went ahead?
2. What governance arrangements would be needed to facilitate the overlapping operations?
3. What effects will there be on the water supply and what level of operational and visitor activity can the water supply function accommodate?
4. Are there any costs for the water supply to accommodate the proposal?
5. Can the two purposes be operated together?

2. The problem and the need

Nationally there are a significant number of critically endangered forest species which require predator-free habitat and where offshore islands can no longer provide sufficient of that habitat to ensure long term security of the species (e.g., kākāpō, rowi kiwi, kiwi pukupuku, hihi, tīeke, tuatara, giant weta). Currently, DOC depends on a small number of community sanctuaries to provide mainland habitat for these species.

The case for predator fencing Wainuiomata rests primarily on its habitat potential for a significant number of these critically endangered indigenous species. The unique features of Wainuiomata which make it important for threatened species management is its size (3,313 ha) and the quality of the habitat (largely unmodified lowland podocarp, broadleaf forest).

Wainuiomata has particular value for kākāpō (*Strigops habroptilus* - conservation status-nationally critical). As of 2020, there are 203 kākāpō in existence. Almost all these birds reside on Whenua Hou, Chalky or Anchor Islands off the southern South Island. The southern islands are at or nearing carrying capacity for kākāpō and new habitat is urgently needed. Kākāpō require predator-free habitat and an abundance of rimu trees for breeding. Wainuiomata has an abundance of rimu and could provide secure habitat for up to 150 kākāpō. Sites of Wainuiomata's quality are extremely rare, and we acknowledge the role that water management has played over many years. in its protection.

3. Water Infrastructure.

Wainuiomata has been an important operating water supply area since 1882 when the first dam was built. The water supply area was extended in 1924 when the Orongorongo catchment was included, and the weir and tunnel built. The entire Wainuiomata/Orongorongo Water Collection Area now cover 7,373 hectares and supplies 20% of Wellingtons water, divided roughly equally between the two catchments. Over the years the water infrastructure has been built up, first with the Morton Dam, then the Orongorongo weir and tunnel and the water treatment plant. See figure one for a map of the water infrastructure.

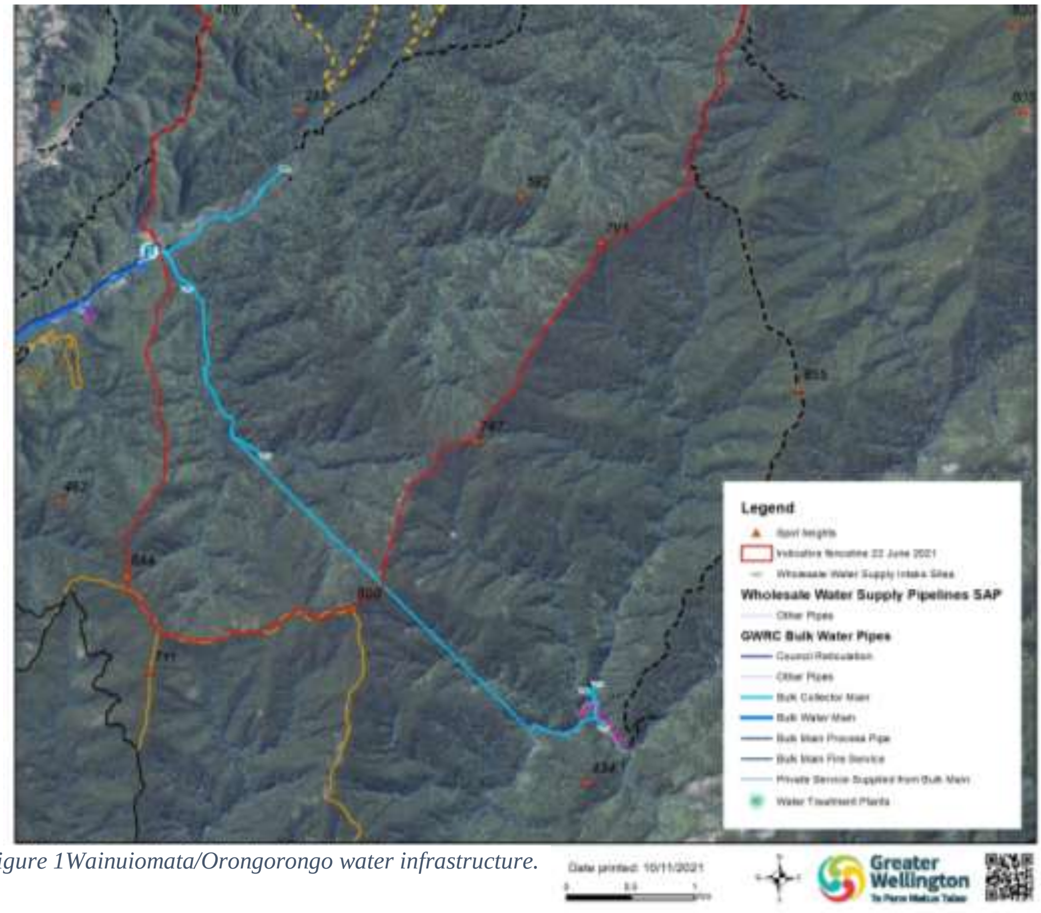

Figure 1Wainuiomata/Orongorongo water infrastructure.

4. Water reform

It is understood that the proposed water reforms could significantly change the future governance arrangements for regional water and that these arrangements may not be fully in place by the time the feasibility study is planned to be completed (October 2021). Therefore, this may constrain Wellington Water in its ability to respond definitively to this proposal by that date.

5. Advantages for the water function of a sanctuary in the catchment

The establishment of a fenced pest free sanctuary will have advantages for the ongoing water supply function as follows.

1. The elimination permanently of all large bodied herbivores (deer, goats, pigs and possums) and the prevention of the damage they do to the forest. This will result in less animal contamination/disease spread and greatly improved forest condition. Large herbivores are known to be vectors for diseases such as Tb. Note that a predator-proof fence is 100% guaranteed to keep these animals out.

2. The reduction of soil erosion and turbidity through improved forest condition. Predator and browser free forests have less animal disturbance, take up more carbon and accumulate much more biomass which leads to higher absorption of water and more stable soils.

3. The near permanent elimination of all small mammals (rodents, hedgehogs, mustelids, rabbits). This will result in less animal contamination/disease spread. These animals are also known to be disease vectors. Note that mice may not be able to be eradicated permanently and some incursions of rodents and mustelids can be expected from time to time. Incursions can be managed to eliminate any transgressors.

4. Over time, there should be a significant reduction in the use of toxins in the catchment. Currently, aerial 1080 is applied every three to four years and 1,200 hectares is permanently treated by a bait station and trapping operation. After the one-off eradication operation, the use of toxins should be greatly reduced. A proviso is that occasional incursions may need to be dealt with by toxin application, but this is likely to be contained in bait stations and of smaller scale than the current mainland island operation.

5. The need for hunters to enter the Wainuiomata catchment will be eliminated permanently. Note: recreational hunting in the catchment is highly restricted and there is no social right for private hunting in the catchment.

6. The above items mean an overall reduction in source water risk for the Wainuiomata catchment.

7. A new perimeter road could mean easier and shorter access to the Orongorongo catchment for water staff and pest control staff. There may be no need to enter the Wainuiomata catchment to service the Orongorongo catchment.

8. All new access roads will be maintained in good condition by the sanctuary staff.

9. The presence of the sanctuary will mean potential opportunities for public education about water supply and public health for visitors to the catchment (but see 7 below).

6. Potential governance framework

The sanctuary governance arrangements have not yet been fully debated but the following is the current thinking based on experience with sanctuary management.

1. The sanctuary is most likely to be run as a joint venture partnership between DOC, GW and Taranaki Whānui.

2. It is likely that they will want to set up a charitable trust to manage the sanctuary. DOC, GW and TW would be the settlors of that trust, which means they would stand the risk if the trust failed. The parties would appoint trustees who would then employ permanent skilled staff to manage the sanctuary.

3. This is the standard model, which is applied to most community sanctuaries, many of whom have relationships with local authorities and multiple partners.

4. Such an arrangement would give Wellington Water and the partners a clear and single point of contact and accountability. It should make the management of overlapping operations simpler.

Service level agreements and operational arrangements can then be negotiated between the water authority and the trust.

Following is an analysis of the various sanctuary activities and effects that will or may occur from them if the proposal goes ahead.

7. Timing

It is understood that the timing of the sanctuary development is important to Wellington Water in respect of the completion of the water reforms and in the completion of projects to improve the 'headroom' for the regional water supply. Much of the timing is difficult to predict but the following is a best estimate.

1.	Completion of feasibility study.	Completed	October 2021
2.	Approval from partners		January 2022
3.	Funding commitments.		July 2022
4.	Formation of a trust		December 2022
5.	Set up and hiring		June 2023
6.	Contracting and resource consents		December 2024
7.	Construction of fence	(two years)	March 2027
8.	Eradication completed		June 2028

This indicates that it could be at least six years before the eradication commences and seven years before the catchment is cleared and species operations begin. the above probably represents a scenario where everything goes according to plan. Any of these activities could be delayed and this would of course set back the timetable.

8. Visitor operations

Note that it is **not intended** that Wainuiomata will become a high-volume retail visitor attraction in the style of Zealandia, certainly not in the first ten years and perhaps not at all. The intention is to maintain it as a premier nationally significant biodiversity site with threatened species and ecosystem restoration as the primary purpose.

Having said that, there will be considerable demand from the public to experience the site in the short term and as species populations build in numbers this demand will likely increase. The arrival of high-profile species such as kākāpō will increase that demand significantly. People will want to get involved in and interact with the sanctuary – which is one of the benefits of it being close to a large population.

It is likely that as soon as the governing body is set up, we will want to offer memberships to gain supporters and donations. We may also want to offer guided tours (similar to those that are run now). Over time the scale and frequency of these may grow and Taranaki Whānui have shown interest in establishing a wharenui in the precincts to showcase their mana and relationship with the sanctuary. This could form the official visitor centre.

Activities and effects

1. Memberships of the trust could be offered to the public. This could become quite popular depending on what benefits are offered and the cost to people. Members would probably be offered preferential and discounted guided tours and preferential access to volunteer activities. Up to 5,000 members could be expected within the first ten years. Apart from rare visits, membership is a very low impact activity. Memberships could be taken as soon as the trust is formed.

2. Volunteer cells could be set-up to assist operations staff and run the guided tours. Volunteers are analogous to staff and would be expected to undergo training and to comply with all health and safety requirements. Up to 100 volunteers could be expected but only a few would be in the valley at any given time. Volunteers would be recruited as soon as the trust is formed and would assist in the eradication.

3. As is currently the case, guided tours would be run. These would involve parties of up to twenty and would be subject to the full health and safety requirements before entering the catchment. Most tours would be to the easily accessible Georges Creek, but a proportion could be day tours to the main valley. At this stage it is guesswork as to when they would start and how many may be needed as it will be demand driven. Guided tours could commence as soon as the eradication is completed but would be restricted so as not to interfere with the eradication and monitoring and water operations.

4. There would be no intention to have freedom walking in the catchment for at least the first ten years. Freedom walking would require the installation of graded tracks, toilet facilities and roving guides and the catchment is so large and the forest so thick that people could easily get lost. It's hard to see freedom walking ever being an option unless it was restricted to the Georges Creek Road.

5. There would be no intention of allowing open access to the perimeter road as neighbours would be unhappy with unrestricted public use of this and it would mean increased traffic through the water collection area. Existing restrictions would apply.

Mitigation

1. Visitation would be kept low and discreet in the first ten years.

2. All visitor staff and volunteers will be trained in stringent health and safety procedures appropriate for a public water supply area. (Similar precautions to those applied now).

3. All visitors would be required to follow existing health and safety procedures and catchment access requirements.

4. Visitors would give Wellington Water an opportunity to raise consciousness and educate the public about water issues.

9. The fence construction

The predator-proof fence will need to be constructed around a 28.8 km route. This will entail the following.

Activities and effects

1. The minor reforming of the existing 12.8 km road on the western and northern boundary and the dismantling of the existing deer fence. This will create only minor disturbance.

2. The construction of a new six-metre-wide road over 16 km on the eastern and southern boundaries. This will mean the clearing of vegetation along the route by heavy equipment (a 12-tonne digger) and the side casting of material, with exposure of bare earth and potential for some temporary silt run-off into the catchments.

3. The construction of a predator-proof fence around the 28.8 km boundary. This will be a substantial construction operation which will last up to one year – possibly with two crews of five or six people operating simultaneously from different directions with machinery.

Mitigation

1. All route and fence construction activities will require a resource consent and Wellington Water will be the primary affected party. WW will have the opportunity to review the programme and request mitigation during this process.

2. Our environmental consultants (Boffa Miskell) advise that the run-off potential is not likely to have a major effect on the water quality as the route is a comparatively small and thin thread in relation to the whole catchment and any effects are likely to be temporary and can be mitigated (see next). Healthy dense native forest captures run-off very efficiently.

3. Roads and fences have been constructed in these catchments in the past, including the western and northern boundaries and the road down to the Orongorongo weir, and no adverse effects have been reported. The 8.6 km road built around the Karori Reservoir in 1999 had no discernible effect on water quality (S. Fuller pers. comm.) and that road is much closer to the Karori dams.

4. Road construction effects can be mitigated by silt trapping, drainage diversion and cement stabilisation where necessary. Construction staff can be required to adhere to strict health protocols and tests. Portable toilets can be required to be used.

Timing

1. The fence construction will be unlikely to get underway inside two years (best scenario) and three years to start is the more likely scenario.

2. Construction needs to be largely over summer and could take over two years to complete if weather or supply delays occur.

10. The pest eradication

While the predator-proof fence is being constructed, work will get underway to eradicate all pests in the catchment. This will entail the following.

Activities and effects

1. The setting out of a monitoring and bait station control grid. This will extend the existing 1,200 ha, 150m X 100m grid to the entire Wainuiomata catchment and tighten it to 75m X 50m. This will take a team of eight working in the catchment for one year. This can be done while the fence is being built.

2. The hunting out of all ungulate herbivores. This will take a hunting team about three months to achieve using dogs. The bulk of this operation will be above the intake and can be managed to minimise impact on water staff.

3. The sowing by helicopter of two applications of brodifacoum anti-coagulant toxin at 20 ppm, each application will be 12kg per hectare to ensure a complete kill. The application will be in winter (July/August). This operation will require the temporary closure of the Wainuiomata catchment water supply for perhaps three months during and after the operation.

4. The mopping up of any remnants which survive the eradication. This will likely include hedgehogs, possums, and rabbits. It could take a team working as required about nine months to clear.

5. The monitoring of pest presence/absence through the operation of the grid. This means as many as forty staff running the lines continuously for three month to detect any remaining animals and loading the grid with toxins or traps if they are found. This activity is scaled down considerably after three months and reduced further to eight to ten staff on site when the catchment is declared ‘all clear’.

6. Our understanding is that the regional water supply currently lacks the capacity to take large components off-line for extended periods of time, especially over summer when water flows are at their lowest (lack of ‘headroom’). This operation would most likely require the catchment to be taken off-line for about three months in winter. This is not very different from what happens with routine aerial 1080 applications.

Mitigation

1. The hunting, monitoring and mop-up activities are similar to what is undertaken now on the mainland island operation, but much more intensive and extended to the whole catchment. Similar precautions as are applied now can be taken for health and safety.

2. As is standard practice for all aerial toxin applications in water catchments, the Wainuiomata catchment will need to be isolated from the Orongorongo catchment and closed for two to three months. The operation will be supervised by the Medical Officer of Health. (MOH).

3. The eradication will use a different toxin (Brodifacoum) instead of 1080. Brodifacoum is a second-generation anti-coagulant and has been used extensively in the mainland island operation in the catchment for many years via ground bait stations. This toxin can only be applied aerially in enclosed areas and has special restrictions on its application as it can persist in the environment longer than 1080 (half-life 12 to 24 weeks) and is insoluble in water. However, it binds efficiently to organic and inorganic material and there is a large and growing body of science which shows that brodifacoum does not show up in detectable levels in water after aerial application. Therefore, it should not affect the ongoing water function which could resume immediately after the MOH gives the all-clear.

4. The eradication will require a permit from and will be supervised by the MOH.

5. The eradication will be a ‘one-off’ operation which hopefully won’t need to be repeated ever. Accordingly, it is probably well worth the temporary inconvenience to reduce the need long term for more toxin application.

6. Our understanding is that within four years the regional capacity and ‘headroom’ problem may have been resolved with new capacity at facilities being proposed at Te Marua. Therefore, the temporary closure of the catchment may not present a problem given the expected timetable in 7 above.

Timing

1. The set up and ungulate eradication operation will commence during the fence construction and the aerial operation will occur immediately after in winter (best scenario) or the following year (worst scenario).

2. The catchment should be declared pest-free about one-year after the aerial operation is completed.

11. Pest-proofing the river

The Wainuiomata River is a relatively fast flowing river which can increase in flow very quickly. At the dam, the river is twenty metres wide and boulder movement occurs in the riverbed. Heavy rain events are common in the catchment. The problem was, how to fence across a fast flowing twenty-metre-wide river where any fence is unlikely to survive the weight of water and gravel/rock movement generated by a flood. Following is the solution developed by Beca engineers.

Activities and effects

1. Construct a pest proof weir across the river at the point of the existing concrete sill (about fifty metres downstream of the dam) where the hard-edge walls still occur in the river. The weir would span the river between the existing walls and would be two metres in height from the riverbed, (to prevent jumping by large animals) bringing it up to the ground level of the riverbanks.

2. The weir would be constructed of concrete, polished at the face to prevent scrambling by small animals with a steel plate overhanging the face (analogous to the fence cap). The weir would be backfilled with stones.

3. A fish ladder would be incorporated to allow small fry unrestricted passage upstream, designed in accordance with MfE provisions for fish passage. This would be a large pipe rising through the weir to the upper riverbed with the entrance covered with mesh and a riddle to allow easy transit of small fry. Larger fish can be trapped and either released down or upstream as appropriate.

4. The weir should have minimal effects on the water supply function as the water is taken out further upstream. If desired a further off-take could be incorporated in the weir to increase the catchment capacity, which would provide a n additional benefit.

5. The weir will require a resource consent to undertake works in a river and Wellington Water would be an affected party.

Timing

1. The weir should be constructed during the fence construction stage.

12. Pest-proofing and discreet entry

Before the predator-proof fence is complete all discreet avenues for pest entry will need to be identified and secured and procedures put in place to ensure that pests cannot invade the catchment. This will entail the following.

Activities and effects

1. The pest proofing of the Orongorongo tunnel. This may mean enclosing the two entrances in a pest-proof mesh cage and instituting strict procedures for access to the tunnels. Also placing bait and trap stations at each entrance.

2. Identifying and pest proofing (with mesh) all pipes and other potential accessways to the catchment.

3. Instituting strict biosecurity procedures for vehicles or persons entering the enclosed area (bag searches and vehicle inspections).

4. Maintaining a pest control regime in the environs outside the fence and raising the consciousness of all who visit or work in the area.

5. Most of these will mean minor disruption to the freedom of the staff to operate in the area.

Timing

1. The pest proofing should be done when the fence is finished and the biosecurity arrangements when the eradication is complete.

2. Our understanding is that the tunnels are not critical for the water staff and their routine operations and are maintained largely for resilience and heritage reasons.

13. General operations inside the fence

After the predator-proof fence has been constructed and the eradication complete, ongoing work will be required to ensure the catchment remains pest free and to restore species to the enclosed area. This will entail the following.

Activities and effects

1. Staff will be required to check the fence every week by vehicles and respond to any callouts which indicate there has been a breech, say for a tree falling on the fence. In the instance of a confirmed breech, they will then institute traps and bat stations in the proximity and attempt to confirm that no pest is present. If a pest is found, then the grid will need to be triggered until it is caught. Dogs may be used to track pests.

2. A team of up to ten operations staff will be working in the enclosed area. Most of them will be in the catchment every day performing such tasks as servicing the monitoring grid, weed control and maintaining the fence, and tracks.

3. Periodically there will be species releases, (four or five each year for ten years) many of which will be public affairs with iwi welcomes and visitors. After the releases the staff will monitor and manage the fauna including maintaining feeding stations in some instances.

4. Teams of volunteers will be recruited, trained and deployed to assist the staff in the more routine tasks.

5. The sanctuary operation and water supply operation will mean two substantial operations working in roughly the same location. This would require a substantial level of co-operation

and goodwill from both parties. Most of the actual work activities will be conducted in quite different spaces so this should be able to be accommodated.

Mitigation

1. The staff and volunteers will be trained in stringent health and safety procedures and access requirements appropriate for a public water supply area. (Similar precautions to those that are applied now).

Timing

1. The ongoing pest and species operations will merge with the eradication as soon as the catchment is declared pest free (about one year after the aerial operation).

14. Pest operations outside the fence

After the predator-proof fence has been constructed and the eradication complete, work may be instituted to take advantage of the migration of species from the valley in due course. It would be desirable if the habitat that the species migrated to were managed to increase the likelihood of populations establishing outside the fence and expanding their range over time.

The Orongorongo catchment is already managed through periodic aerial 1080 applications and by hunting. Some trapping work is also undertaken. It is envisaged that this work will continue and may expand as the forest health of the Orongorongo is important to water quality. At this stage there is no intention to expand the managed area much beyond the immediate surrounds of the fence but Predator-free 2050 Ltd have shown interest in a predator-free style landscape management programme and it is logical that in due course this will happen. If this occurred, the following may be possible in the Orongorongo/Remutaka and neighbouring land (such as Brookfield) where landowners are willing to allow it.

Potential activities and effects

1. Fence patrolling. As in 13.1 above, staff will be required to check the fence every week by vehicle and respond to any callouts which indicate there has been a breech. This will involve vehicles on the road and activities if a breech is detected, which could happen as often as once a week. Although there is no intention to allow public access to the road (existing restrictions would apply), it may be useful to recruit volunteers to do this task via bicycle or quadbike.

2. A grid of bait stations and traps could be placed around the perimeter to capture pests before they approach the fence. There is debate about the value of this and how deep the grid would have to be – 100m X 300m depth has been proposed. It would be prudent to keep this option open at this stage.

3. Periodically there would be aerial toxin operations in the Orongorongo, and regular hunting operations as is the case now. Trapping is conducted in the Remutaka now by the Remutaka Conservation Trust to protect a kiwi population. If a predator-free operation were instituted, then a comprehensive trapping grid would be set-up and maintained and aerial toxin applied across a wider zone, more frequently and probably at higher rates. The Orongorongo is much more rugged and inaccessible than Wainuiomata and would need a different approach. However, it would be valuable science to compare the two regimes and their respective effectiveness over time.

Mitigation

1. The staff and volunteers will be trained in stringent health and safety procedures appropriate for a public water supply area. (Similar precautions to those that are applied now).

Timing

1. The ongoing pest and species operations will merge with the eradication as soon as the catchment is declared pest free (about one year after the aerial operation).

2. An extended predator-free operation is unlikely to get underway inside five years.

15. Facilities

The sanctuary will require a range of facilities and equipment to enable the operation.

These include the following.

1. An office and reception centre for the General Manager and her/his staff, with meeting room.

2. Accommodation for permanent duty staff.

3. A substantial field base for the operations staff (up to ten) which would include garaging for up to six vehicles of varying size, substantial storage for a wide range of equipment and materials, a first aid station, staff toilets, and a rest and a gathering area.

4. A volunteer training and gathering base where volunteer equipment could be stored. Ideally a little separate from the staff facilities.

5. A facility to provide for handing of and emergency treatment for fauna.

6. Longer term (after ten years) land may be required for a wharenui and/or visitor facilities and additional staff facilities.

There are many existing facilities on site which may be surplus to Wellington Water and GW requirements, or which could be repurposed for the sanctuary to take over from WW or GW. These include the existing rangers base and rooms, the storage shed and three houses. There also appears to be other surplus buildings which could be allocated for use by the sanctuary. The area also appears to be generously endowed with surplus land which could be used for new facilities if the existing items are inadequate.

A discussion will be needed with Wellington Water and GW to determine which assets are surplus and could be allocated to the sanctuary.

16. Costs for the water supply

The sanctuary will not incur any additional costs for the water operation. All developments are expected to be funded externally and the sanctuary management will bear the costs of the new operations.

Currently Wellington Water pays half the salary and costs of the resident Park Ranger and shares some costs for the upkeep of the area. This arrangement should continue through a service level agreement.

17. Can a sanctuary be run in conjunction with the existing and future water supply function?

The above can be summarised as follows.

1. There are significant long-term advantages and benefits for the water supply if the area is managed as a pest free sanctuary, including a cleaner environment, healthier forest, less use of poisons in the long run, public education about water and improved access. The development will reduce source water risk.

2. The main disadvantage for the water function is a two-year fence and road construction period which will cause vegetation loss and disturbance, the need to close the catchment and water supply for the aerial toxin operation (a one-off event) and greatly increased sanctuary staff activity in the catchment during the grid set-up, fence construction, the eradication and post operational work. Most of these are shorter term and appear able to be accommodated.

3. Long term (after five years) a pest control/monitoring/incursion response programme and species restoration programme will require significantly increased and permanent staff activity.

4. The potential of a visitor programme brings a potentially higher level of impact and will require further discussion as the sanctuary develops but in the early stages it should be manageable and also be able to work in with the water function.

The provisional conclusion is that the two operations should be able to function efficiently together, but that it would require goodwill all round, close co-operation, negotiated service level agreements and mutual understanding of each operation's needs.

18. What is needed from Wellington Water and next steps?

The above is submitted for your consideration and response. We understand that it will be referred to the Potable Water Committee for their consideration. It would be excellent if we could have a response by **late September** so Wellington Waters views and position can be included in our feasibility report. May I suggest the following process?

1. This paper is submitted for your consideration.

2. We could arrange a presentation and discussion with the Potable Water Committee as soon as practical.

3. At this meeting we can clarify any fine points and discuss matters of concern.

4. The committee can then decide what their response to the proposal can be.

This paper is submitted to you accordingly.

Wayne O'Donnell. GW General Manager Catchment Management.

James R. Lynch QSM. Feasibility study Project Advisor

4th October 2021

APPENDIX G:

The Fence Route

Wainuiomata Sanctuary Feasibility Study

Paper No:	**Appendix G**
Title:	**The fence route**
Date:	**20th September 2021**
Author:	**James Lynch** Project Advisor
Reviewed by:	**Stephen Fuller** Boffa Miskell**; Paul Wopereis** Beca

1. Introduction

The assumption is that there is a viable route along which the catchment can be fenced and that the loss of vegetation along the route is an acceptable trade-off. This assumption was based on a provisional route taken from maps and local knowledge by GWRC staff.

Questions to be answered include.

1. What is the best route to accommodate a fence?
2. What environmental issues, losses and gains with the proposed fence route?
3. What issues are there with neighbours?
4. Can a resource consent be obtained for the fence route?
5. What are the costs and risks of the proposed fence line route?

2. Background and precedents

In 1999 Zealandia built the first multi-species predator proof fence in New Zealand (Campbell-Hunt D and C, 2013. Ecosanctuaries). Since then, fourteen significant fences of similar design have been constructed for a mixture of private, NGO and LTA eco-sanctuaries. The largest of these ring-fenced eco-sanctuaries is Maungatautari at 3,400 ha which is the same scale as Wainuiomata. Seven of these are ring fenced and seven are peninsula fences. The ring-fenced sanctuaries have been spectacularly successful in enabling the return of extremely sensitive fauna such as tieke, hihi, kiwi pukupuku, tuatara and giant weta[1].

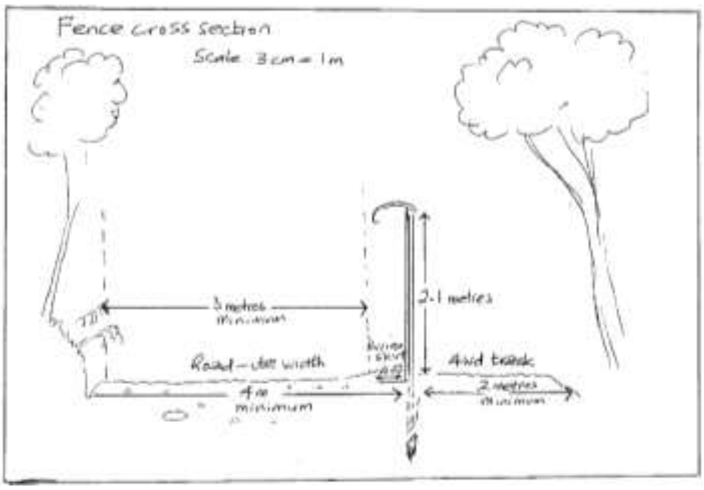

Figure 1 Typical fence cross section

Fencing requires a roadbed (generally six-metres width) which is graded and configured to (ideally) allow water run-off away from the fence. The fence is placed on the inside of the roadway as in figure 1 to allow vehicle access for maintenance. Vegetation must be cleared back from the road to prevent jumping and to reduce the chances of windthrow on the fence.

Where the gradient is too steep, the access road can sidle away from the fence line or be cut narrower than six metres and pedestrian access provided. Slopes of up to 45 degrees can be accommodated

[1] Innes J, et al. (2019). New Zealand ecosanctuaries: types, attributes and outcomes, Journal of the Royal Society of New Zealand.

depending on the stability of the slope. On long boundaries, turning bays must be provided.

The underlying geology of the route is important to ensure stability. Stable ground is needed to found the posts and unstable sections may need to be retained. Very hard rock will require rock drilling for post holes and increases costs. Ridge lines are an important element in route placement. Ridges are generally less steep than sides and drainage is more easily managed. Ridgelines tend to have less dense vegetation but are also more exposed to weather.

Predator-fencing has been in existence for over twenty years and there is a substantial body of experience in the field to draw on. It can be assumed to be a proven technology. Matters of feasibility for a route now hinge on such things as slope, ground stability, vegetation loss and accessibility.

3. *The Wainuiomata catchment*

Wainuiomata is a complete catchment, being the headwaters of the Wainuiomata River. It has natural and accessible ridgelines on the western (Moore’s Valley), northern (Whiteman’s Valley), eastern (Orongorongo catchment) and southern boundaries and a fast flow river at its entrance. There is an existing road and deer fence (built 2005) which runs for sixteen kilometres along the western and northern boundaries. This existing road has roughly the same qualities that a predator proof fence requires and will only require some tidying up to make it fit for purpose.

The eastern and part of the southern boundaries run along substantially forested ridgelines with about 1.7 km of existing road which is part of the road that gives access to the Orongorongo River and water works. The ridgelines are generally of moderate slope (up to 20 degrees) with occasional steep sections (up to 30 degrees) and some very steep sections (over 30 degrees). It is the eastern and southern boundaries and the escarpment up to the western boundary (fifteen kilometres) which are most at issue as these sections will require a new road. See Figure 2 for a view of the whole catchment with the proposed route and associated features,

4. Feasibility of the proposed fence route

The fence route in the original concept plan[2] was plotted by GW staff from topographic maps and local knowledge of the area. This envisaged using the sixteen-kilometres of existing roads and cutting a new fifteen-kilometre route down the eastern and southern ridges. Some concerns had been noted regarding the loss of potentially valuable vegetation on the ridgelines, calculated as about nine to ten hectares. To cross the river and return to the western ridge a long switchback was proposed using the existing roads to the western ridge. This was put forward to avoid what looked like an impossibly steep section up the scarp below the Morton dam.

In October 2020 Boffa Miskell and Beca staff were commissioned (pro-bono) to undertake a provisional survey for the proposed route to determine its feasibility. This involved a walk over the entire route noting any difficulties and issues but not doing a complete survey. Their provisional opinion was that the route could be roaded and fenced. A potentially more efficient route up the western scarp was noted but not surveyed.

In April/May 2021 Boffa Miskell and Beca carried out a complete survey of the proposed route to determine its feasibility and to provide enough base data for specifications for fence contractors to supply indicative prices. They looked particularly for the following.

- The necessary width of maintenance track and fenceline formation (note we believe a minimum width of six metres is possible along much of the alignment which will minimise clearance and earthworks volumes).
- Excessively steep slopes (≥ 24 degrees) where vehicle access won't be possible with a particular focus on the steep to very steep ascent from the Wainuiomata River to the Western ridgeline.

[2] Lynch, JR. (2020) The Wainuiomata Project. Proposal to GWRC.

- Exposure of the fence to damaging winds (on the site visit winds were gusting up to 80km/hr)
- The substrate (hard rock, weathered rock, clay) and how this will affect fence construction methods.
- The potential impact of side-casting of overburden and how to minimise effects.
- The potential impact of sediment runoff from works into adjacent headwaters and how to minimise this.
- Possible alternative routes from the eastern ridgeline to Morton Dam.
- Methods for crossing of the Wainuiomata River below Morton Dam.
- Operational issues related to installation and operation of gates in the fence for GWRC staff and Wellington Water.
- The likely need for turnaround areas for vehicles along the fenceline.
- Potential boundary issues along the northern and western fencelines.
- Separation of the proposed fenceline from the Whakanui track.
- The loss or modification of beech and kamahi forest along this alignment and the measures that could minimise this loss.
- Potential edge effects of forest along the fenceline and how these can be mitigated.
- The quality of potential lizard habitat that will be affected.
- They also visited the Orongorongo River headwaters and a beautiful natural wetland on river terraces adjacent to the stream1 to confirm that effects on these significant features can be avoided during construction.

Two comprehensive reports were obtained as follows.

1. Geotechnical and Survey Input to Proposed Fenceline. Beca. (June 2021). Paper attached as Appendix H.

2. Ecologist Report Boundary Fenceline. Boff Miskell. (June 2021). Paper attached as Appendix I

Boffa Miskell reports as follows.

> "Overall, we conclude that, while there are some unique construction challenges, there are design solutions for each. The issues for some of these challenges will primarily be one of cost.
>
> "We also confirm that the route provided to us is the best alignment, subject to minor adjustments that account for slope and width of the ridgeline and the need in some locations to separate the maintenance road and fenceline for a distance".

BECA reports as follows.

> "Although there are challenges in building a predator proof fence and a stream crossing structure the building of these structures is considered feasible. Management of risks that are related to natural hazards is also considered feasible.
>
> "Detailed design will be necessary and additional work will be required to support a resource consent application for the proposed Wainuiomata Sanctuary".

The route was completely mapped and measured and a comprehensive assessment with issues noted has been provided with the report.

The recommended route

The final route recommended is shown below in figure 2. See the Boffa Miskell report for a detailed description and the Beca report for geological and construction issues. The route recommended is

28.8 kilometres in length and encloses 3.313 hectares. The existing road (with deer fence) can be utilised along a length of 12.76 km. A new road is required on sixteen kilometres of the route on the eastern and southern boundaries.

The switchback in the original route has been found to be unnecessary as a viable route was found running directly up the western scarp. This is very steep for 250 metres but then flattens off considerably. This section will be too steep for a vehicle road and will need to be cleared of vegetation and left as a pedestrian service route only. This section should have as little surface disturbance as possible.

Conclusions

The conclusion is that there is a viable route of 28.8 kilometres for a predator proof fence enclosing 3,313 ha of the Wainuiomata catchment. While there are challenges, the solutions are primarily a matter of design and costs.

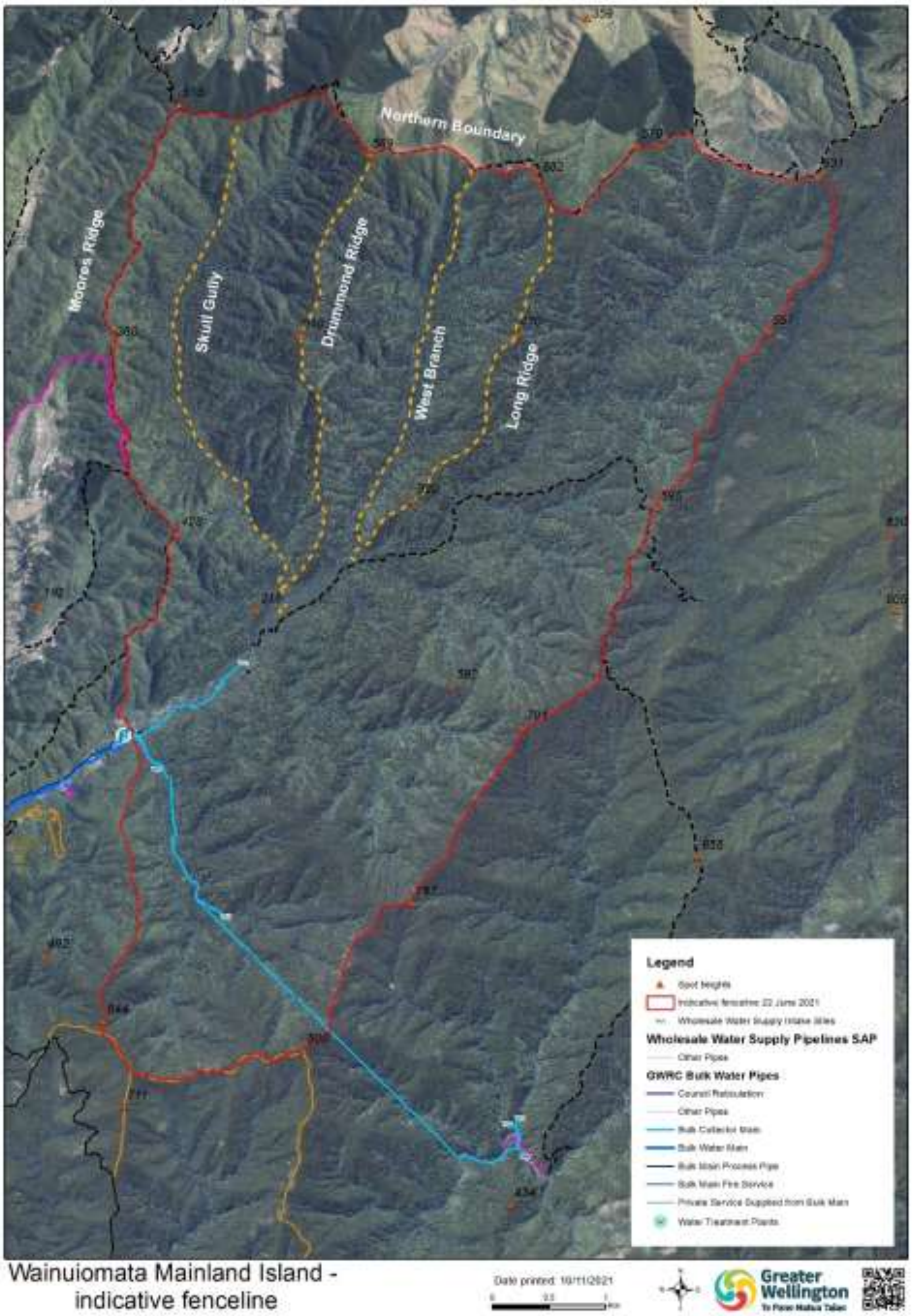

Figure 2. Wainuiomata and associated features with fence route. Map GW.

5. The river crossing

A major challenge is, how the Wainuiomata River is crossed without allowing a pest entry point. Almost every fenced site has to confront the issue of how to cross and secure watercourses. Some places have many watercourses. Wainuiomata is fortunate in having only one water course to navigate, albeit a large (twenty-metres wide) and sometimes wild one.

The solution proposed by Beca engineers is to construct a weir in the riverbed which will be both predator-proof and still allow flood control and fish passage. See Paper, 'Pest proofing the Wainuiomata river'. Lynch JR, (Sept 2021). attached as Appendix J, for details and probable costs. Note that this solution is a concept only and detailed engineering design, costings and resource consents will be required for the river crossing. The extent of this work was outside the scope of this study.

Conclusions
The conclusion is that crossing and pest-proofing the Wainuiomata River via a weir while retaining fish passage is challenging but feasible. This is subject to detailed design and costings and the granting of a resource consent for the works,

There are risks involved but the solutions are primarily one of additional costs, or in the case of the fish passage, good design.

6. *Effects on neighbours*

The catchment has six private landowners as neighbours on the western and northern boundaries and public owners on the eastern and southern boundaries.

An assessment of neighbour issues was conducted by the Park Ranger. See paper by Clarkson R and Lynch JR, (September 2021). Neighbour issues. Attached as Appendix K.

The conclusions of that assessment are as follows.

1. The number of affected private landowners (six), all on the northern and western boundaries, is comparatively low. Good relations have been maintained between these neighbours and GW over time and goodwill is high.

2. In general, they are favourable towards the project and seem willing to support it – providing the existing access arrangements can be maintained.

3. The private owners obtain an advantage from the existing road which allows them access to the rear of their properties without any cost to them.

4. The major issue involves the mostly informal transgressions along this boundary where the road crosses onto private land, which occurs in approximately seventy places in total. Many of these are minor but several are quite significant.

5. It is not certain just how accurate the existing boundary data is and ideally the western and northern boundaries should be re-surveyed before the fence is built. This would provide an accurate picture of the full extent of the transgressions before the fence is built. However, this may not be necessary if the most recent survey is adequate and existing arrangements can be maintained with neighbours.

6. After the boundary has been clarified, the existing route should be scrutinised to identify where the road can be reformed to avoid transgression on neighbouring land. If this can't be avoided, then agreements should be obtained regarding use of neighbour land which can ensure the security of access long term.

7. Existing restrictions on public access to the roads should be maintained.

7. Effects on the environment

During the surveys the ecologists and engineers took particular note of the potential environmental effects and how they could be mitigated. Following is a summary of those potential effects.

Vegetation loss
Cutting a road route will require vegetation clearance along approximately 15.5 kilometres of the eastern, and southern boundaries. This will result in the loss of approximately 9.5 hectares of forest. The majority is mature beech, kamahi, or kanuka forest with some regenerating rewarewa. The route will involve the loss of some stands of old growth beech on the eastern ridge. The proposed route can avoid almost all of the few old podocarp and rata trees, all of which have been LIDAR mapped.

The opening up of a route corridor may increase the risk of windthrow. Windthrow prone trees will need to be trimmed back or taken out.

The mitigation for vegetation loss is to minimise the loss of big trees by designing the final route to skirt these where possible. The primary mitigation is the overall benefit and biodiversity gain which the fence will provide for the rest of the catchment. the region and the nation.

Disturbance of rare habitat
The route comes close to the Orongorongo wetland in the north-eastern section. This is a rare and well-preserved montane wetland and care should be taken to prevent disturbance. The route can be designed to avoid it and measures can be taken to prevent siltation and run-off into the wetland during the road construction. (See side casting).

Otherwise, the habitat disturbance will largely be ridgetop beech and kamahi forest which is not a rare habitat in the area. No other special populations or habitats were identified in the survey.

Soil and substrate disturbance
The cutting of the route will involve the exposure of soil and substrate with the attendant risk of erosion and run-off. There are some light clay colluvium soils which will be prone to run-off and to causing sedimentation. However, most of the route consists of weathered or hard greywacke which is more stable.

These effects can be mitigated by optimising the construction methods to minimise run-off and sedimentation. (See side casting).

8. Side casting

Side casting is a process whereby excess soil and substrate is placed to the side of the road during construction and left there. Side casting can result in undue run-off and sedimentation if not managed well. Side casting has been standard practice in road construction in steep and remote areas but latterly consents have required ‘end-hauling’ where excess spoil is trucked off-site to a clean fill location.

A half-way house could be called ‘cut, place and care’ where the road is constructed in the following manner.

1. The cutting crew fells all the vegetation on the route.

2. The vegetable matter is mulched on the ground and stored on site. This will prevent debris clutter around the road. Note. Quite large trees can be mulched.

3. Valuable timber sticks are set aside for later extraction.

4. The road crew cuts and fills behind as required to create the roadbed using as much spoil as they can. Large stumps are extracted and placed off the road.

5. Excess spoil is placed to each side and battered carefully. Some spoil is retained on the road to cover the fence skirt.

6. The saved mulch is then placed over the edge and batters. This rots down quickly, reduces the chance of run-off, prevents debris clutter, and retains the biomass in the environment. The batters revegetate quite quickly.

7. In especially sensitive areas e.g., near the Orongorongo wetland or above stream heads, side casting is avoided. Hessian silt traps and other methods can be put in place elsewhere. These hold the material against storm event run-offs and are organic and rot down over time.

8. The geologists report details what methods should be used for road construction in this ecologically sensitive area.

All existing roads in the water collection area would have been side cast without any thought for the environment and the method described above is many times more environmentally safe than what was done before and is standard practice in environmentally sensitive areas.

Road contractors have advised that trucking out the spoil is impractical and would likely double the cost as a start point (if it can be done). Spoil dumps are unlikely to be available on site or in the catchment which means a clean fill site would need to be found off-site. The nearest may be the Wainuiomata tip which is ten km away from the ridge road.

The damage that end-hauling would cause would far outweigh any effects of leaving it on-site. It could require a wider road (and more vegetation loss and end-hauling), temporary dump sites at risk from storm events and thousands of truck trips up and down a very difficult road. The existing road won't be able to carry that amount of heavy traffic and getting even medium sized trucks up and down the very steep access road would be a serious safety risk. Hauling would create a huge amount of carbon emissions and unnecessary landfill.

A contractor has estimated that to end-haul all the material from the road to a clean fill site would involve up to 18,000 truck trips and cost as much as $3.2 million – twice the cost of the road itself.

The conclusion of our consulting ecologists, engineers and road contractors is that end-hauling for this site is not a realistic option.

9. Consents

Resource consents will be required for the various works identified here as follows (as advised by GW consents staff.

- Consents will be required from both GWRC and Hutt City Council (HCC).
- The HCC district plan has designations over this area –HCC will need to be contacted to discuss the requirement for, or application for a waiver of, an outline plan.
- Step by step methodologies are required for all works
- An Assessment of Environmental Effect (AEE) for any consent applications will need to clearly set out the mitigation hierarchy regarding any actual or potential effects of the activity: 1. Avoid 2. Minimise (mitigate, moderate, reduce, alleviate) 3. Remedy (rehabilitate, restore, reinstate) 4. Offset
- A mana whenua assessment is to be prepared by a suitably qualified and experienced person before lodgement of the consent application.
- All earthworks relating to fence construction, new road formation and existing road reforming must have an erosion, sediment control and stabilisation plan prepared before lodgement of the consent application by a suitably qualified and experienced person.
- The general provisions are to avoid side-casting material altogether – the earthworks should be planned in a way that cut and fill volumes are balanced, or material is end-hauled to a suitable fill site. (But see '8 Side casting' above.)

- Vegetation clearance will require consent from HCC –an assessment of effects will be needed, prepared by a suitably qualified and experienced person before lodgement of the consent application.
- A consent will be required to do works in the river for the weir. Consent applications will need to demonstrate how this allows for flood flows and will protect against erosion and scour, also how this structure will comply with NIWA's 'New Zealand Fish Passage Guidelines for Structures up to Four Metres'.

Apart from the side casting provisions, the above should be able to be accommodated in design and planning without difficulty. The costs of obtaining these consents and the time it will take will be factored into the final pricing. Indicative pricing by contractors has allowed for the works to be conducted in an environmentally responsible way but not for end-hauling.

10. Costs

Indicative prices (on 2021 costs) have been obtained from two local road contractors for the new road on the eastern and southern boundaries; a distance of fifteen kilometres. These prices vary considerably and range from $106 per metre to $150 per metre.

This makes the indicative costs of the new road between $1,600,000 and $2,300,000.

The indicative prices (on 2021 costs) for reforming the existing 12.8 km road on the western and northern boundaries and dismantling the deer fence range from $6 per metre to $9 per metre.

This makes the indicative costs for the old road between $77,000 and $115,000.

Road design and construction supervision by the ecologists and engineers needs to be allowed for. The sum of $200,000 has been allowed for this.

The costs of the river weir cannot be calculated until detailed design is completed but a PC sum of $750,000 should be allowed. This would allow engineering design, supervision, and construction but not resource consents (see below).

Costs to obtain the required resource consents as outlined above are difficult to assess and will depend on whether the consents are non-notifiable or notifiable. A PC sum of $200,000 should be allowed for consents. This would include consulting ecologist fees for preparing an AEE.

Contractor pricing detail is not included (to protect commercial rights) but are available to view on request.

For bidding purposes, the highest indicative prices have been used. This makes the full costs of the road and weir as follows.

• New road design and supervision fees	$ 200,000
• New road construction	$2,300,000
• Reforming of old road & deer fence dismantle	$ 115,000
• Weir design, supervision, and construction	$ 750,000
• Resource consents -road and weir	$ 200,000
Total	$3,565,000

Note. Contingencies have not been included as 15% contingency will be applied to the whole project costing and the highest indicative price has been included.

11. *Risks*

The following major risks to constructing the fence route have been identified.

Risk	Significance and likelihood	Contingency
Resource consent requires end-hauling	Highly significant and moderately likely	Argue against it. This would be impractical and may result in the abandonment of the project.
Consent process slows the project down	Significant and likely	Early investigation of and discussion with GW, HCC and partners on all the issues. Seek a non-notifiable process.
Costs increase above indicative prices and estimates due to inflationary and high demand factors in the economy and lag times to start construction and resource consent requirements.	Significant and likely	Allow contingencies in costings. (15% Allowed on whole project)
Neighbour issues prove difficult to resolve.	Significant and possible	Engage in early dialogue and agreements.

These risks are considered acceptable and manageable, provided end-hauling isn't required.

12. *Summary and conclusions*

The conclusions of this part of the study are as follows.

1. There is a viable route of 28.8 kilometres for a predator proof fence enclosing 3,313 ha of the Wainuiomata catchment. A new road of 16 km length will be required on the forested eastern and southern sections. While there are challenges, the solutions are primarily a matter of design and costs.

2. The neighbouring landowners who could be contacted are in favour of and support the project. Issues include the road intruding on private property in many places and the need to restrict public access (as is the case now). These issues can be resolved with goodwill.

3. Crossing and pest-proofing the Wainuiomata River via a weir while retaining fish passage is challenging but feasible. This is subject to detailed design and costings and the granting of a resource consent for the works. There are risks involved with the weir, but the solutions are primarily one of additional costs, or in the case of the fish passage, good design.

4. There are adverse environmental effects in building the new road including the loss of nine to ten hectares of primarily beech, kamahi and kanuka forest, risks to the Orongorongo wetland and soil and substrate disturbance.

5. Consents will be required from GW, HCC and DOC for the road works and the weir. All provisional conditions appear to be able to be accommodated. The key consideration for securing consent for the earthworks will be erosion and sediment control. Methods for immediate stabilisation will be required given the ecological sensitivity of the catchment.

6. Costs for the road, weir and consents are assessed as up to $3,565,000. This includes all design and consent fees, and the dismantling of the existing deer fence.

7. There are significant risks arising from the resource consent requirements, the potential for cost increases and neighbour issues. Most risks appear to be manageable.

James R. Lynch

Project Advisor

13. References

Beca. (June 2021). Geotechnical and Survey Input to Proposed Fenceline. Attached as Appendix H.

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Innes J, et al. (2019). New Zealand ecosanctuaries: types, attributes and outcomes, Journal of the Royal Society of New Zealand.

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Clarkson R and Lynch JR, (Sept 2021). Wainuiomata Feasibility Study. Neighbour issues. Attached as Appendix K.

APPENDIX H:

Geotechnical and Survey Input to Proposed Fenceline

Beca

Appendix H.

By:	Paul Wopereis and Sarah Duggan	**Date:**	15 June 2021
Subject:	Wainuiomata Sanctuary - Geotechnical and Survey Input to Proposed Fenceline	**Our Ref:**	Rev 1

1 Background

The proposed Wainuiomata Sanctuary is entirely within the Wainuiomata River Water Supply catchment area managed by Greater Wellington Regional Council (GWRC). The sanctuary covers an approximate area of 3100 hectares and will have a perimeter fence 28.7km long.

A field inspection was carried out by Paul Wopereis (Beca engineering geologist) and Sarah Duggan (Beca surveyor) over the weekend of 21 -22 November 2020 as part of a team of nine people including Boffa Miskell and GWRC staff. Part of the route was inspected by walking (east and southern sections) and part by 4WD inspection (northern and western sections).

An additional geotechnical inspection was carried out by Paul Wopereis on 7 May 2021 for the route of the crossing of the Wainuiomata River and the proposed route of the fence up a slope northwest of Morton Dam above the river. Will McGuire (Beca senior civil engineer) also carried out an engineering inspection on 7 May 2021 of the proposed river crossing site located approximately 50m downstream of Morton Dam.

Discussions on fence construction, access for equipment/machinery and the river crossing were carried out between Paul Wopereis (Beca), Stephen Fuller (Boffa Miskell) and Ricky Clarkson (GWRC) during the inspection trips. Jim Lynch also guided these discussions on technical aspects at team meetings.

2 Geology

The underlying geology is predominantly greywacke and minor argillite, being typical rocks of the Wellington area. The rocks are part of the Rakaia terrane, Torlesse Supergroup. The fence route passes over strong unweathered grey rock on parts of the north and east sections. Elsewhere the fence route passes over moderately to highly weathered rock and areas with clay colluvium soil cover. Thin topsoil (generally 100 - 200mm thick) is present on forested slopes along the ridgelines.

There are no mapped active faults in the project area.

3 Slope Stability

A review of Google Earth imagery and aerial photographs did not reveal deep-seated landslides within greywacke bedrock. The pattern of prominent ridges and gullies indicates that the present topography is a result of a combination of slow uplift of the ranges and progressive downcutting by streams. Shallow slips involving colluvial soils were noted on some steep slopes and are most likely to have occurred as a result of saturation of soils after heavy rain events. Some older slips may have occurred during the large earthquake on the Wairarapa Fault in 1855.

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4 Natural Hazards

The most significant natural hazards are likely to be heavy rainstorms, floods, damaging wind, slips and treefalls.

The ridgeline along the route of the proposed fence is subject to strong winds especially from the westerly quarter and wind loadings on the fence will need to be considered as well as risk from treefalls onto the fence. It is advisable to build a short section of fence on the ridgeline to test its ability to withstand winds. Several old treefalls were observed along the eastern ridgeline and the risk of treefall onto the fence would have to be accepted as this risk cannot be entirely avoided or mitigated. It will be important to have replacement materials for the fence to be on hand for rapid repairs.

The Wellington region is subject to a high earthquake risk. Strong earthquake shaking could result in minor damage to sections of the fence, access roads or to the river crossing structure.

Liquefaction and ground rupture are considered unlikely due to the nature of the geology.

Slope instability has been observed on some steep slopes and could impact on the fence on steep slope areas, however the fence can readily be repaired if this event was to occur. Soil creep was noted to have observed at a few small areas of the existing deer fence along the northwestern boundary.

5 Fence Construction

It is proposed that the predator proof fence will require a minimum width cleared horizontal corridor of 6m. Fence posts of treated timber poles will support the fine mesh fence and will be embedded at least a minimum 600m deep into competent ground (either rock or stiff colluvium). The fence will be approximately 2.3m high and with an overhanging metal hood (top hat) to prevent entry of pests. Installation of the posts will depend on the type of ground and is likely to be by the following three methods:

- Driven posts where the ground is topsoil underlain by soft – firm clayey colluvial soils and without rock (using a post hole driver mounted on a tractor).
- Augered post holes where the ground is stiff clay and/or weathered rock (using a 7 – 12 tonne excavator with a post hole auger).
- Drilled post holes where the ground is strong unweathered rock (using a rock drill).

It is proposed that the fence will include a 400mm wide buried fence mesh skirt on the inside of the fence to prevent burrowing and this skirt will be buried with a minimum of 150mm thickness of compacted fill. If tuatara lizards are to be released into the proposed Wainuiomata Sanctuary, then addition of lime or cement stabilisation will be required to harden the fill and prevent burrowing near the fence.

The fence requires a stable foundation corridor to be cut into natural ground or constructed out of compacted fill.

An existing deer fence along the western ridgeline will need to be progressively removed prior to construction of the new predator proof fence.

The main earthworks for the fence line could be carried out by a zero-swing 12 tonne excavator using a toothed bucket to remove soils and rip the rock as required. An excavator has an advantage over a bulldozer in that it has more precision to cut and place material and minimise unnecessary damage to trees, roots and sub canopy vegetation along the edges of the fence corridor. A zero-swing excavator

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does not have a protruding rear counterweight extending beyond the tracks so it can operate more effectively within a tight corridor and is less likely to damage trees on the edge of the fence corridor.

Where the boundary ridgeline is narrow the ridge may need to be partially cut down in order to achieve the minimum required corridor width of 6m. In some cases the sidecast fill will be placed on the edges of the fence corridor. The fill will need to be either clayey colluvium or a mixture of colluvium and rock and will need to be compacted and not placed on side slopes steeper than 2H: 1V (27 degrees). Topsoil and tree roots will need to be removed before placing sidecast fill. Compaction can be achieved with a small drum roller or a plate compactor in order to minimise the risk of soil creep, settlement or slipping of the fill on side slopes.

A few fill disposal areas may be required near to the fence for any surplus fill. These could be placed in agreed locations for vehicle turnaround sites.

In environmentally sensitive areas (e.g. near wetlands) no sidecasting of fill should occur on slopes above these areas, in order to eliminate the risk of sedimentation.

Silt fences and cut-off swale drains can be used to mitigate the risk of erosion and rilling on steep slopes of exposed soils and clay along the fence corridor.

Overhanging vegetation and cutting of side limbs on trees will be required to prevent predators jumping into the sanctuary from outside.

6 Access

Access for 4WD vehicles will be required for construction and ongoing maintenance of the fence. It is proposed that there would be a 3.5m wide all-weather vehicle access road alongside the fence. This will require gravelling with road metal or crushed rock on areas of clayey ground. Broken rock from on site can be crushed and placed as roading aggregate to reduce the need to bring in screened road metal.

On the inside of the fence there should be enough width to allow inspections and access by quad bike.

Where the fence runs down slopes that are too steep for a 4WD utility vehicle the road access route will need to be cut away from the fence and detour around the slope by traverse or by zig-zag to regain the fence corridor.

The steepest part of the proposed fence route is up a slope of 30 - 40 degree above the Wainuiomata River crossing near the Morton Dam and up to the western perimeter ridgeline. This will present special challenges during construction and may require winching of materials and equipment. Inspection and maintenance of this section of fence will need to be on foot as it will be impossible to provide complete road access.

All existing 4WD roads and tracks with the Wainuiomata Project area will need to be maintained.

Predator-proof gates and access hatches are be created on the fence where needed.

A water pipe tunnel that brings water from the Orongorongo River will also need to be predator proofed.

7 Drainage

It is important that whenever possible the fence is constructed on the crest of the catchment divide and avoids side traverses of slopes. Drainage of stormwater and associated sediment run-off across the fence must be avoided.

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The camber of the access road beside the fence should be slightly outwards sloping away from the fence.

Where the access road has cuts beside it there should be a roadside swale drain at the toe of cut batters to ensure drainage of the road surface.

Existing access roads within the sanctuary will need to have maintenance works to ensure proper drainage and repairs as necessary.

8 Sediment Management

An erosion and sediment control plan (ESCP) will be required to minimise the likelihood of sediment run-off into streams. A range of options would likely include silt fences, cut-off drains, floc socks, hydro-mulching, planting of ground cover, geosynthetics and small sediment ponds. Each option would be appropriate to the situation and the location it would be used in.

Earthworks could be carried out using an "adaptive management plan" that allows flexibility and is not overly prescriptive.

9 River Crossing

It is proposed that the Wainuiomata River will be crossed by bringing the fence to the edge of the concrete outlet channel approximately 50m downstream of Morton Dam and installing a new weir approximately 2m in height to be constructed in the channel. The weir will have an overhanging lip and will be designed to prevent entry of predators whilst passing all flood flows. The weir will also incorporate a fish passage on one side that will be designed to be predator proof.

Will McGuire, Beca senior engineer, will provide the design for this weir and associated works.

10 Boundary Considerations (Legal Survey)

The western side of the proposed fence route bounds private property and has a deer fence along it. Due to the age of the underlying surveys the boundary will need to be defined by survey to ensure the new predator proof fence is not constructed over the legal boundary.

Where the 4WD access track along the fence diverges into private property an easement over the track is recommended. It is noted that the existing access track currently diverges onto private property and we are not aware of the current agreement to use this track.

On the south-eastern side of the fence route, along the Wainuiomata / Orongorongo divide the proposed location falls close to the boundary between GWRC land and DOC land. In this area it is recommended that the boundary be defined by survey to avoid having to complete a boundary adjustment survey between the parcels once the fence is constructed.

11 Other Survey Considerations (Topographic Survey)

A large proportion of the proposed fence route is covered by tall dense native forest. This environment restricts the methods of survey that will be able to be used. If the 'as constructed' fenceline is required to be surveyed it is recommended that this occur once all tree felling and construction has been completed. This will increase the ability for survey accurate measurements to be taken.

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LiDAR topographic imagery has been flown over the site for GWRC. It is recommended that before using the LiDAR for design that onsite ground truthing is completed to ensure that the LiDAR accurately represents the ground surface. It will also be important to understand if any known changes in topography have occurred since the LiDAR was flown.

Additional topographic survey will need to be undertaken in hotspots during the design phase to ensure that the fenceline can be designed correctly in these areas. Examples of these hotspots are areas with steep grades and areas close to private property.

12 Conclusion

Although there are challenges in building a predator proof fence and a stream crossing structure the building of these structures is considered feasible. Management of risks that are related to natural hazards is also considered feasible.

Detailed design will be necessary and additional work will be required to support a resource consent application for the proposed Wainuiomata Sanctuary.

Paul Wopereis

Paul Wopereis

Senior Engineering Geologist

Sarah Duggan

Licensed Cadastral Surveyor

APPENDIX I:

Ecologist Report Boundary Fenceline

Boffa Miskell

Appendix I

Boffa Miskell

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Attention:	Jim Lynch
Date:	June 2021
From:	Stephen Fuller
Message Ref:	Wainuiomata Predator Fence Feasibility Study. Boundary Fenceline.
Project No:	W15002

Dear Jim

This memo is to confirm that over several site visits on Saturday 21 and Sunday 22 November, and 7 May 2021, a team from Boffa Miskell and Beca, supported by GWRC staff, traversed the full length of the proposed Wainuiomata predator fence. The eastern and southern boundaries and the steep ascent from the Wainuiomata River to the Western Ridgeline, which lie in native forest, were walked. The existing deer fence on the northern and western boundary was walked in part and the remainder was driven.

Attending

The team was made up of the following:

- Stephen Fuller, BML Ecologist (Zealandia Project Manger 1995-2002)
- Paul Wopereis, Beca engineering geologist (Brook Waimārama Sanctuary member)
- Sarah Duggan, Beca surveyor
- Jeremy Garrett-Walker, BML Freshwater
- Mel Brown, BML Botanist
- Amanda Healy, BML Herpetologist
- Karin Sievwright, BML Ornithologist

Out thanks also to:

Ricky Clarkson and Dion Ngatoro (Park Rangers), and Bruce Brewer and James Graham (Pest animal team), for guiding the group on each day, and for their many helpful insights into valley management, current fauna, pest distribution and control, boundary issues, and extreme weather conditions.

Scope

As per your letter of September 2020, this survey sought to determine, based on our experience at Zealandia and Brook, whether it is feasible to construct and operate a predator fence surrounding most of the Wainuiomata River Catchment (Excluding the Recreation Area). Specifically, the scope called for:

- A survey and mapped route for a roadbed of minimum 10 metres width more or less following the existing deer fence (16.1 km) and the provisional uncut eastern ridge route provided (14.7 km) and enclosing the entire catchment.

- Recommendations for an alternative or more favourable route if this is in evidence from the survey on the ground.
- An assessment of the practicality of constructing and maintaining a predator-proof fence on the road route in due course, including vehicle access, etc).
- An assessment of any environmental issues which this will entail – including substrate stability, loss of vegetation, sediment run-off, material side casting, potential stochastic events and their likely impact.
- Potential solutions for or mitigation of these issues.

On the walkover we specifically considered:

- The necessary width of maintenance track and fenceline formation (note we believe a minimum width of 6m is possible along much of the alignment which will minimise clearance and earthworks volumes);
- Excessively steep slopes (≥ 24^0) where vehicle access won't be possible with a particular focus on the steep to very steep ascent from the Wainuiomata River to the Western ridgeline;
- Exposure of the fence to damaging winds (on the site visit winds were gusting up to 80km/hr)
- The substrate (hard rock, weathered rock, clay) and how this will affect fence construction methods;
- The potential impact of side-casting of overburden and how to minimise effects;
- The potential impact of sediment runoff from works into adjacent headwaters and how to minimise this;
- Possible alternative routes from the eastern ridgeline to Morton Dam;
- Methods for crossing of the Wainuiomata River below Morton Dam;
- Operational issues related to installation and operation of gates in the fence for GWRC staff and Wellington Water;
- The likely need for turnaround areas for vehicles along the fenceline;
- Potential boundary issues along the northern and western fencelines;
- Separation of the proposed fenceline from the Whakanui track:
- The loss or modification of beech and kamahi forest along this alignment and the measures that could minimise this loss:
- Potential edge effects of forest along the fenceline and how these can be mitigated;
- The quality of potential lizard habitat that will be affected;
- We also visited the Orongorongo River headwaters and a beautiful natural wetland on river terraces adjacent to the stream[1] to confirm that effects on these significant features can be avoided during construction.

Overall, we conclude that, while there are some unique construction challenges, there are design solutions for each. The issues for some of these challenges will primarily be one of cost.

We also confirm that the route provided to us is the best alignment, subject to minor adjustments that account for slope and width of the ridgeline and the need in some locations to separate the maintenance road and fenceline for a distance.

We did not consider the costs of these works. This will require a greater level of survey detail than was possible over these two days.

The following sections provide images of each section of ridgeline and detailed descriptions.

[1] The wetland visited is not shown as part of the Orongorongo Swamp in in Map 1 (Outstanding water bodies) of the Proposed Natural Resources Plan. However, we believe this small outlier is equivalent in composition and character to the larger Orongorongo Swamp and so have consider it to be part of that wetland complex.

VALLEY FLOOR & WEIR

Photo 1:
Vehicle gate at this location.

Photo 2:
From gate to Wainuiomata River showing dam wall and managed lawn.

Photo 3:

- Potential location of ford across river to western ascent.

WESTERN ASCENT: A continuous moderately steep to steep climb 740m long, from the Wainuiomata River (125m a.s.l.) to the Western Ridgeline (360m a.s.l.). Runs through tall podocarp broadleaf forest. Short section at bottom are very steep (>35 degrees), reducing to moderately steep slopes 20 to 25 degrees, reducing to a rolling spur which meets the main western ridgeline. Intent to have a fenceline and walking track only, and to disturb ground surface as little as possible. Fence posts could be mounted on screw piles to minimise need for machinery access. Seek to prune and limb trees where we can to minimise tree loss. Seek to weave where necessary to avoid large rata and podocarps (matai, rimu, miro).

Photo 4: Western Spur from dam wall.

Photo 5: Ascent along spur to left of image attempting to avoid the large rata and matai.

Photo 6: Typical understorey of lower section with large rata, over kamahi. Chainage 0350

	Photo 7: Kamahi – tree fern forest over upper half of western ascent. Chainage 0500
WESTERN RIDGELINE: 5.86 km of existing rolling ridgeline track with a deer fence on the Wainuiomata Catchment side. Track runs through native scrub and regenerating seral forest. The track climbs from 360m to 505m, with short climbs and descents to saddles along the way. The slope is generally rolling to strongly rolling (0 to 15 degrees), with a few short steep sections which are up to 25 degrees for some tens of metres.	
	Photo 8: Looking east along northern ridgeline, Wainuiomata Catchment to the right.

NORTHERN RIDGELINE: 6.9km of existing strongly rolling ridgeline track with a deer fence on the Wainuiomata Catchment side. Track runs through a variety of pine forest, pasture, native scrub, regenerating seral forest, and mature native forest. The track climbs from 505m to 628m, crossing three spot heights (569m, 632m Devine, and 631m). Overall the ridgeline is rolling to moderately steep. There are three short moderatealy steepr ascents and descents into saddles and up to spot heights which have slopes 20 to 25 degrees for short distances.	
	Photo 9: Rolling to strongly rolling ridgeline looking east. Note separation of fence and track.
	Photo 10: Rolling ridgeline looking west. Wainuiomata catchment to left. Mis of pasture, scrub and pine on farmland to right.
	Photo 11: Surface exposure of greywacke.

	Photo 12: Standing at junction of north and east ridges looking west. Chainage 13520
EASTERN RIDGELINE (North of Transmitter tower): 5.86 km of existing rolling ridgeline track with a deer fence on the Wainuiomata Catchment side. Track runs through native scrub and regenerating seral forest. The track climbs from 360m to 505m, with short climbs and descents to saddles along the way. The slope is generally rolling to strongly rolling (0 to 15 degrees), with a few short steep sections which are up to 25 degrees for some tens of metres.	
	Photo 13: North end of the eastern ridgeline showing typical mature kamahi dominated forest.
	Photo 14: Occasional clearings of old windthrow. Several matai visible.

	Photo 15: Pig rooting is widespread along the eastern ridgeline separating the Wainuiomata Catchment and Orongorongo catchment.
	Photo 16: Existing access track at eastern ridgeline. Formed width is 5.9m. Lengths of this track will require widening to provide for both large vehicles and the fence.
	Photo 17: Eastern Ridgeline. A vehicle gate needed here. A second gate will be needed 1.2km further along this track.

ORONGORONGO RIVER AND WETLANDS. These require consideration in final design and construction of fenceline track.	
	Photo 18: Orongorongo River headwater. This lies around 80m from the ridge and has very high natural and ecological values. Design will need to ensure protection of water quality.
	Photo 19: True left bank of Orongorongo River showing the wetland margin.
	Photo 20: Orongorongo Wetland.

EASTERN RIDGELINE (South of Transmitter station): The southern half of the eastern ridgeline runs for 6.83 km where it meets the southern ridgeline. It is rolling to strongly rolling over most of its length with a few moderately step sections. descending from 790m to 661m by way of four peaks separated by steep descents into saddles and ascents to the next peak. It starts at the transmitter tower at 18900 and ends at spot height 644m. The ridgeline is strongly rolling to moderately steep, with a couple of steep sections. The ridgeline is vegetated over its full length in mature beech forest.

Photo 21:Typical mature beech forest on this section.

Photo 22: Tape showing 6m width.

Photo 23: Wind throw showing very shallow rooting of beech on this ridgeline.

Photo 24: Windthrow showing weathered greywacke immediately below the roots.

SOUTHERN WETLAND: This section of ridgeline is very rocky and narrow. It is typically rolling to strongly rolling with a short moderately steep descent to a saddle at 24650. The ridgeline is vegetated over its full length in stunted beech forest, with frequent windfall and canopy flagging by prevailing northerly gales. The Whakanui Track (DOC) runs along this ridge and separation between the fenceline and this public tramping track is desirable.

Photo 25: Some narrow and moderately steep sections may require separation of track and fence.

Photo 26: Windfall common on the southern end of this ridge. Note rocky exposures. Ridgeline narrows and exposed to prevailing wind showing canopy flagging. Will be high wind loading on fence over this section.

SOUTH-WESTERN: From spot height 644 this ridge descends 2.95km to the Wainuiomata River. The vegetation is a mix of seral forest types, dominated by kamahi and tree fern on the upper slopes merging into kanuka on the lower slopes. The ridge is rolling to strongly rolling (8 to 20 degrees) with two short (approx. 100m) moderately steep sections (21 to 25 degrees), and a short (50m) steep section at the toe of the slope (to 30 degrees).

Photo 27: Looking along start of the southern ridgeline toward spot height 644.

Photo 28: Start of southern descent to Wainuiomata Valley. Tall Kamahi tree-fern forest. Occasional podocarp or rata but can be avoided.

Photo 29: Lower third of descent through kanuka regen.

	Photo 30: Looking up the southern spur from the valley floor.

Wainuiomata Fenceline Descriptions

Slope definitions

Slope as %	NZLRI	Slope as Angle
7 to 12.5	Undulating	4^0 to 7^0
14 to 27	Rolling	8^0 to 15^0
30 to 36	strongly rolling	16^0 to 20^0
40 to 46	moderately steep	21^0 to 25^0
50 to 66	steep	26^0 to 35^0

Ridgeline Details

Steep ascent to Western Ridgeline					
A continuous moderately steep to steep climb 740m long, from the Wainuiomata River (125m a.s.l.) to the Western Ridgeline (360m a.s.l.). Runs through tall podocarp broadleaf forest. Short section at bottom is very steep (>35 degrees), reducing to moderately steep slopes 20 to 25 degrees, reducing to a rolling spur which meets the main western ridgeline. Intent is to have a fenceline and walking track only, and to disturb ground surface as little as possible. Fence posts could be mounted on screw piles to minimise need for machinery access. Seek to prune and limb trees where we can, to minimise tree loss. Seek to weave fence where necessary to avoid large rata and podocarps (matai, rimu, miro).					
Chainage Start	Chainage End	Length (m)	Length (km)	Location	Vegetation
00000	00045	45	0.05	Banks of Wainuiomata River - End of dam to ford / weir	Lawn / mown
00045	00085	40	0.04	Crossing of Wainuiomata River	Constructed ford / weir
00085	00300	215	0.22	Ascent - Wainuiomata River to western ridgeline	Steep to very steep ascent of lower slope above river - 25 to 40 degrees for 180m. Mature native forest, predominantly rewarewa-rata-matai-rimu emergent over beech-kamahi.
00300	00480	180	0.18	as above	Slope reduces further, generally 20 to 25 degrees with some short, steep sections to 30 degrees. Still mature rata-matai/beech-kamahi forest.
00480	00740	260	0.26	as above	Slope reduces further following broad rolling spur averaging 8 to 15 degrees with short steeper sections of 20 degrees up to western ridgeline. At 450m route leave mature podocarp beech forest and enters seral kamahi dominated forest. Emergent trees are large hinau and rewarewa.
00740	00740	0	0.00	Meet western ridgeline track	
Total length		740	0.74		

Western Ridgeline					
5.86 km of existing rolling ridgeline track with a deer fence on the Wainuiomata Catchment side. Track runs through native scrub and regenerating seral forest. The track climbs from 360m to 505m, with short climbs and descents to saddles along the way. The slope is generally rolling to strongly rolling (0 to 15 degrees), with a few short steep sections which are up to 25 degrees for some tens of metres. Intent to generally use/upgrade existing track and replace the deer fence with the predator fence. May be some diversions of track and fence in response to resolution of boundary issues.					
Chainage Start	Chainage End	Length (m)	Length (km)	Location	Vegetation
00740	00740	0	0.00	Start of Western ridgeline	From here existing 4WD track and deer fence run north and east from 00740 to 135100 (12.77km)
00740	06600	5,860	5.86	Western ridgeline (Deer fence)	Indigenous forest and scrub both sides of deer fence track. Gently to strongly rolling. Fence and track typically adjacent.
06600	06600	0	0.00	End of western ridgeline	
Total length		5,860	5.86		

Northern Ridgeline					
6.9km of existing strongly rolling ridgeline track with a deer fence on the Wainuiomata Catchment side. Track runs through a variety of pine forest, pasture, native scrub, regenerating seral forest, and mature native forest. The track climbs from 505m to 628m, crossing three spot heights (569m, 632m Devine, and 631m). Overall, the ridgeline is rolling to moderately steep. There are three short moderately steep ascents and descents into saddles and up to spot heights which have slopes 20 to 25 degrees for short distances. Intent to generally use/upgrade existing track and replace the deer fence with the predator fence. May be some diversions of track and fence in response to resolution of boundary issues.					
Chainage Start	Chainage End	Length (m)	Length (km)	Location	Vegetation
06600	06600	0	0.00	Start of Northern ridgeline	
06600	07900	1,300	1.30	Northern ridgeline (Deer fence)	Pine forest to north, native forest to south of deer fence track. A rolling ridgeline with a short 200m climb at the end which is strongly rolling.
07900	08600	700	0.70	as above	Scrub and regenerating forest to north, native forest to south. A rolling ridgeline descending to a low saddle and then rising gradually to spot height 569m.
08600	10350	1,750	1.75	as above	Pasture and shrublands to north, native forest to south. Rolling to strongly rolling over most of its length (10 - 20 degrees) with a gradual descent from Spot height 569m to a saddle (483m), a short moderately steep climb (20 to 25 degrees) for 200 m, and then a strongly rolling climb for 400 to Devine (632m).
10350	13520	3,170	3.17	as above	Pasture, native scrub, and pine forest to north, native forest to south of deer fence track. Long gentle descent from Devine to low saddle (445m) at 12800. 0 to 15 degrees over most of length, 20 degrees for last 300m. Then a strongly rolling to moderately steep ascent (15 to 25 degrees) for 800m to end of northern ridge at spot height 631m. Note from 12200 to 13300 access track sidles on slopes below fenceline.
13520	13520	0	0.00	End of Northern ridgeline	At this point gate through deer fence and then begin south along the eastern ridgeline.

Total length		6,920	6.92		

Eastern Ridgeline - North of Transmitter tower					
The northern half of the eastern ridgeline is 5.4 km of undulating to rolling (4 - 7 degrees) relatively broad ridge, with generally gentle ascents and descents to saddles. It starts at spot height 631m at 13550, running south for 3.95km km to 17450 where it meets the Orongorongo 4wd access track at a saddle (569m a.s.l.). It then travels a further 1.45 km along this track to a transmission tower at 18900m, climbing from the saddle at 569m a.s.l. to 763m a.s.l. For this section intend for fence and track to run in parallel for full length. Two vehicle gates are needed for operation by Wellington Water.					
Chainage Start	Chainage End	Length (m)	Length (km)	Location	Vegetation
		0	0.00	Start of Ridgeline section	Leaves farmland and enters Orongorongo forest.
		0	0.00	Orongorongo Wetland	From 14100 to 17100 the headwaters of the Orongorongo River run parallel to this ridge and at the northern end there is less than 80m separation. Significant wetlands occur within these headwaters. Management of sediment from side casting over this section will be an important consideration for consenting.
13520	17460	3,940	3.94	Ridgeline through kamahi forest	A rolling ridgeline typically between 0 and 7 degrees with short sections up to 15 degrees. It passes through predominantly kamahi dominated forest. At 3940 the ridgeline meets an access track.
		0	0.00	Vehicle gate required	For WW operations
17460	18750	1,290	1.29	Follows access road	Road generally follows ridgeline in part and sidles around steeper sections on the east side of ridgeline climbing gently toward the Transmitter Station. Slope and track consistently 4 to 7 degrees. The fence to be formed on outside of road (Orongorongo side). Some track widening required. Seral kamahi, beech, and broadleaf forest to either side of the road.
		0	0.00	Vehicle gate required	For WW operations
18750	18920	170	0.17	Follows ridge to Transmitter	Short moderately steep section of fence running parallel to the access track to the transmitter station. Runs through stunted beech forest.
		0	0.00	End of ridgeline section	Opposite Transmitter station.
Total length		5,400	5.40		

Eastern Ridgeline - South of Transmitter tower					
The southern half of the eastern ridgeline runs for 6.83 km where it meets the southern ridgeline. It is rolling to strongly rolling over most of its length with a few moderately step sections. descending from 790m to 661m by way of four peaks separated by steep descents into saddles and ascents to the next peak. It starts at the transmitter tower at 18900 and ends at spot height 644m. The ridgeline is strongly rolling to moderately steep, with a couple of steep sections. The ridgeline is vegetated over its full length in mature beech forest. For this section intend for fence and track to run in parallel as much as possible but there are a few short steep sections where the track may need to separate and sidle to east.					
Chainage	Chainage	Length	Length	Location	Vegetation

Start	End	(m)	(km)		
		0	0.00	Start of Ridgeline section	Transmitter station.
18920	19750	830	0.83	Transmitter station to spot height 791m	Undulating to rolling ridgeline to Spot height 791m with very large mature beech trees over shallow soils and lightly weathered greywacke.
19750	21740	1,990	1.99	To Puketahā 767m	Strongly rolling to moderately steep descent (15-20 degrees over 250m) from Spot 791m down to a long rolling to strongly rolling ridgeline climbing gradually to Puketaha 767m. Large mature beech trees over shallow soils
21740	23570	1,830	1.83	To Spot height 800m	Rolling and increasingly narrow ridgeline descending gradually for 700m, then climbing gradually for 1.2km to spot height 800m with a couple of short moderately steep sections. Large mature beech trees over shallow soils
		0	0.00	End of Ridgeline section	Spot height 800m
Total length		4,650	4.65		

Southern Ridgeline					
This section of ridgeline is very rocky and narrow. It is typically rolling to strongly rolling with a short moderately steep descent to a saddle at 24650. The ridgeline is vegetated over its full length in stunted beech forest, with frequent windfall and canopy flagging by prevailing northerly gales. The Whakanui Track (DOC) runs along this ridge and separation between the fenceline and this public tramping track is desirable. For this section intend for fence and track to run in parallel as much as possible but there are a few short steep sections where the track may need to separate from fence and sidle to east.					
Chainage Start	Chainage End	Length (m)	Length (km)	Location	Vegetation
		0	0.00	Start of ridgeline section	Spot height 800m
23570	25750	2,180	2.18	Moderately steep & narrow southern ridgeline	From spot 800m the ridge descends on an undulating ridgeline for 1.1km before a short strongly rolling section 100m long to a saddle at 24750. It then climbs on a strongly rolling and narrow ridge to spot 644m.
		0	0.00	End of ridgeline section	Spot height 644m
Total length		2,180	2.18		

South Western Ridgeline to Wainuiomata River					
From spot height 644 this ridge descends 2.95km to the Wainuiomata River. The vegetation is a mix of seral forest types, dominated by kamahi and tree fern on the upper slopes merging into kanuka on the lower slopes. The ridge is rolling to strongly rolling (8 to 20 degrees) with two short (approx. 100m) moderately steep sections (21 to 25 degrees), and a short (50m) steep section at the toe of the slope (to 30 degrees). For this section intend for fence and track to run in parallel as much as possible but there are a few short steep sections where the track may need to separate form fence and sidle to east.					
Chainage Start	Chainage End	Length (m)	Length (km)	Location	Vegetation

		0	0.00	Start of Ridgeline section	Spot height 644m
25750	28750	3,000	3.00	A narrow spur descending to the river.	From 644m a steady descent through kamahi dominated forest with scattered beech and rewarewa for 1.95km where the vegetation changes to kanuka dominated scrub. It then descends a further 920m to the valley floor in the location of a required vehicle gate. The ridge is generally narrow but with some broader sections.
		0	0.00	Vehicle gate required	For WW operations
		0	0.00	End of Ridgeline section	Dam wall.
Total length		3,000	3.00		

General specs

- Perimeter = 28,750 m (28.8 km)
- Area = 3,313 ha
- Lowest Point = 124m at river crossing
- Highest point = Spot height 800m
- Length of deer fence = 12,760m

APPENDIX J:

Pest Proofing the Wainuiomata River

Wainuiomata Sanctuary Feasibility Study

Paper No:	**Appendix J**
Title:	**Pest proofing the Wainuiomata river**
Date:	**22nd September 2021**
Author:	**Author J. Lynch** (with BECA consultants)
Reviewed by:	**W. Maguire.** Beca**. Paul Wopereis** Beca.

1. Introduction

Running through the heart of the proposed fenced sanctuary, the Wainuiomata River is a regionally significant river for biodiversity[1]. It is fast-flowing and about twenty metres wide at the Morton dam face. The river can rise quickly to two metres in heavy rain events and some gravel and rock movement occurs.

With the potential establishment of a predator- proof fenced sanctuary at Wainuiomata, we need to consider the question “How can we cross the Wainuiomata River without compromising the pest proofing qualities of the perimeter fence and at the same time maintaining fish passage?”

No other sanctuary project has had to cross such a fast-flowing river as the Wainuiomata.

Following is the provisional scheme which Beca Engineers have devised to solve this problem. It will still require detailed engineering design before the fence is constructed to confirm the assumptions made and solve the fish passage issue. However, based on the information supplied and the inspections undertaken, the following scheme appears practical and achievable.

2. The Wainuiomata River and Morton Dam

The Wainuiomata river is a fast-flowing river about twenty metres wide at the dam face. The river can rise quickly to two metres in heavy rain events and some gravel and rock movement occurs. The river was dammed in 1907 when the dam was built. At the river crossing, a spillway was constructed with a concrete sill in the riverbed extending some distance downstream.

When the dam was decommissioned in 1987, a 20-metre-wide gap was cut in the spillway, the banks were retained with stone walls for approximately fifty metres downstream (for flood control)

Figure 1 View of river from the sill.

[1] Proposed Natural Resources Plan. Schedule F1. GW. 2019.

and concrete wing walls installed for about 75 metres downstream (to stabilise the banks) on both sides of the river.

The river is habitat for about 13 species of native fish, some of which are migratory[2]. The Morton Dam would have impeded their passage for eighty years and some have recolonised the river since the dam was decommissioned. The existing water off-take weirs are not considered to impede fish passage unduly.

3. The Issue

Given the width and flow of the river and the movement of material in heavy rain events, putting a pest proof fence across the river is impractical. Any fence would be destroyed in the first flood event, and it is not realistic to construct a fence that can withstand the movement of the river rubble involved.

Left unsecured, the river would be an entrance pathway for almost every target pest.

4. The potential Solution.

Using the existing infrastructure to prevent pest animals from climbing up the river past the fence, yet retaining river flows and fish passage, the solution proposed is to:

1. Construct a concrete weir on the existing concrete spillway sill across the river at the point just above where the existing concrete wing walls run out. The river is approximately twenty metres wide and two metres deep at this point.
2. The weir would be two metres in height and sit in the riverbed between and attached to the existing wing walls. This should bring it to the height of the riverbank.
3. The weir is to be one-metre thick and constructed of reinforced concrete. The concrete front of the weir can be polished smooth to prevent any small mammals from climbing the front wall.
4. The weir is to be keyed into the existing sill by drilling holes through the sill into the riverbed below and securing with steel piles. It can be keyed into the wing walls by a similar method. Detailed design will be required to provide a specification for the weir and to determine if the wing walls can carry the load required.
5. The existing true left-wing walls will need to be raised with pre-cast concrete panels or mass blocks to retain the river in the channel during flood events.
6. The weir will be pest proofed by placing a steel plate on the top and extending the lip of the plate 300 mm over the front edge. The concrete face of the front wall of the weir will be polished to eliminate footholds. This should prevent small mammals from scrambling over.
7. The fence will meet the weir at the riverbank. As it is elevated on the riverbank, it will be two metres above the weir top and animals could jump from the bank to the top of the weir. To prevent this happening, the fence (or extended wing walls) will return for several metres downstream along the riverbank with baffles put in place to ensure small mammals can't run along the wingwall top to access the top of the weir.
8. The above should prevent the ingress of all target animals, including deer, pigs, goats, dogs, cats, mustelids (3), rodents (3), hedgehogs.

See the schematic (Figure 2) on the following page.

5. Flood control

The weir will need to take account of floods which periodically raise the river. The weir will effectively raise the river level about two metres at the crossing point so some protection will need

[2] Wellington Fish and Game Council (1996). Fisheries Survey of Hutt Catchment, Wainuiomata Catchment, Orongorongo Catchment.

to be installed on the riverbank above the weir to prevent flood spill over. This can be done by installing mass blocks along the riverbank to act as a flood containment barrier.

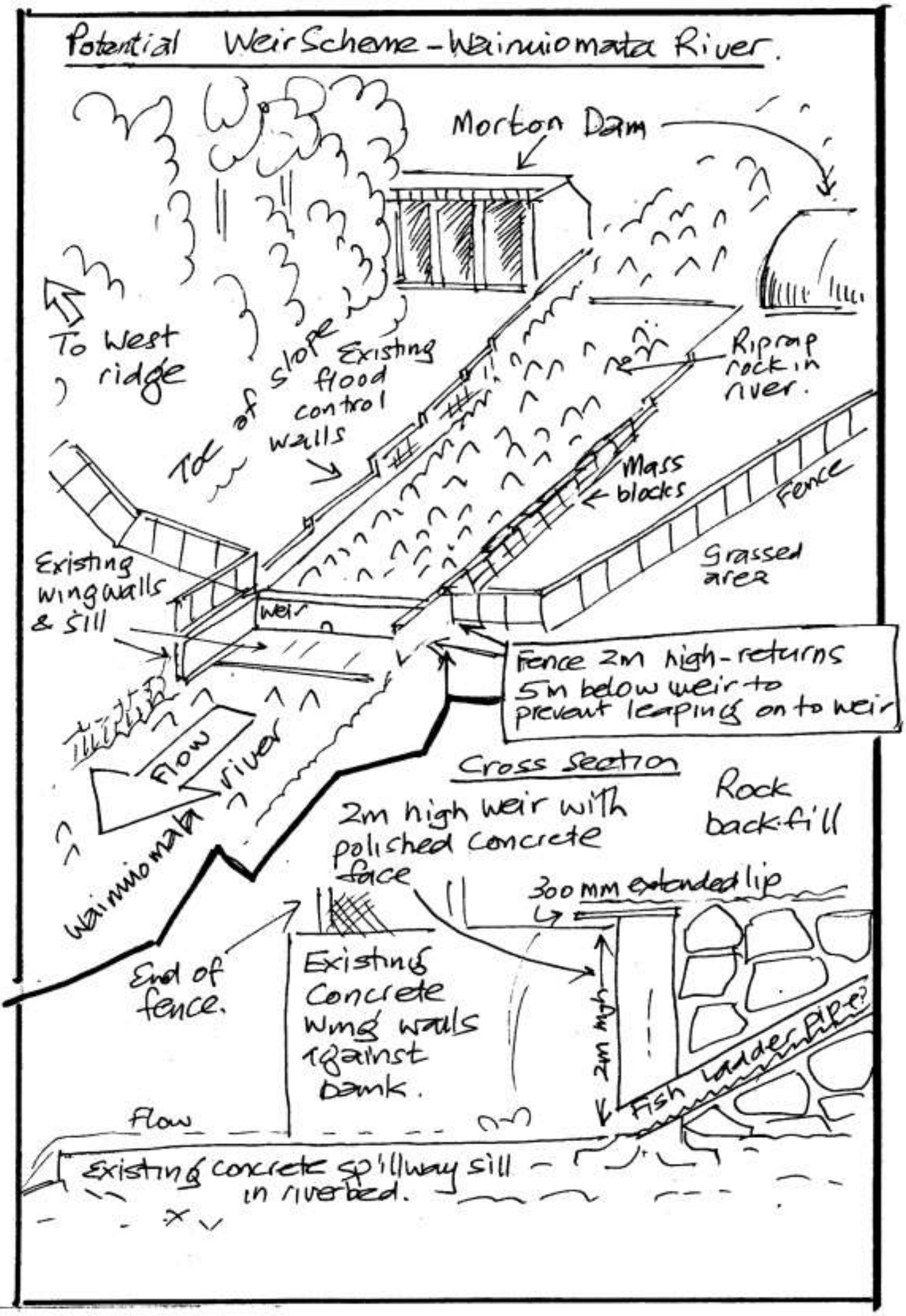

Figure 2 Potential Weir scheme (Note. Schematic only. Not definitive.)

6. Fish Passage

Any solution to pest proof the river will inevitably have the effect of impeding the free passage of fish species. Any solution designed will need to meet DOC/NIWA[3] and GW[4] requirements for fish passage.

The Wainuiomata River and its tributaries above black creek is listed in Schedule F1 of the Proposed Natural Resources Plan (2019) as a river with significant indigenous biodiversity providing habitat for indigenous threatened or at-risk fish species including at least six or more migratory species.

The weir concept will not impede egress but will prevent ingress. We assume the majority of fish migration upstream is undertaken by fry, many of which are very small and can wriggle through quite tight spaces. Migratory fry are also adept at climbing quite significant obstacles, although the polished concrete weir will defeat them. A system of traps and grilled pipes may work but is not proven.

Allowing the passage of fish while excluding mammal pests will not be an easy task. By definition the two objectives are mutually exclusive, and solutions are not immediately obvious. The qualities of the weir which make it pest proof (height, overhangs, polished face) are directly opposed to the recommended guidelines for constructing weirs for fish passage.

Detailed design for fish passage is beyond the scope of this study and there has not been the time to establish a fish passage concept with experts. Unless a solution to build fish passage into the weir can be found, the weir as conceived may not be consentable (see next). Therefore, fish passage has been raised as a major risk to obtaining the resource consents needed for the project.

The weir will have the advantage of keeping adult (and fertile) trout out of the catchment, although it may not prevent their fry from accessing the area.

7. Resource consents

Building a weir of this nature will require a consent to do works in a river. The consenting authority is the Greater Wellington Regional Council as it is their land, they and DOC may be the only affected parties. DOC will have an interest in the scheme due to the impeding of fish passage. Wellington Water is not affected as the weir is downstream of their operation.

8. Cost estimates.

The weir and fish ladder are a substantial item and will incur costs as follows.

Design and engineering supervision, resource consents, concrete delivered to site. 40-45cubic metres, steel capping for top of weir, reinforcing steel and miscellaneous, timber for formwork, concrete panels/mass blocks, crane and other machinery hire, pipes and baffles for fish ladders, labour, contingencies.

As there is only a concept for the weir, it is not possible at this stage to obtain even indicative prices. Therefore, a provisional allowance of $750,000 has been included in the costings.

9. Risks

The risk is that the engineering and design solutions are more difficult than predicted, especially in flood control, and that costs increase proportionately. There will be a technical solution, but it will be cost sensitive.

[3] FishPassageGuidelines-upto4m-NIWA-DOC-NZFPAG.pdf. https://niwa.co.nz/sites/niwa.co.nz/files/NZ-FishPassageGuidelines-upto4m-NIWA-DOC-NZFPAG.pdf
[4] Fish passage | Greater Wellington Regional Council (gw.govt.nz)

There is a risk that the resource consent will not be granted, unless a satisfactory solution for fish passage can be designed.

10. Conclusion

The conclusion is as follows.

1. Crossing and pest-proofing the Wainuiomata River is challenging but technically feasible.
2. This is subject to detailed design and costings and the granting of a resource consent for the works and fish passage.
3. A design solution for preserving fish passage will be required.
4. It has not been possible to undertake detailed design for the weir scheme and fish passage so a PC sum of $750,000 has been allowed in the project costings.
5. There are significant risks involved in obtaining consents. The solutions are primarily one of additional costs, or in the case of fish passage, good design.

James R. Lynch QSM.

Project Advisor

22nd September 2021

11. References

GW Fish passage | Greater Wellington Regional Council (gw.govt.nz)

NIWA-DOC-NZFPAG. FishPassageGuidelines-upto4m-.pdf. https://niwa.co.nz/sites/niwa.co.nz/files/NZ-FishPassageGuidelines-upto4m-NIWA-DOC-NZFPAG.pdf

Wellington Fish and Game Council (1996). Fisheries Survey of Hutt Catchment, Wainuiomata Catchment, Orongorongo Catchment.

APPENDIX K:

Neighbour Issues

Wainuiomata Sanctuary Feasibility Study

Paper No:	**Appendix K**
Title:	**Neighbour issues**
Date:	**2nd September 2021**
Author:	**Ricky Clarkson** Wainuiomata Ranger**; James Lynch** Project Advisor
Reviewed by:	**Amanda Cox** GW

1. Introduction

A question to resolve with the potential establishment of a fenced sanctuary at Wainuiomata Catchment and the construction of a predator proof fence is "How will the fence affect the existing neighbours?"

To answer this question, the Wainuiomata Park Ranger Ricky Clarkson contacted as many neighbours as practical, surveyed their opinions of the scheme and identified issues which may affect them and the project. The details and a summary of the survey are included below.

2. The Wainuiomata Catchment Boundary

The potential fence route has been surveyed by Boffa Miskell and Beca Engineers and a practical route measuring 28.8 km has been identified.[1]

The Wainuiomata/Orongorongo Water Collection Area (7,373 ha) comprises the headwaters of the Wainuiomata and Orongorongo River. The proposal includes the headwaters of the Wainuiomata River (3,350 ha) with the eastern boundary adjoining the Orongorongo segment of the catchment. The entire Water Collection Area is owned by Greater Wellington.

The western boundary borders Moore's Valley and the Northern ridge borders the southern end of Whiteman's Valley. These two boundaries adjoin private land, with nine private landowners. There is an existing access road of 12.8 km with a deer fence on these boundaries.

The southern boundary adjoins the Orongorongo valley and the Wainuiomata Valley and Remutaka Forest Park (DOC) and the Wainuiomata Recreation Area (GW). The DOC managed Whakanui Track runs for a short distance along the south-eastern boundary into the forest park.

3. Boundary History

The boundary was last surveyed around 2000 (exact date unable to be determined at this point). In 2004 the road on the western and northern boundaries was reformed and the deer fence built to prevent ungulates and stock from accessing the catchment from the farmland.

Discussion with neighbours has occurred regularly between GW staff and the neighbours over the years, reflecting a "good relationships" management approach. No major issues have occurred over the last twenty years and relations are generally cordial. GW maintains the road which benefits the landholders by providing access to the rear of their properties. There is an informal agreement to restrict public access to this road to prevent stock disturbance and unwanted general public activities.

[1] See Boffa Miskell report and map Figure 1.

Generally, the road follows the cadastral boundary quite closely but there are occasions where the road transgresses onto private land and there are several points where the road has to sidle quite significantly away from the fence due to the steepness of the gradient. Current access (depending on route) requires going through between ten and thirteen gates which are a mix of deer fence height and standard barred farm gate.

4. Private Owners

There are nine private landowners on the northern and western boundaries. These people have been contacted personally (bar two who could not be reached) and the project was discussed with them.

In general, the feedback on the proposal was very favourable with few issues or concerns lodged. However, four owners raised significant issues which will need to be addressed. These all centre around the existing road transgressing on private property and this occurs in multiple places. A quick count identified as many as seventy transgressions, most of which are minor. However, several of these transgressions are quite large and involve big swings away from the fenceline to facilitate ease of access.

The arrangements with GW to date have been largely informal based on mutual benefit. The landowners receive a significant benefit by gaining cost free access to the rear of their lands.

If the fence was built then very little would change for these landowners, as long as public access remained restricted.

For this report, the order flows from NE end of road to SW (for properties adjacent to current estimate of sanctuary fence area). Owners are numbered and not named for privacy reasons.

Owner one. Whiteman's Valley. Boundary length approx. 1200 metres.

A phone conversation was held. No concerns or issues were expressed. The owner wants to be kept informed and to discuss it again when the project gets the go-ahead.

The owner uses the access road regularly (much of which is on his land), and GW also uses these roads for access to the back boundary. Stock are present.

Issues. Significant. The current road transgresses onto the private property in several places due to the steep banks near the existing fence. This arrangement may need to be retained due to the terrain and will need to be confirmed before the new fence is built.

Owner two. Russell's Rd, Upper Hutt. (Whiteman's Valley). Boundary length approx. 2700 metres.

A phone conversation was held. No major concerns or issues. Supports the project and only concerned if others were accessing his land. They require access for maintenance works. Stock is present.

Issues. Significant. The existing road goes outside the GW boundary onto the private property. GW uses this access road onto the neighbour's land for vehicle access to the rear boundary.

There are 3 Stock Gates on the property adjoining current fence. This arrangement may need to be retained due to the terrain and will need to be confirmed before the new fence is built.

1 of 2

2 of 2

Owner three. Russell's Road. Upper Hutt. (Whiteman's Valley). Boundary length approx. 1600 metres.

A phone conversation was held. No major concerns or issues. They use the road for access around the property. Stock is present. Two gates adjoin the fence.

Issues. Significant. The existing road goes outside the GW boundary, and through the pine plantation on the western side of the property. There is a very steep road on this section and this arrangement may need to be retained due to the terrain and will need to be confirmed before the new fence is built

Owner four. Kakariki Way, Upper Hutt. Boundary length approx. 300 metres.

A phone conversation was held. No major concerns or issues. Supports the project. Has concerns about high levels of poaching in the area and the potential opening up of access to the track. Advised that landowners would be consulted before any decision regarding opening the track to the public. No stock is present.

Felling of the pine plantation is about to begin in the area in next twelve months and will last one to two years.

Issues. None. But the boundary does get very close to the road in places.

Owner five. Kakariki Way. Upper Hutt. Boundary length approx. 500 metres.

Unable to make contact. However, there are no major issues on the aerial view below. The trees are likely to be felled in the next two years.

Issues. None evident, and the road does not transgress on private property. In fact, some of the trees appear to be on GW land. Contact will need to be made in due course.

Owner six. Kakariki Way. Upper Hutt. Boundary length approx. 400 metres.

A phone conversation was held. No major concerns or issues. Uses the road for access around the property. No stock is present.

Issues. Minor. The existing road falls within a small dog leg of the boundary.

Owner seven. Montgomery Cres. Moore's Valley. Boundary length approx.196 metres.

Unable to make contact. However, no major issues on the aerial view. The trees are likely to be felled in next two years.

Issues. None evident, and the road does not transgress on to private property. Contact will need to be made in due course.

Owner eight. Moore's Valley Road. Boundary length approx. 2158 metres.

A phone conversation was held. Wishes to maintain a gate at each end of the property for security, which may be awkward. A face-to-face meeting has been requested to discuss options as to whether we would look at deer fencing a section to the NW end of their property instead of fencing off the road to prevent the need for gates.

GW has a "partial" MOU with this landowner. No stock are present. They use the road as access for trapping.

Issues. Moderate. The existing road goes outside the boundary in several places, but re-alignment should be possible if required.

Owner nine. Moore’s Valley Road. Boundary length approx. 3284 metres.

A phone conversation was held with the son of the landowner as the landowner is unwell. Stock are present and there are two gates.

No immediate concerns. The son was to discuss with his sisters, a follow up call suggested a face-to-face meeting in due course. They use the track to manage wandering stock and to walk dogs.

Issues. Significant. The existing road goes outside of boundary in multiple places

From this point onwards, the properties are not affected by the new fence. The existing deer fence will remain in place and changes will relate only to fence re-alignments to reduce the number of gates and to join the fenceline.

5. Public Owners

GW is the landholder for the Wainuiomata- Orongorongo Water Collection Area which occupies the eastern boundary. The proposal includes driving a new route along the ridgeline which will require significant mitigation of effects to be consented. These are dealt with in a separate study which investigates the impacts of the proposal on the water supply function.

The southern boundary is adjacent to DOC held land as part of the Remutaka Forest Park. The local DOC office advises that there are no significant issues from a recreational perspective, but the East Whakanui Track may run along or close to the proposed boundary. There will need to be discussion about where and how the tracks intersect and what effect that may have on recreational users of the track, particularly if public access is restricted to the road.

6. Public access

GW and Wellington Water already restrict public access to the roads. It is recommended that this policy continues to both support neighbour concerns and to prevent health and safety issues from arising. The rear and eastern boundaries are a long way from help and support and the area will still be managed as a water supply source.

7. Summary of Issues and conclusions

The number of affected private landowners, all on the northern and western boundaries is comparatively low. Good relations have been maintained between them and GW over time and goodwill is high.

In general, they are favourable towards the project and seem willing to support it – providing the existing access arrangements can be maintained.

The private owners obtain an advantage for the existing road which allows them access to the rear of their properties without any cost to them.

The major issues involve the mostly informal transgressions along this boundary which number approximately seventy in total. Many of these are minor but several are quite significant.

It is not certain just how accurate the existing boundary data is and ideally the western and northern boundaries should be re-surveyed before the fence is built. This would provide an accurate picture of the full extent of the transgressions before the fence is built. However, this may not be necessary if the most recent survey is adequate and existing arrangements can be maintained with neighbours.

After the boundary has been resurveyed, the existing route should be scrutinised to identify where the road can be reformed to avoid transgression on neighbouring land. If this can't be avoided, then agreements should be obtained and formalised regarding use of neighbouring private land. This will ensure the security of access in the long term.

Existing restrictions on public access to te roads should be maintained.

Ricky Clarkson	James R. Lynch
Park Ranger	Project Advisor

APPENDIX L:

Fence Construction

Wainuiomata Sanctuary Feasibility Study

Paper No:	**Appendix L**
Title:	**Fence construction**
Date:	**23rd September 2021**
Author:	**James Lynch** Project Advisor
Reviewed by:	**Stephen Fuller** Boffa Miskell; **Paul Wopereis** Beca

1. Introduction

The assumption is that a predator-proof fence can be constructed on the route to keep out all pests. There is an additional assumption that a fence can be built that will keep kākāpō in. Predator fencing is now a well-established and proven technology and there are several commercial businesses that specialise in them. However, the requirement to contain kākāpō is a new element to the design and costs.

Questions to be answered include:

1. What is the best design for the fence?
2. How can we keep kākāpō in the valley?
3. What will it cost to build?
4. What will it cost to maintain?

2. Background and precedents

In 1999 Zealandia built the first multi-species predator proof fence in New Zealand[1]. Since then, fourteen significant fences of similar design have been constructed for a mixture of private, NGO and LTA eco-sanctuaries. The largest of these ring-fenced eco-sanctuaries is Maungatautari at 3,400 ha which is the same scale as Wainuiomata. Seven of these are ring fenced and seven are peninsula fences. The ring-fenced sanctuaries have been spectacularly successful in enabling the return of extremely sensitive fauna such as tīeke, hihi, kiwi pukupuku, tuatara and giant weta[2].

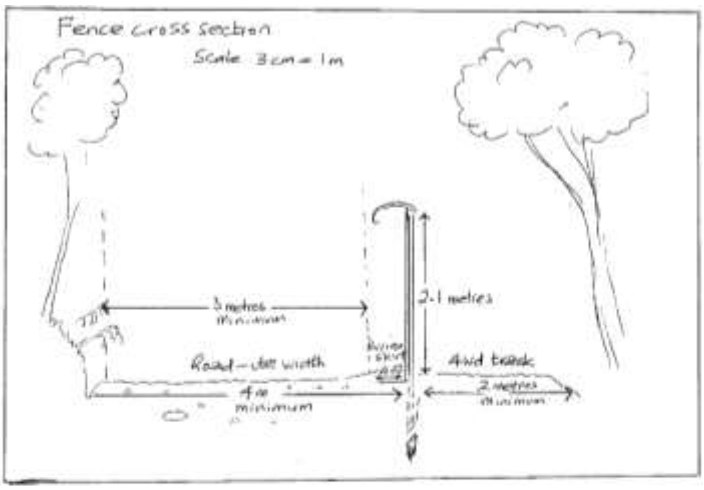

Figure 1 Typical fence profile

[1] Campbell-Hunt D and C, 2013. Ecosanctuaries

[2] Innes J, et al. (2019). New Zealand ecosanctuaries: types, attributes and outcomes, Journal of the Royal Society of New Zealand.

Fencing requires a roadbed generally, six metres in width. See Appendix G. ‘The fence route’, for details of the route. There is a viable 28.8 kilometres route for the fence around the catchment.

The fence is placed on the inside of the roadway as in figure 1 to allow vehicle access for maintenance. Vegetation must be cleared back from the road to prevent jumping and to reduce the chances of windthrow on the fence.

The fence includes a metal capping which prevents animals scrambling across and a buried ‘skirt’ which prevents burrowing. The small mesh size prevents animals crawling through the wire.

Predator-fencing has been in existence for over twenty years and there is a substantial body of experience in the field to draw on. It can be assumed to be a proven technology.

3. Methodology

With predator fencing an established technology, the following approach to design and costing was selected by the working party, which included DOC staff and consultants from Boffa Miskell and Beca with experience of predator fencing.

1. Develop a design and performance specification for the fence.
2. Ask selected contractors with recent experience of building predator exclusion fences in NZ to submit a design for a fence to meet the specifications, with an indicative price.
3. Evaluate these responses to determine if they can meet the specifications supplied.

Note that while a fence is essentially a construction task and can be undertaken by any competent building contractor, the market for these fences is quite small. Accordingly, there are only a very few companies who can be approached for indicative pricing.

Two companies with a track record and reputation in the field were chosen and were approached to supply indicative prices. Both agreed to participate. Both were supplied with the design specification (below), the ecologists and geologists report and maps. Both were offered a site visit and one took up the offer.

Note that the details of the companies and their offers have been kept private for commercial reasons.

4. Performance specification for the fence

The contractors were asked to provide INDICATIVE prices for the following tasks.

- Reform where required a near thirteen (12.8) kilometre fence route comprising the existing road along the western and northern ridgelines of the Wainuiomata Water Catchment.
- Dismantle and remove the existing deer fence ahead of construction.
- Construct a predator-proof fence along this route and the freshly cut route of near sixteen (15.97) km along the eastern and southern ridgelines and the ascent to the western scarp. Total fence length is twenty-eight and seven-tenths kilometres (28.7 km).
- The supplier may provide the price based on their proprietary fence designs so long as the design meets the performance specification provided.
- The works must be able to comply with all design requirements and resource consent provisions.

The fence must exclude the following target pests

- Deer, pig, goat, cattle, sheep, dog, cat, ship rat, Norway rat, European and Asian mouse, hedgehog, stoat, ferret, weasel, possum, rabbit, hare.
- The preferred height of the fence is 2.0 metres.

Longevity

- The fence must have a minimum lifespan of 30 years before the major componentry requires replacing from general age, wear and tear.

Durability

- The construction and materials must be such that the fence can withstand damage from a one in ten-year storm, casual and opportunistic vandalism, challenge by large animals, and casual and moderate accidental contact by vehicles and bicycles.
- The materials included must be resistant to corrosion or deterioration for the 30-year projected lifespan of the fence.
- The materials and fixing system proposed must be able to function within the extreme temperature variations which will be encountered without requiring repair or regular maintenance. Expansion and contraction of material must be allowed for.

Ease of maintenance

- The fence componentry as proposed must be able to be easily and quickly replaced if damaged.

Damage warning

- The indicative price should include the installation of a system which will provide an alarm to base for debris or other matter falling on the fence.

Access

- There should be installed and spaced at to be designated places along the route, a minimum of five pest-secure self-opening and closing accessways (gates) sufficient to allow the transit of service vehicles.
- Access hatches should be built into the fence to allow staff easy/ingress/egress; to be placed every two kilometres.

Drainage

- The route has been chosen to maximise the flow of water away from the enclosed area. Where the gradient or route demands it, the water must be able to flow through the fence without compromising the ability to keep out the target pests or require undue servicing. Allow for a minimum of ten drainage units to be installed.

Disruption to water supply activities

- The works must be conducted with reference to the operations of Wellington Water and conducted without disruption to their day-to-day operations. All health protocols must be adhered to in terms of personal hygiene and wash down of vehicles and plant before entering the catchment.

Both contractors duly supplied the indicative prices requested.

5. Results

The adjusted prices from both suppliers ranged from $385 per metre to $405 per metre. These prices are ex-route works (i.e., fence materials and construction only). Both designs submitted appear to fit within the performance specification provided. There was no obvious variation in quality although the designs submitted did have differences in materials and construction. Both prices include a contingency allowance of 10%.

Neither contractor saw any difficulty in constructing a fence on the site assuming the road has been built to specification.

These prices indicate a total price for fence construction of between $11,165,000 and $11,745,000.

Note. Both suppliers indicated that the fence would take at least two years to build and employ crews of up to thirteen workers

6. Kākāpō containment

The primary purpose for constructing the fence is to provide secure habitat for kākāpō. Kākāpō are flightless but are very capable climbers and would be able to escape across a normal predator proof fence with ease.

The DOC Kākāpō Recovery Team have been conducting trials with kākāpō to determine what would be required to keep kākāpō contained within the fenced area. These trials have now concluded, and a workable design has been settled on which will be tested over the next two years at Maungatautari. By the time Wainuiomata is ready the system will be fully tested.

The solution involves attaching a 320 mm band of plastic or metal sheet near the top of the fence on the inside (see figure 3). The sheeting must not have fixings which are raised enough to provide purchase for the kākāpō, so quality of fixing is important. Research into materials will be required to ensure the sheeting doesn't distort in different temperatures, that the materials don't react with the fence materials and to assess durability. Further design will be needed to see how the sheeting can extend around the access gates.

A PC sum will need to be included in the costs to allow for kākāpō proofing. A sum of $10 to $12 per metre is likely. This indicates the cost of kākāpō proofing to be $350,000 in addition to the cost of the fence.

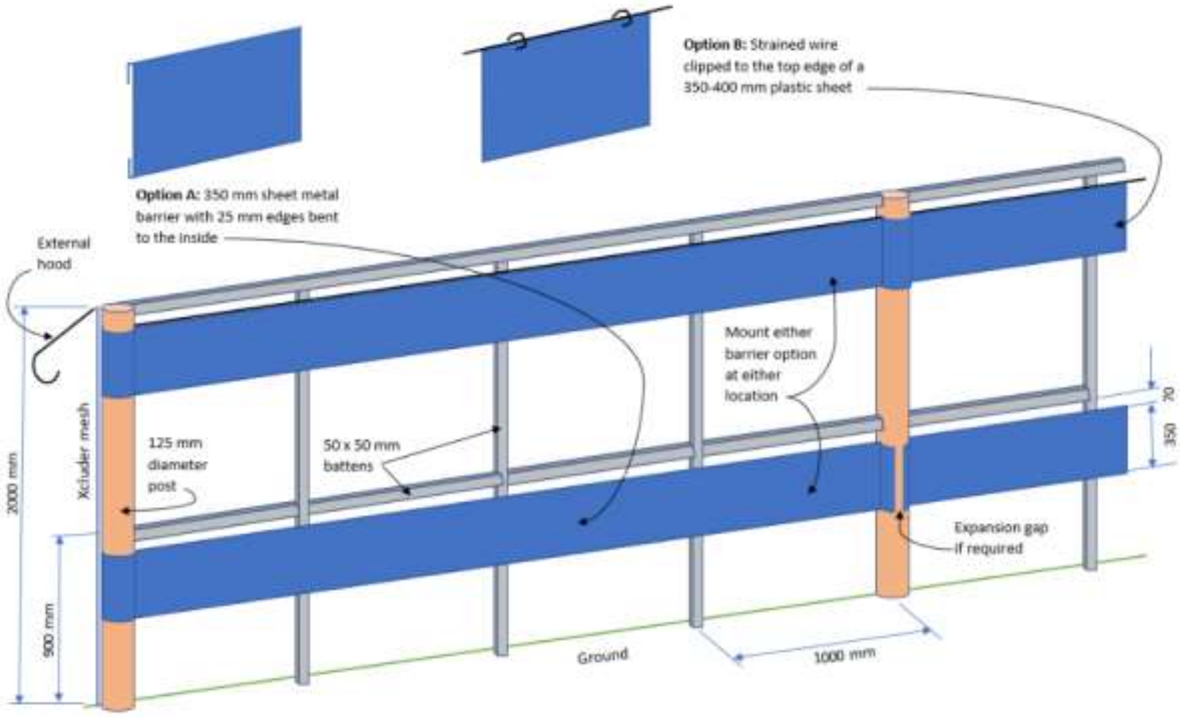

Figure 2 Kākāpō proofing solution. Courtesy DOC Kākāpō Recovery Team.

7. Pest proofing of discreet entry points

Rodents and mustelids (especially weasels) are very good at worming through tiny spaces to obtain entry into enclosed areas. Potential entry points through the fence for rats and mustelids will need to be identified and secured.

The highest risk is the tunnel which connects the Orongorongo water works with the Wainuiomata system through the hill to Georges Creek. Four potential access points exist at this point of the tunnel.

1. The gate and tunnel
2. The tunnel drainage system
3. The conduit covering for the electrical cable
4. The Wainuiomata/Orongorongo water main.

The Wainuiomata weir off-take pipe also represents a major risk.

Each of these will need to be fully assessed and a solution to pest proof them developed. A provisional assessment by the Park Ranger and Wellington Water engineers indicates this is feasible but would need the co-operation of Wellington Water. Most often this involves screening with narrow mesh.

Before construction, a full search of discreet entry points will need to be conducted looking for such things as decommissioned pipes, drains, and subterranean channels.

A PC sum will need to be included in the costs to allow for this to be done. A sum of $20,000 appears reasonable.

8. Consents

A building consent will be required from Hutt CC for the fence construction.

9. Costs

Indicative prices (on 2021 costs) have been obtained from fencing contractors for the fence. These prices indicate a total price for fence construction of between $11.165,000 and $11,745,000.

The estimated price for kākāpō proofing is $350,000

The estimated price for miscellaneous pest proofing of discreet entries is $20,000.

Total costs are assessed as $12,115,000.

10. Risks

The following major risks to constructing the fence route have been identified. Note that this technology is proven and well tested, so risks are comparatively low.

Risk	Significance and likelihood	Contingency
Costs increase above indicative prices and estimates due to inflationary and high demand factors in the economy and lag times to start construction.	Significant and likely	Allow contingencies in costings. 15% contingency has been allowed on the costs of the whole project.

These risks are considered acceptable and manageable.

11. Summary and conclusions

The conclusions of this part of the study are as follows.

1. It is feasible to construct a predator-proof fence on the surveyed route which will keep out all target pests.

2. Two contractors have provided indicative prices for a 28.8 km fence on the site which will meet our performance specifications.

3. The indicative prices indicate a total price for fence construction of between $11,165,000 and $11,745,000.

4. Neither contractor saw any difficulty in constructing a fence on the site assuming the road has been built to specification.

5. The fence can be secured to contain kākāpō. $350,000 should be allowed for this.

6. A number of discreet entry points for pests have been identified, including the Wainuiomata/Orongorongo tunnel and the various water pipes. These can be secured and the sum of $20,000 should be allowed for this.

7. Total costs for fencing and pest proofing are assessed as $12,15,000.

James R. Lynch
Project Advisor

12. References

Beca. (June 2021). Wainuiomata Sanctuary - Geotechnical and Survey Input to Proposed Fenceline. Attached as Appendix H

Boff Miskell. (June 2021). Wainuiomata Predator Fence Feasibility Study. Boundary Fenceline. Attached as Appendix I

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Clarkson R and Lynch JR, (Sept 2021). Wainuiomata Feasibility Study. Neighbour issues. Attached as Appendix K.

APPENDIX M:

Eradication of Pests

Wainuiomata Sanctuary Feasibility Study

Paper No:	**Appendix M**
Title:	**Eradication of Pests**
Date:	**30 September 2021**
Authors:	**James R. Lynch. Glen Falconer.** GW
Reviewed by:	**Keith Broome** DOC; **Helen Nathan** ZIP; **Ricky Clarkson** GW

1. Introduction

Once the pest- proof fence has been constructed, all pests must be eradicated from the catchment and prevented from re-entering. If there is an incursion, then a response system must be designed and ready to manage incursions.

This paper analyses whether or not this is feasible, the best options to achieve this and the costs and risks involved.

It is assumed that the fence will be constructed around the proposed fence route and that it can be made secure against incursion by the species listed below.

2. How we approached the task

The method employed was as follows.

1. Reference to precedents and similar operations. These include past eradications and the current operations of other fenced sanctuaries and eradications from islands. There is a large body of work to draw on in this area with established technology.
2. An initial scoping of the task, including a site visit, was conducted by a group of experienced practitioners in the field from a range of agencies, including people who know the catchment intimately.
    - Glen Falconer Team Leader Pest Animals-Biosecurity. Greater Wellington (GW).
    - Keith Broome. Terrestrial Science. DOC
    - Helen Nathan. Zero Invasive Predators (ZIP)
    - Kim Broad GW. Wainuiomata Mainland Island Co-ordinator.
    - James Mathews. Operations Ranger. Sanctuary Mountain (Maungatautari)
    - Ricky Clarkson. Park Ranger. Wainuiomata.
3. A draft design, concept plan and costing were prepared by Glen Falconer using current GW and DOC procedures and policies[1].
4. Review and finalisation of the plan and this paper with the working group.

[1] Falconer, G. (2020). Wainuiomata Eradication Method and Cost Sheet. Appendix Q.

3. Precedents and similar situations.

There are a number of precedents and experiences comparable to Wainuiomata, with the most similar being Sanctuary Mountain/Maungatautari. A representative from this sanctuary has been consulted and was involved in the study.

Sanctuary Mountain/Maungatautari is 3,400 ha located in farmland near Cambridge. A 38 km perimeter fence was constructed there in 2006 and two inner-fenced ‘cells’ bring the total fence line to 47 km. All pests were eradicated from the fenced area in 2007/8, however mice subsequently reinvaded. Many species have been successfully translocated on to the mountain, including tieke and hihi, which are the most sensitive to predation. Maungatautari is an excellent analogue for Wainuiomata due to its size and fifteen years of experience in dealing with pest incursions. Wainuiomata’s proposed fenceline is 10km shorter than the Maungatautari perimeter.

There are five other fully ring-fenced community sanctuaries in New Zealand which have been operating for some time. These include.

Zealandia (Wellington City) 225 ha. Fence 8.6 km. Fenced 1999. Eradication 1999. Mice present. Otherwise, pest free since then except for several weasel incursions.

Bushy Park (Wanganui) 90 ha. Fence 4.8km. Fenced 2005. Eradication 2005. Mice present. Otherwise, pest free.

Orokonui (Near Dunedin) 307 ha. Fence 9km. Fenced 2007. Eradication 2007. Mice present. Otherwise, pest free but has had a stoat incursion.

Rotokare (near Stratford) 250 ha. Fence 8.2 km. Fenced 2008. Eradication 2009. Mice managed to zero density. Has had stoat and rat incursions. (Note this is an open sanctuary with an unattended gate through which the public can gain access).

Brooke Waimarama (Nelson) 690 ha. Fence 14.4km. Fenced 2016. Eradication 2017. Mice present. Weasel and rat incursions occurred after eradication – now eradicated.

In summary. Predator fencing is a proven technology which has been operating for twenty-two years and has allowed the successful reintroduction of even the most threatened species. With the exception of mice, all pests have been removed from these enclosed areas and they have been able to maintain a pest-free status.

4. Target pests present in the catchment and adjacent areas

The catchment and environs contain the following target pest animals.

1. *Mus musculus*. **House mouse**. 0-5% TTI (May 2021). Likely to be suppressed by rats, predators, and current management. Numbers will increase exponentially when predation pressure is released. Note. It is unlikely that the eradication can permanently remove mice from the managed area.
2. *Rattus rattus*. **Ship rat.** 6% TTI (September 2021). Very low in the Mainland Island (MI).
3. *Rattus norvegicus*. **Norway rat**. Rare in the area. May be a few around houses and water courses.
4. *Mustela erminea*. **Stoat.** 4% TTI in non-controlled area (Feb 2021). Densities unknown but will be present in average numbers for this productive forest, except in the MI
5. *Mustela nivalis*. **Weasel.** Densities unknown but will be present in average numbers for this productive forest, except in the MI.
6. *Mustela putorius*. **Ferret.** Not known to be in the area, Porirua the closest confirmed.

7. *Felis catus*. **Feral cat**. Will be present around the lower and central valley riverbed and western and northern boundaries but are not in high numbers.
8. *Oryctolagus cuniculus*. **Rabbit.** May be in small populations in the regenerating kanuka of the old inundation zone around the lower river and near the adjacent farmland on the western and northern boundaries.
9. *Trichosurus vulpecula*. **Possum.** Possum numbers are low in the catchment due to long term management. BMI is currently at 0% in the MI and 2% in the NT area.
10. *Erinaceus europaeus.* **Hedgehog**. 3% TTI in non-controlled area Feb 2021. Will be present in small numbers throughout the area.
11. *Cervus elaphus.* **Red deer**. Control and deer fence has reduced numbers considerably but still present.
12. *Capra hercus.* **Goat.** Not in large numbers but still present in isolated pockets.
13. *Sus scrofa.* **Pig**. Present in large groups seasonally, especially July in response to hinau fruiting.

There is no intention to eradicate any bird species, freshwater fish or invertebrate species as part of this operation.

Integrated pest management over the last twenty years has greatly reduced the general abundance of pests in the catchment and will assist the success of this operation. No trapping of possums will be needed to reduce the population prior to eradication.

5. Objective

The objective of is to.

> **Eradicate the above thirteen target pest animal species permanently from the enclosed area within one year of completion of the fence.**
>
> **Thereafter maintain a pest free status over time.**

Note: The eradication of mice will be attempted because it may not cost more and if successful would result in additional biodiversity gains. However, the chances of a complete and permanent removal of mice from the catchment are remote. There is currently no instance of mice being removed permanently from a fenced area of this size. Mice have been successfully eradicated from a number of large islands so while eradication may well be possible here, there are no precedents among large, fenced sanctuaries for sustaining mouse free status.

It should be noted that the risks with an eradication are much greater than with a routine operation. Every animal must be accounted for, and it is a ‘one-shot’ situation where failure has serious consequences. The scale of this operation (3,313 hectares) adds to the risk. There is no room for experimentation, and it is essential that only proven methods are used. See the section on risks and contingencies.

6. Limitations

The operation must be completed without undue disruption to or degradation in quality of the water supply from the catchment.

Animal welfare and health and safety regulations must be adhered to.

7. Overall strategy and process

The preferred overall strategy for clearing the catchment of target pests is as follows.

1. Establish a permanent monitoring/incursion response grid.
2. Set up pre-post operation monitoring programme.
3. Hunt out ungulates and poison/hunt rabbits.
4. Apply rodenticide baits by air to everywhere inside the fenced area.
5. Monitor and mop-up any remnant pests detected.
6. Maintain the network and surveillance system, with readiness to respond to incursions.

This strategy is expanded in the following sections.

8. Timing

The timing of these phases is critical to the success of the exercise and is dependent on the water supply, seasonal factors, pest densities and the completion of the fence.

Water supply

It will be necessary to close the water supply from the catchment during the aerial toxin application until the bait is no longer toxic. This commonly takes about six weeks for brodifacoum. (See section on methods and the appendix). This is a risk as currently the regional water supply lacks the capacity to cope with a prolonged decommissioning of the Wainuiomata river supply (10% of Wellington's water) especially over the summer months or in dry years. The completion of the Bell Road and Prince of Wales Park reservoirs in Wellington City and further works to expand Kaitoke will most likely ameliorate this situation by providing as much as 20% further storage and supply capacity. However, these schemes will not be completed for two years, so any operation will most likely need to factor this into the timing.

Should those other mitigations be unavailable, the aerial operation will need to be conducted in winter when the water requirements are low, and supply is at its peak.

Aerial toxin operations at Kaitoke for possum control will also need to be staggered with Wainuiomata as it is not practical to close both catchments at the same time.

Seasonal factors

Given its temperate latitude, the catchment is a 'high energy' area which results in heavy seasonal fruiting events, especially in mast years. In late autumn, supplejack, coprosma, rimu, miro and matai often fruit heavily in sequence and hinau is abundant and on the ground in early winter and as late as July. Mast years are becoming more prevalent with warmer temperatures. An aerial 1080 operation in the catchment recently partially failed due to a mast year. It is therefore prudent to avoid a mast year completely and to time the operation after the hinau fruiting and before the spring burst (August). DOC protocols and best practice exist for the timing of aerial applications, and these will be adhered to. Good phenology (fruiting and flowering) monitoring will provide important data to enable the prediction of masting.

Pest densities

Aerial applications of toxin should be timed for when the target animals are at their hungriest. Rodents are at maximum abundance in late autumn and decline in numbers in winter in response to colder weather and lowered food availability. Mast years will keep the rat and mouse densities high and consequently mustelid numbers will also stay high.

Given the above the optimal time for the aerial operation is early winter (June/July) in a non-mast year. Monitoring of index lines will inform the precise timing of the aerial operation.

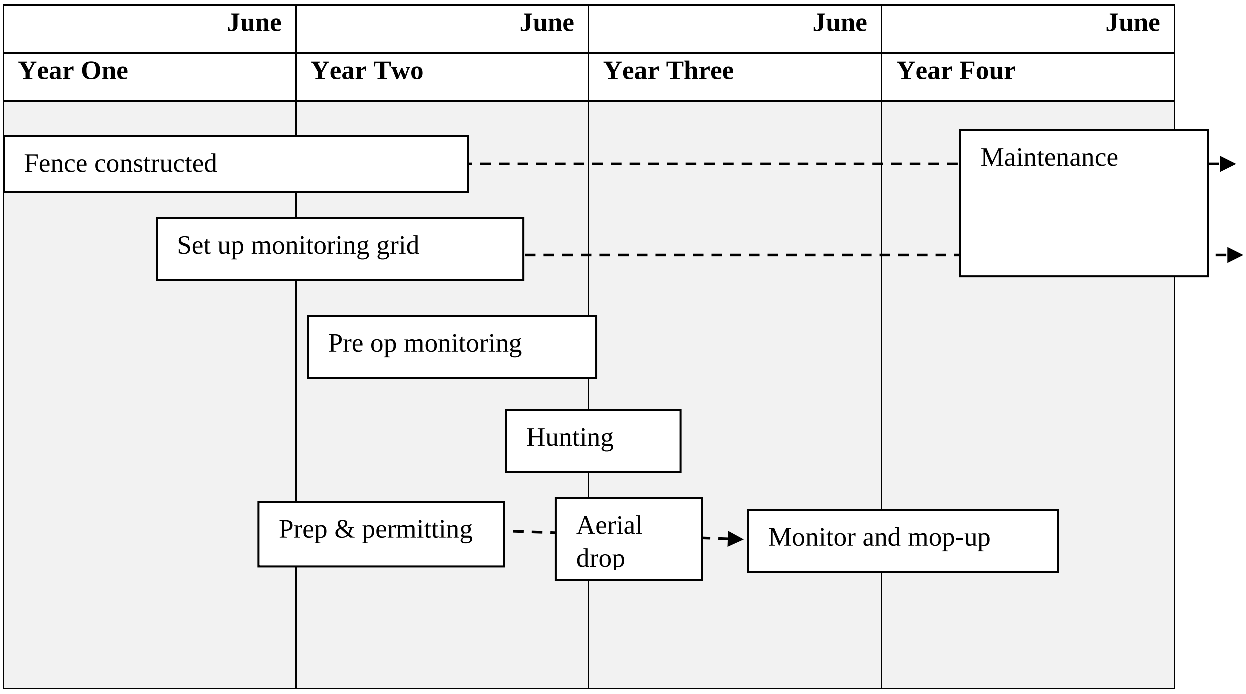
Completion of the fence

A successful aerial application requires the completion and commissioning of the fence.

Commissioning is complete when all work is signed off and all potential entry points (gates, pipes, drains, waterways, etc) have been sealed and tested. Ideally the commissioning of the fence should be timed for completion in late summer to allow the aerial drop to be undertaken that winter. However, steps one and two of the strategy can (and should) be commenced while fence construction is underway and completed to coincide with the commissioning of the fence. Step three (hunting) can occur while the fence is being completed.

Timeline

Following is a schematic timeline for the operation.



9. Managing and minimising risk

Pest eradications are a high-risk operation. There are many things which can go wrong and some (such as weather and animal behaviour) are things which managers have little or no control over. Accordingly, eradications must be well resourced and precisely undertaken by experienced professionals. Moreover, keeping an area free of pests is a similarly risky venture which requires constant vigilance and immediate and effective responses when needed.

Many community sanctuaries operate on very constrained budgets and are rarely resourced to do what is a very difficult task. Many depend on volunteers to do critical work. Under-resourcing adds substantially to the risk, is unfair on staff and adds substantially to staff turnover.

Wainuiomata will have high profile species under its care which the public and DOC will expect to be kept safe at all times. For example, the loss of kākāpō would be unacceptable. The consequences of failure will be considerable, both in added costs, risk to species and credibility.

Accordingly, the working group recommends that a risk minimisation approach underpins this exercise. This means designing an optimum system which has a high probability of succeeding in the long term rather than cutting corners to reduce costs. This system will be tighter and more resource intensive than may be the case in ordinary circumstances without being extravagant.

10. Eradication best practice

The industry practice of eradication has been developed over the last fifty years on offshore islands and through mainland operations, including fenced sanctuaries. Following are the methods of eradication which are now standard practice.

For **rodents** (mice, ship rat, Norway rat) the standard eradication methodology is rodenticide toxins (brodifacoum). For such a large area this toxin can only be practically applied aerially. Traps are not viable for rodents in such a large and densely vegetated area because of their small territories and high rate of breeding.

For **possums**, the standard eradication methodology is toxins, also applied aerially. Any residual population can be trapped. Because possums are in low densities as a result of past control operations the beneficial by-kill of possums from the aerially applied rodenticide will be sufficient to allow survivors to be trapped.

For **mustelids** (weasel, stoat, ferret) and **feral cats** the preferred methodology for eradication is beneficial by-kill through secondary poisoning, where the target predator animal consumes toxic rodents and receive a lethal dose from the prey animal. Rodenticides such as brodifacoum have been proven to be particularly effective for this. Traps are required for surviving individuals.

For **hedgehogs**. These animals semi-hibernate during winter and may not be out when poison is dropped, thereby limiting beneficial by-kill. They will require trapping.

For **deer, goat, and pig**. Ground hunting is the standard and only viable methodology for these species.

For **rabbit.** Pindone ground spread carrot toxin can be used along with ground hunting. Beneficial by-kill of rabbits from the rodenticide poisoning can be expected.

To ensure eradication has been successful following the aerial application of brodifacoum baits, a network (grid) of devices will need to be installed and checked post-operation to ensure that any surviving populations are dealt with quickly. The network is constructed along cut lines at carefully calibrated intervals and designed to give confidence that every surviving animal would be detected within their home range in the shortest possible time. This network is retained post-eradication and becomes the surveillance and incursion response network.

The methodology proposed will apply the standard methods above.

11. New technology

To ensure that the project has access to all new and best practice technology, representatives of the DOC technical staff and Zero Invasive predators (ZIP) were included in the working group. DOC and ZIP confirms that the methodology and equipment chosen and costed represents the most up to date proven methods and resources available and the design is optimised for the location and task.

A large multispecies eradication such as this is not the place to test new, experimental or unproven techniques if they could pose any risk to the success of the project.

12. Phasing

The eradication will involve three distinct phases as follows.

1. **Pre-aerial operation**. This phase begins one year before the fence is completed and aerial operation commences and aims to accomplish steps 1-3 of the strategy. The network of lines and devices is set up and tested ready for the post -operation phase. This phase

includes the hunting of ungulates which can commence as soon as the fence is secure enough for them.

2. **Aerial operation**. Beginning in early winter after the fence has been completed and checked for quality, this phase includes step 4. The catchment is sown twice about two weeks apart with rodenticide by helicopter.
3. **Post-aerial operation**. Encompassing step 5, this stage continues for twelve months after the aerial operation or until it is confirmed that there are no target animals left in the catchment. The control network is fully deployed to locate and remove any animals not specifically by the aerial poison baiting (ungulates, rabbits, mustelids, cats, possums and hedgehogs).

When the ‘all clear’ is given**,** the network must continue to operate to be ready to detect any incursions and remove them as quickly as possible (step 6). This phase is dealt with in the next section of this study – 2.11 **Maintaining a pest free status**. In addition to operating the network, this includes fence maintenance and repair.

13. Phase one: Pre-aerial operation

The eradication and ongoing management of the catchment will require the establishment and maintenance of a permanent monitoring and incursion response network of service tracks and trap/bait stations.

The objective of this phase is to:

> **Enable the detection of and response to any target animal incursions into the catchment at any time post eradication.**
>
> **Remove the bulk of ungulates from the catchment.**

The network will be set up as follows. (**See** section 22 for a map of the proposed network and Appendix Q for full details of the methods and costs.)

- Lines will be created at 75m intervals (as per GIS mapping plan) on an 82 magnetic bearing across the Valley. They will utilise the existing lines in the Mainland Island area, adding to these and following the same bearing.
- There is opportunity to re-orientate some of these lines nearer the treatment plant to suit the steep face above Georges Creek with the proposed fence line.
- Lines will be marked in both directions with permanent plastic marker triangles/rectangles at very frequent intervals, and cut, mostly by hand tools, so staff with back packs can follow the lines and get through efficiently.
- Along these lines, a detection site will be established every 50m (measured with hip chain cotton). This is likely to contain devices such as a tracking tunnel/multi use device, wax tag and chewcard for closing out the eradication, for use with ongoing surveillance and for any incursion work in the future.
- At every 100m interval (every second 50m spaced detection device) will be a double set run through BT200 Stainless steel trap and wooden box. These will be used again for closing out the eradication, and ongoing surveillance and for any future incursion work.
- The trap boxes will be fitted with moto lures, and some will have reporting nodes. They will be initially opened up for hedgehogs and will be future proofed for native parrot interference (such as weka- and kākā-proof stainless-steel ends) by purchasing strong stainless-steel ends and baffles for installation later. On installation these will be locked open, and plate screwed down.
- A network of baited cameras will be in place for closing out the eradication, ongoing surveillance and for any future incursion work. Trail cameras (black flash/SD cards) will

be set up on an internal 500m internal grid, focusing on terrain and topography suited for best detection sites.

- Hi-spec baited cameras will be spaced 500m around inside the boundary fence, these cameras will be most likely thermal and may transmit any detection encounters.
- See figure 1 for the network layout. Note that this is a very intensive operation which is highly resource intensive. For example, 9,178 BT 200 traps will be required and 9,000 tracking tunnels. 471.4 km of track will need to be cut and marked.

Ungulates will be hunted out as follows.

- The ungulate team of professional hunters will form six months before the aerial operation for planning, recruitment, and training. They will work with the fence builders while predator fence is constructed to limit re-invasion.
- When the fence is nearly completed, the team will commence sweeps in the catchment, using 'wall of death' methods and dogs where needed. The area will be divided into hunting catchments to work systematically in sweeps using indicator and bailing dogs where needed.

Sample animals will be captured, collared, and released for later monitoring.

Hand baiting for rabbits will begin one month before the aerial operation.

Resource and costs – Phase one

See the separate cost sheets supplied by GW Biosecurity for details of costs[2]. Following is a summary of the costs for Phase one – Pre-aerial operation.

Labour	Field Operations Leader, Ungulate team, Aerial Ops team, Line prep team, Field team, Data specialist 10 growing to 24 FTE at various times	
	@$62 per hour average. (GW Standard labour cost rate)	$1,541,568
Materials and capital items		
	Field equipment, traps, lures and baits, vehicles, field base and fit out, consumables, miscellaneous	$3,712,808
	Total pre-operation	$5,254,376

NOTE. The cost paper allows for a Project Leader. This person has been taken out of this exercise and included in the governance and Management section as Manager of the whole project.

14. Phase two: Aerial operation

The eradication of rodents will require an aerial application of a suitable rodenticide. The primary target of this will be mice, ship, and Norway rat. Possums, mustelids, and cats will not be primary targets but will most likely be affected by the operation and will be acceptable by-kill.

The objective of this process is to:

Eradicate three target species from the enclosed area: mice, ship rat, Norway rat.

Reduce the numbers of possum, weasel, stoat, ferret, feral cat through acceptable by-kill.

[2] Falconer, G. (September 2021) Appendix Q**.** Wainuiomata Eradication method and cost sheet.

The **preferred methodology** is to apply brodifacoum rodenticide by helicopter to the entire enclosed area (3,313 ha). This is the accepted and proven product and method for eradicating rodents from large islands or enclosed areas. Brodifacoum is a second-generation anti-coagulant which is efficient for rodent eradication because it is a chronic toxin which takes three to five days for the rodent to die after consumption of a lethal dose. This delayed action means that the animal cannot associate feeling unwell with the consumption of bait. This has been proven to increase the chance of every target animal consuming a lethal dose.

Brodifacoum is the only toxin which can reliably be used in this regard. Brodifacoum binds to soil and breaks down slowly (half-life twelve to twenty-five weeks) so can be persistent in the environment. It is therefore restricted in its use. It is insoluble in water and because of its capacity to bind to solid matter, it generally does not show up in water sampling after aerial application. (See Appendix Q for a literature review of Anti-coagulant toxins and their effect on water and soil)

The **alternative** to brodifacoum is sodium fluoroacetate (1080). 1080 is an acute toxin which means it is effective within hours of consumption. This fast action means it is possible that the target animal will consume a sub-lethal dose and the animal can associate feeling unwell with the bait eaten. It is therefore much riskier and is never used for island eradications of rodents. Recent trials show that, with a two-phase operation consisting of pre-feeding with non-toxin bait in two applications and applying a high dose in a single follow up application, (repeated in the second phase), eradication with 1080 is possible. This would be more expensive as it would require six aerial applications over two phases (each phase would need two pre-feeds plus one toxic) and is less proven and reliable.

A **third option** is to apply brodifacoum in a ground operation by bait stations through a 50 X 50 metre monitoring grid. This method is used now with the current mainland island operation (with a 150 X 100 metre grid). This is not a viable option because it would take many months to complete, is very human and resource intensive and is unproven at this scale.

Optimum timing is for June in a non-mast fruiting year. A suitable weather window is required with fine weather for both applications.

The aerial bait application will be conducted as follows.

- Obtain permits and establish health and safety and water protection procedures.
- Set-up bait storage and helicopter loading site in a secure area below the water treatment plant.
- Procure and store brodifacoum ‘Pest-off’ bait 20 ppm, 100 tonnes.
- During weather window and using GPS, conduct first aerial bait drop. Fly the catchment by helicopter equipped with bait dispenser. Apply at 12 kg per hectare.
- Assess the accuracy of the operation and fill any gaps.
- Two weeks later, with appropriate weather window, repeat this operation with 12 kg per hectare.
- Monitor for water sampling and permit requirements.

The aerial operation will need to comply with all DOC and other best practice protocols and health and permit requirements.

Resource and costs – Phase two

See the separate cost sheets supplied for details of costs. Following is a summary of the costs for Phase two – Aerial operation.

Labour	Field Operations Leader, Ungulate team, Aerial Ops team, Hand baiting and aerial team, Field team, Data specialist. Up to 46 FTE for one month @ $62 per hour average	$479,136
Materials	Baits, helicopters, storage, freight, consumables, miscellaneous	$ 857,400
	Total Aerial operation	$1,336,536

15. Phase three: Post aerial operation

Once the eradication has been completed there will need to be verification of the success of the operation and any remaining individuals (including hedgehogs) will need to be detected and removed.

The objective of this process is to:

> **Confirm and complete the eradication of all target species and trap out emerging hedgehogs.**

Confirmation of the success can take twelve months or more after the operation to guarantee a pest-free environment. Detection will involve continuing the same regime as the pre-operational monitoring programme using the grid and established methods and repeating the ungulate hunts. DNA testing of selected catchments can also be employed to detect any presence.

Hedgehogs will begin to emerge from hibernation around October and will need to be trapped and baited after that. This is done by loading traps on the grid, set and baited for hedgehogs.

A final sweep of the catchment with predator dogs can be used to confirm absence.

The post-aerial operation will be conducted as follows.

- Track fate of radio tagged animals. Verify deaths.
- Trap out emerging hedgehogs.
- Monitor on the grid for any sign of target animals. Traps, bait stations, tracking tunnel, cameras, supplemented by EDNA[3] testing. Weekly service for three months and monthly thereafter for another nine months.
- Mop-up any remnants as required.
- Conduct EDNA water sampling particularly for ungulates. Collect and analyse faecal DNA samples for targeted control and cross analysis with shot animals.
- Conduct sweeps of the catchment with predator-dogs.
- Declare clear when no animal is detected after a suitable search effort and time has elapsed (this will be subject to expert review).
- Timing. August for twelve months or as required.

[3] Environmental DNA.

Resource and costs – Phase three

See the separate cost sheets supplied for details of costs. Following is a summary of the costs for Phase three – Post aerial operation.

Labour	Field Operations Leader, Ungulate team, Aerial Ops team, Field team, Data specialist. Dog handlers Up to 48 FTE for one-month reducing to 14 FTE after nine months	
	@ $62 per hour average	$3,447,696
Materials	Baits, lures, cameras, storage, freight, consumables, miscellaneous	$ 475,682
	Total Post aerial operation	$3,923,378

16. Maintain a biosecurity response system

Following the eradication, an ongoing programme must be maintained to detect and deal to any incursions. This ongoing operation is covered in the next section of this study with a separate paper for details. Appendix N. Maintaining a pest free status.

17. Permits and other requirements

Following are the permits and other requirements for the operation.

Medical Officer of Health. To discharge toxin in a public water supply area.

Wellington Water. To discharge toxin and maintain animal control operations in the catchment.

18. Resource and cost estimates

Following are the resource requirements and cost estimates for the operation.

Human resource

The eradication is a major undertaking which will require a substantial human resource commitment. The personnel will change during each phase to accommodate the different tasks to be undertaken.

Pre-aerial operation the team will consist of the following.

- A Project Manager to plan and resource the whole project and supervise the team leaders. Note. Costs for the Project Manager are included under Governance and Management.
- A Field Operations manager to manage the network operation and supervise teams of field workers, including an animal collaring team. This is a full-time and permanent position.
- Ungulate Team supervisors with contract hunters under them.
- A line clearing team to cut tracks and lines. These are temporary positions.
- An Aerial Project Manager and team to supervise the vital aerial operation.
- Volunteer cells can be set-up to assist the team throughout the operation, as required.
- An expert reference group should be established to advise the Operations Manager and confirm best practice.

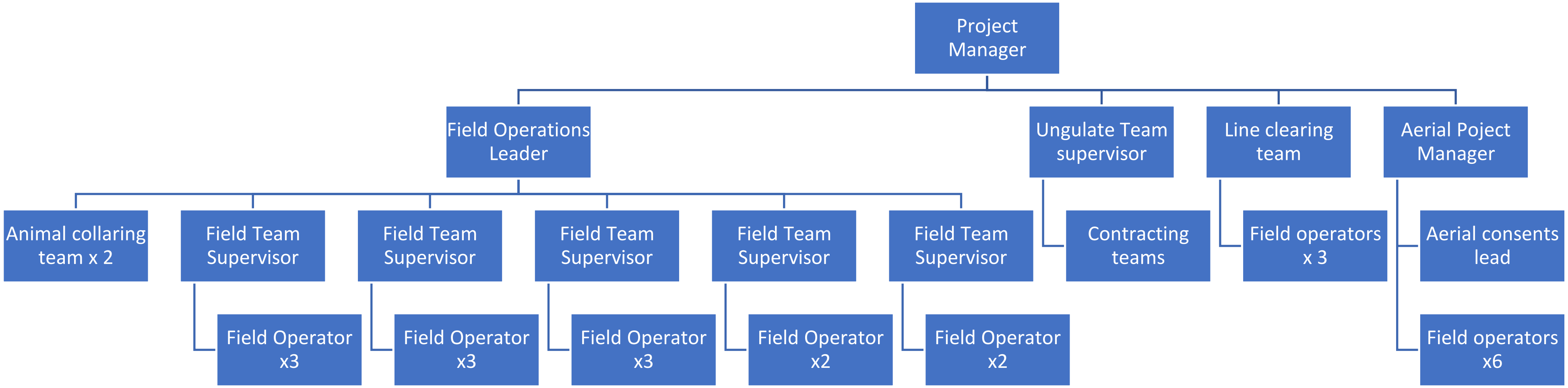
Post-aerial operation the team will consist of the following.

- A Project Manager to plan and resource the whole project and supervise the team leaders.
- A Field Operations manager to manage the network operation and supervise teams of field workers. This is a full-time and permanent position.

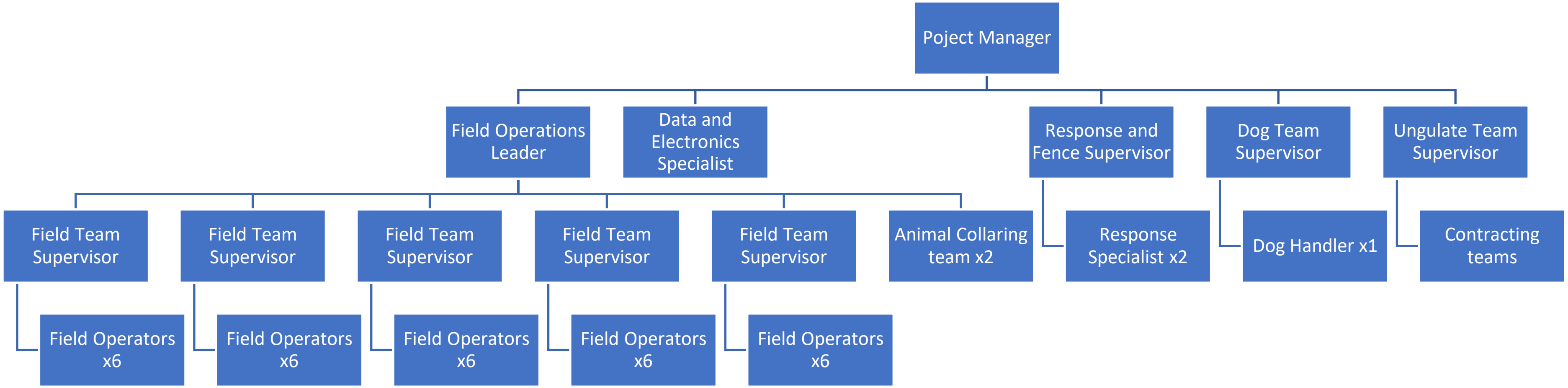
- A data and electronics specialist to establish numbers for all devices, map these and develop a recording and reporting programme
- One Ungulate Team supervisor with contract hunters under them to complete the eradication.
- A response and fence team. These are permanent positions.
- A dog team to monitor for residual pests and incursions.
- A data and electronics specialist.

See next page for a structure chart of the pre-and post-aerial operation.

Pre-aerial operational structure (First twelve months)



Post-aerial operational structure (twelve months)



Facilities and equipment

The field team must be well equipped to handle this demanding task. Facilities and equipment needed include the following.

- A field base (shed and workshop) to store equipment and park vehicles under cover. This can include offices and meeting room. (Note this should be large enough to accommodate the species team in due course).
- A staff house for on-site and/or duty personnel. (Note, the existing houses could suffice for this).
- Vehicles – including four-wheel drive utility vehicles fully equipped as mobile fence repair workshops and LUV vehicles.
- Radios and communications.
- A range of tools such as chainsaws and scrub cutters.
- Safety gear, fire control and rescue equipment.

These items will mostly be one-off capital purchases which can be acquired at the start of the operation and become part of the routine asset management programme. They have been included in the materials and equipment cost projections.

Inventory

Some facilities and equipment are already on-site as part of the GWRC ranger operation. A full inventory of existing facilities and equipment will be needed to see if any can be transferred to the sanctuary operation and on what terms.

Cost summary

Costs (excluding GST) are estimated for the operation as follows. See cost sheet for details.

Operating costs two years

Phase	Units and explanation	Year 1	Year 2
Phase One. Pre-aerial operation (First twelve months)	Labour Materials & equipment	$1,541,568 $3,712,808	
Phase two. Aerial operation.	Labour Materials	$479,136 $857,400	
Phase three. Post Aerial operations (Second twelve months)	Labour Materials		$3,447,696 $475,682
Totals		$6,590,912	$3,923,378

Total cost for first three phases - two years $10,514,290

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19. Risks and contingencies

The eradication is a high-risk operation. The risk is raised by the scale of the operation which will be equivalent in size to the largest mainland eradication ever undertaken (Maungatautari). It also spreads across several years and is dependent on some factors over which we have no control (weather and seasonal fluctuations). Accordingly, this operation will need to be planned and executed with great care and precision and must be resourced adequately.

Following is an analysis of the risks involved and how those risks can be dealt with or mitigated.

Risk	**Likely or significant**	**Prevention**	**Mitigation if it happens anyway.**
MOH restrictions greater than expected. WW objections	Unlikely but significant	Early discussions with MOH and WW (during feasibility study.	Adjust or review the intended programme to accommodate them.
Fence construction delayed beyond March of a calendar year	Likely but not significant	Align eradication with construction programme	Reassess schedule. This may cause a year's delay.
Mast year occurs.	Likely and significant	Undertake phenology monitoring to predict mast. Adjust programme.	Delay if mast year occurs.
Residual pest populations	Unlikely Significant	Excellent project management	Hunt down remnants. Rodent remnants will mean operating the grid.
Inclement winter weather	Likely Significant	Allow for in planning window	Adjust time frames
Cost overruns	Likely and significant.	Careful costing and allow for contingencies.	Reassess costs before the operation commences.

20. Conclusions

The following conclusions have been drawn from this study.

1. It is feasible to eradicate all target animals from the fenced area (3,313 ha) apart from mice (see below). There are precedents for a site of this scale and up to date best practice suggests it is challenging but achievable.

2. It is unlikely that mice can be permanently removed from the site. If eradicated they will most likely find their way back in due course. However, attempting their removal is justified given that it will not alter the costs of the multispecies eradication, the associated biological benefits, and the potential for successfully defending the area from mouse re-establishment.

3. Because the site is so large and high-profile species will be on site (kākāpō), we recommend a risk reduction approach and an optimum methodology. This will require

additional people and funding above what would typically be allocated to a community-led fenced sanctuary.

4. The recommended method is as follows.

    1) Establish a 75-metre monitoring and incursion response network of tracks and lines across the entire catchment with detection or kill devices at 50 metre intervals on each line. Hunt out ungulates.

    2) Aerial application of toxin.

    3) Complete removal of remnant pests and confirmation of eradication.

5. Costs for the two years are assessed as $10,514,290 which includes all labour and materials and fully equipping and housing a team which at times will number as many as 45 on site (for short periods) and generally will require about 13 permanent staff.

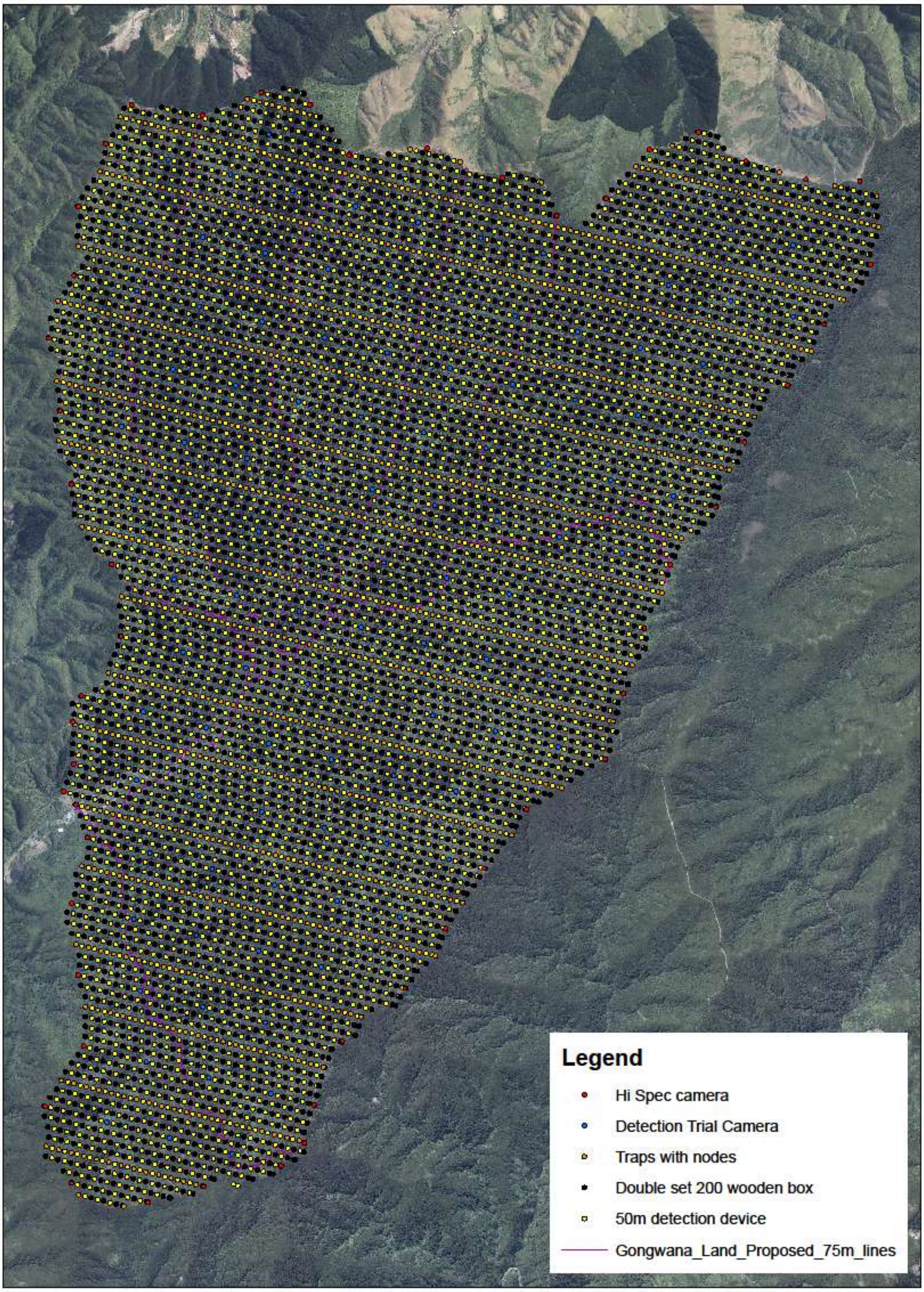
6. There are significant risks in this operation – although the design of the programme is intended to minimise those risks and there are realistic contingencies.

21. Credits

Prepared by: James Lynch (Project advisor) and Glen Falconer (GWRC Biosecurity)

Contributors. Keith Broome, Helen Nathan, Ricky Clarkson, Kim Broad, James Matthews.

22. Appendix – Surveillance and response network



Wainui Fence proposed 75x50m grid

Date printed: 3/09/2021

0 0.5 1 Km

Greater Wellington Te Pane Matua Taiao

APPENDIX N:

Maintaining a Pest Free Status

Wainuiomata Sanctuary Feasibility Study

Paper No:	**Appendix N**
Title:	**Maintaining a pest free status**
Date:	**4th October 2021**
Authors:	**James R. Lynch** Project Advisor; **Glen Falconer** GW Biosecurity
Reviewed by:	**Keith Broome** DOC**; Ricky Clarkson** GW**; Helen Nathan** ZIP

1. Introduction

An important question for the feasibility of the project is "can the catchment be kept pest free over time?" The catchment is a large and rugged forested zone which will house highly sensitive species and it is vital that it can be kept predator-free permanently. Therefore, once the pest- proof fence has been constructed, and all pests eradicated from the catchment a system must be maintained to prevent any animals from re-entering.

If there is an incursion, then a response system must be in place and ready to manage incursions. Other problems such as weeds, exotic birds and fish and natural events may also need to be managed. This paper analyses whether or not this is feasible, the best options to achieve this and the costs and risks involved.

It is assumed that the fence will be constructed around the proposed fence route and all species have been removed from the fenced area.

Note. The species reintroduction and management part of the ongoing operation is dealt with in a separate section. 2.12. Restoring Species to the Site.

2. How we approached the task

The question was considered by the eradication working group as part of their remit. See section 2.10 Eradication of pests and Appendix M.

Costs and resources for the ongoing operation have been assessed by the GW Biosecurity team in consultation with the working group.[1]

3. Precedents and similar operations

There are a number of precedents that are comparable to Wainuiomata. The most comparable is Sanctuary Mountain/Maungatautari. A representative from this sanctuary has been consulted and involved in the study.

Sanctuary Mountain/Maungatautari is 3,400 ha located in farmland near Cambridge. A perimeter fence was constructed there in 2006. All pests were eradicated from the fenced area in 2007/8, however mice subsequently reinvaded. Many species have been successfully translocated on to the mountain, including tīeke and hihi, which are the most sensitive to predation. Maungatautari is an excellent analogue for Wainuiomata due to its size and fifteen years of experience in managing a large, primarily biodiversity focused operation and from dealing with semi-regular pest incursions. Maungatautari intends to introduce a small number of kākāpō to the site shortly. Wainuiomata's proposed fence line is 10km shorter than the Maungatautari perimeter. The Maungatautari annual operating budget is approximately $1,400,000 pa.[2]

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[1] Appendix Q**.** Wainuiomata Eradication method and cost sheet. Glen Falconer, September 2021
[2] Maungatautari Annual Report. (2020).

There are five other fully ring-fenced community sanctuaries in New Zealand which have been operating for some time. These include.

Zealandia (Wellington City). 225 ha. Fence 8.6 km. Fenced 1999. Eradication 1999. Zealandia is not regarded as the best analogue as it is in a more mature phase, operates a high-volume retail visitor/education and higher-cost corporate model and the fenced area is much smaller. Zealandia's annual operating budget is $6.45 million pa[3]

The remaining sanctuaries are regarded as too small or too dependent on voluntary work to be usefully analogous to Wainuiomata, but all have managed to maintain an essentially pest free (bar mice) status despite incursions.

Predator fencing is a proven technology which has been operating for twenty-two years and has allowed the successful reintroduction of even the most threatened species. With the exception of mice, all fenced community sanctuaries have been able to deal with incursions and maintain a pest-free status.

4. Objective

The objective of this operation is to.

Maintain a pest free status over time.

Mice

Note; while eradication of mice will be attempted, the chances of the permanent removal of mice from the catchment are remote. There is currently no instance of mice being removed permanently from an area of this size on the mainland.

The presence of mice will cause management problems including, reduced carrying capacity due to consumption of fallen fruits and seeds, predation of invertebrates, and interference with tracking and monitoring systems. Mice should not unduly interfere with the primary purpose of providing habitat for threatened avian species.

Recent research suggests that mice limit populations of several indigenous invertebrate groups, but mice alone are definitely preferable to having all the other pest mammals present.[4]

5. Managing risk

As with the eradication, the risks of incursion are much greater due to the scale of this operation (3,313 hectares) and the presence of high-profile species (kākāpō) for which loss by predation is not acceptable. There is no room for experimentation, and it is essential that only proven methods are used. It is essential that the enterprise is resourced to succeed. See the section on risks and contingencies.

6. Limitations

The ongoing operation must be undertaken without undue disruption to or degradation in quality of the water supply from the catchment. Animal welfare and health and safety regulations must be adhered to.

[3] Zealandia Annual Report. (2021)
[4] Watts, C. et al. (2017). Impacts of mice alone on biodiversity: final report of a Waikato field trial. Landcare Research

7. Overall strategy and process

The preferred overall strategy for maintaining the operation is as follows.

1. Establish a permanent monitoring/incursion response network. (Done as part of the eradication. See Appendix M. 'Eradication of pests' for details of the network.).
2. Maintain the network and surveillance system.
3. Maintain the fence and route.
4. Respond to all incursions.
5. Manage other threats.

This strategy is expanded in the following sections.

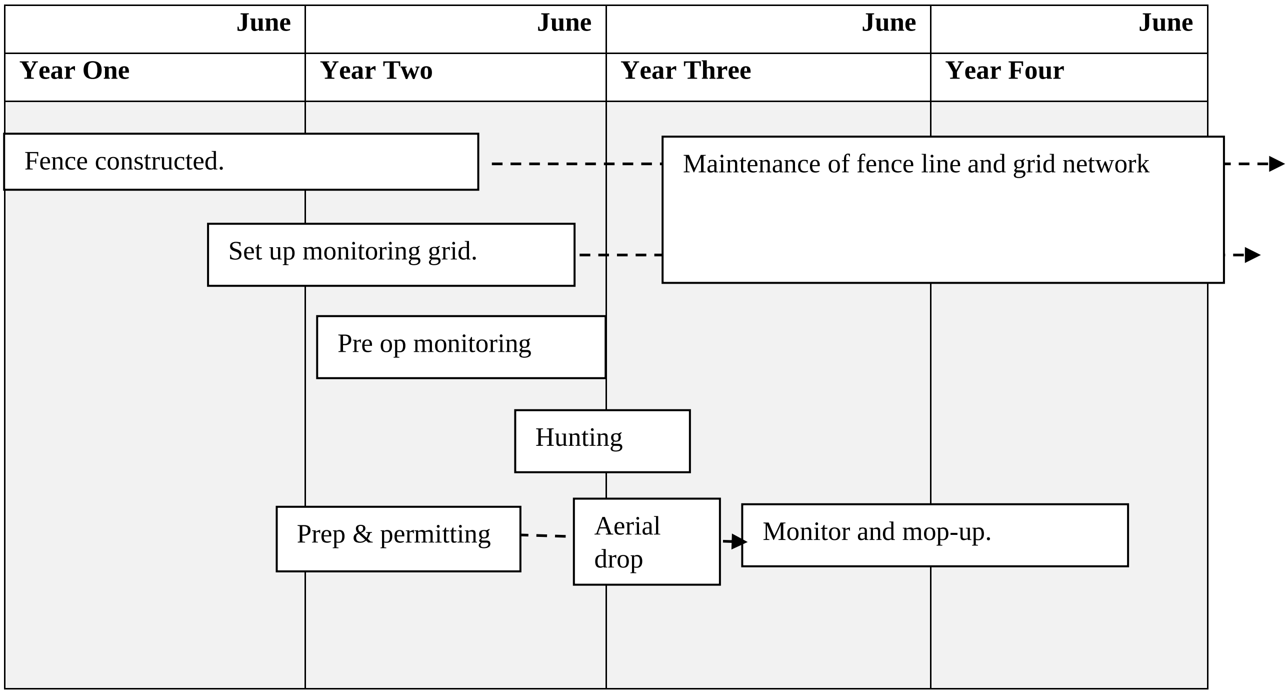
8. Timing

Timeline

The eradication is not considered complete until the catchment has been declared 'pest free' – at least one year after the completion of the aerial toxin application.

The maintenance phase begins when the catchment is declared 'pest free'.

Following is a schematic timeline for the operation.



9. Maintaining the network and surveillance system.

Once the catchment has been declared 'pest free' the surveillance network must be maintained and serviced sufficient to ensure it is ready to be deployed fully in the event of an incursion and to detect the presence of pests.

- For ongoing surveillance, the lines with cameras and perimeter cameras will be checked monthly. All devices and traps on these lines will be rebaited and kept active.

- A portion of the rest of the network will be checked on a regular basis (3 monthly) and a portion will contain trap nodes that will alert if triggered.
- Other parts of the network will be used on random audits and when needed for incursion response.
- All cut lines will need to have a maintenance programme, so if an incursion occurs these areas can be accessed quickly without delay and operational activities deployed.
- The maintenance operation will require a dedicated field operations team with a team leader and four Field Surveillance Officers. (See operating structure). This team can be augmented by a data specialist, a dog handler and volunteers organised through a volunteer co-ordinator.
- An operating budget assessed at $420,998 pa will be required for materials, equipment maintenance and consumables.

10. Maintaining the fence and route

As soon as the fence has been 'handed over' by the contractors, it will need to be patrolled and maintained for defects and damage. A brand-new fence doesn't necessarily mean less maintenance in the short term as there will be a period of 'settling down' of the overall structure and construction defects. Weather events will create immediate issues including possible damage to the road and fence. Construction defects will be covered by warranty but will still consume staff time to resolve.

- A stock of fence components should be ordered with the fence construction (as part of its contingency ordering) and stored ready for use. Enough for five years should be provided for. After that new componentry will need to be ordered and stored.
- The fence will be fitted with an alarm system to signal base when there has been a break in the wire. These signals will trigger a call out.
- The road and fence will be inspected every two to three days initially and then at least weekly, or when a callout is received or immediately after major weather events. Fence patrols or callouts must have two people present. All personnel must be trained in communications and first aid as the far end of the road is quite remote. Some volunteers could be recruited and trained for routine fence patrol but cannot be fully relied upon. A camera drone could be used for immediate surveillance to aid call out response.
- The fence team should be equipped with 4WD vehicles kitted out as mobile repair platforms with the capacity to take fence componentry and all tools needed for tree removal and repair. At least two vehicles will be required to allow for downtime.
- The road will require routine maintenance in the form of grading of rough sections and trimming of vegetation growth. As it will not be worthwhile purchasing the equipment needed for this it would be more cost effective to have this work done by contractors. Contractors may also be required for emergency fixes. An annual budget of $70,000 should be allowed for this task.
- The fence maintenance operation will require a dedicated Response and Fence team with a team leader and two response Officers. (See operating structure). This team can be augmented by volunteers and the field team in emergencies.
- Some materials will be catered for through the general Field Team budget. e.g., vehicle running and maintenance, various field consumables. However, an additional operating budget assessed at $50,000 pa will be required for materials, equipment maintenance and consumables specific to fence maintenance.

11. Responding to incursions

Incursion readiness and response is a vital part of the success of fenced sanctuaries. The Response and Fence team must be always in a state of readiness and have immediate support from the field team if needed.

Maungatautari experiences up to 90 callouts each year, only about ten of these result in incursion responses and animal removal. Most of these are due to treefall on the fence.

Wainuiomata should have less of this to contend with as the new section of fence is only 15 km (out of 28 km total length) compared to Maungatautari's 48 km. The 13km deer fence on the western and northern boundaries is stable and rarely experiences tree fall damage.

- Each call-out must be responded to and assessed for its seriousness. If it is possible that an animal incursion has occurred, then a full response can be triggered. This will result in the loading of as much of the network as deemed necessary. The response is maintained until it is certain the animal(s) have been removed.
- A response will typically involve all field staff including dog handler and the data specialist. Outside assistance (GW and DOC) and volunteer help can be called upon if required.
- No additional resource is required as the responses are allowed for in the various team budgets as above.

12. Managing other threats

There will be a need to manage other threats to the biodiversity or the sanctuary operation as they arise or become priorities. These include invasive weeds, pest birds, wasps, pathogens and security breaches by unwanted visitors, including intrusions to the perimeter road. These are unlikely to be major issues in the short term but will need to be assessed for priority and resources allocated accordingly.

- Invasive weeds are managed in the catchment (roadsides, blackberry, buddleia, etc) and funds are allocated for weed control of several species. This work will need to continue.
- Magpies are present in the lower recreation area. Not managed at present.
- Wasps are present in the lower recreation area and beech ridges and could become a problem if feeders are used.
- Wellington Water operates a security system, and this would need to extend to the sanctuary infrastructure and assets. There is a resident ranger on site, shared between Wellington Water and GW and this arrangement would need to continue.
- The sum of $20,000 pa should be allowed for miscellaneous threats and $50,000 for shared security and on-site ranger.

13. Species reintroduction and management programme

Once there is confidence in the pest free status of the catchment, then the primary purpose of reintroducing threatened species can be undertaken. This is dealt with separately in the following section and paper.

14. Resource and cost estimates

Following are the resource requirements and cost estimates for the ongoing operation of the sanctuary.

Human resource

When the eradication has been given the all-clear, there will be a reorganisation of the project team to consolidate into an ongoing operational mode as follows.

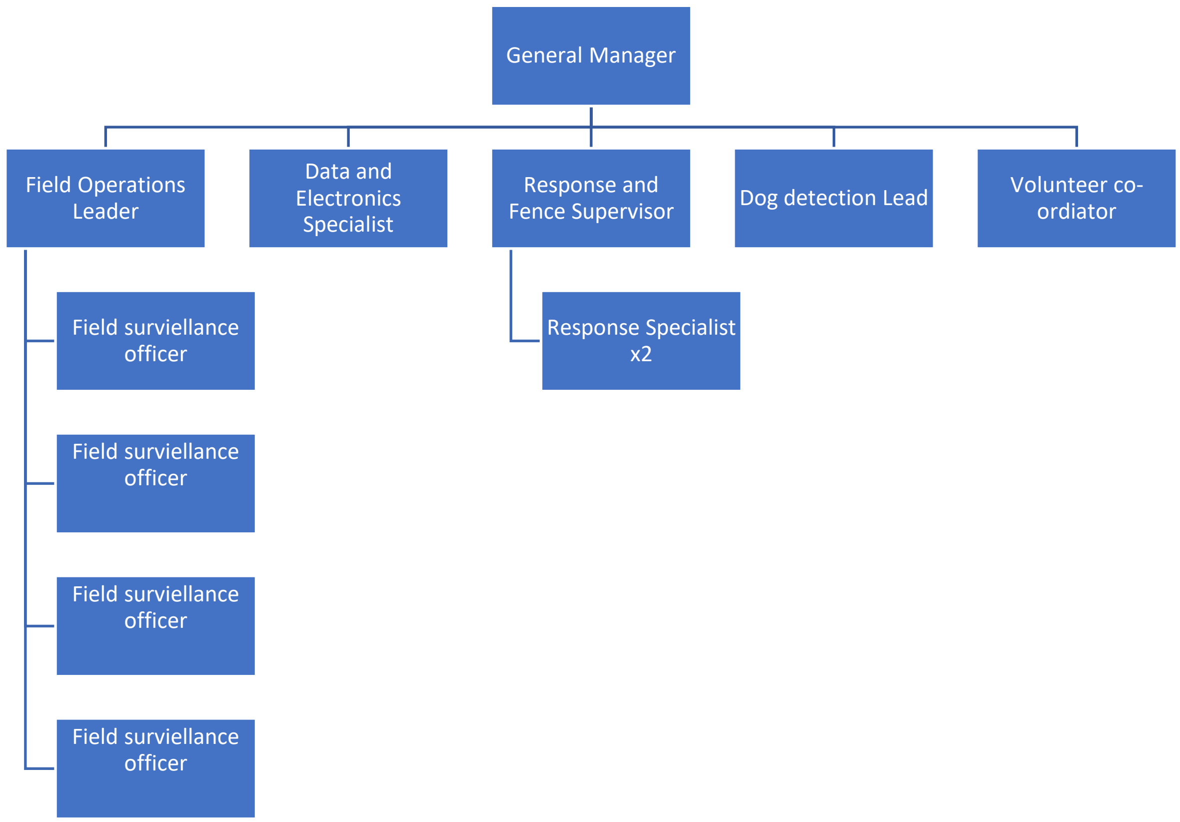
- A Project Manager to plan and resource the whole project and supervise the team leaders. Note. The Project Managers costs have been included in the Governance and Management costs (Section 2.1).
- A Field Operations manager to manage the network operation and supervise a team of four field workers. These are full-time and permanent positions.
- A response and fence team of three persons. These are permanent positions.

- A dog handler to monitor for residual pests and incursions.
- A data and electronics specialist.
- A volunteer co-ordinator.

See below for a structure chart of the pre-and post-aerial operation.

Note. The species management operation is dealt with separately.

Post eradication operating structure.



Facilities and equipment

The field and response teams' equipment and materials will carry over from the eradication but there will need to be an annual operating budget to allow for the following.

- Refreshing lures and monitoring equipment (tunnels boxes etc)
- Replacing worn and damaged equipment and tools.
- Vehicle running and servicing.
- Radios and communications.
- These have been included in the materials and equipment cost projections. Fence and road maintenance - materials and contractors and other threat management and security have been added to the overall costs.

Cost summary

Costs are estimated for the ongoing operation as follows. See cost sheet for details.

Operating costs two years

Phase	Units and explanation	Per annum
Ongoing field and fence operations	Labour	$1,374,992
	Materials	$420,998
	Fence/road maintenance/fixes	$120,000
	Other (weeds, security)	$70,000
	Totals	$1,985,910

15. Risks and contingencies

The operation to maintain a pest free status is well known and proven. However, there are risks as follows.

Risk	Likely or significant	Prevention	Mitigation if it happens anyway.
Mice cannot be kept out	Likely and significant	Mouse proof fence and strict biosecurity measures.	Live with mice.
Animal incursions through fence breeches or biosecurity failure.	Likely and significant	Fence patrol and maintenance and strict biosecurity procedures	Maintain a rapid response capability and maintenance of the network. (Allowed for)
Cost overruns	Likely and significant.	Careful costing and allow for contingencies.	Reassess costs before the operation commences.
Tree fall risk greater than expected	Likely and significant	Tree trimming and maintenance allowed for in costings.	Allow contingency (15% allowed for on whole project).

16. Conclusions

The following conclusions have been drawn from this study.

1. It is feasible to maintain a pest free status in the fenced area. However, to achieve this will require the ongoing operation of a permanent surveillance and response system.
2. This will involve strict biosecurity procedures, ongoing 24/7 fence surveillance and maintenance and the permanent operation of the surveillance network.
3. It is unlikely that mice can be permanently removed from the site. If eradicated they will most likely find their way back in in due course. However, their removal should be attempted and their presence in the catchment should not impede the primary purpose of the site.
4. Other threats, including weeds, pest birds and fish, wasps and security will need to be managed.
5. As with the eradication, and because the site is so large and high-profile species will be on site (kākāpō) the recommendation is for a risk reduction approach and an optimum methodology. This will mean additional resource and cost (without extravagance).
6. Annual operating costs for maintaining a pest free status are assessed as $1,985,910 which includes all labour and materials for eleven permanent staff.
7. There are significant risks in this operation – although the design of the ongoing operation is intended to minimise those risks and there are realistic contingencies.

17. Credits

Prepared by: James Lynch (Project advisor) and Glen Falconer (GWRC Biosecurity)

APPENDIX O:

Restoring Species to the Site

Wainuiomata Sanctuary Feasibility Study

Paper No:	**Appendix O**
Title:	**Restoring Species to the Site**
Date:	**7th October 2021**
Authors:	**James R. Lynch**
Reviewed by:	**Paul Jansen** DOC; **Amanda Cox** GW

1. Introduction

We assume that, once pests have been eradicated from the catchment, it can be kept clear in perpetuity and missing extant species can be returned to the site. This process of fenced sanctuary development is also well tested, and the costs are well known.

Questions to be answered include

1. When can species be reintroduced to the catchment?
2. How should these be managed?
3. What will this cost to operate long term?

It is assumed that the fence will be constructed around the proposed fence route, all pest animal species have been removed from the fenced area and the incursion and response system can keep the fenced area clear of all species bar mice.

2. Methodology

The method employed in answering the question was as follows.

1. Discussion with species managers and recovery group leaders.
2. Reference to precedents and analogues from other fenced sanctuaries. There is a large body of work to draw on in this area with established technology.
3. Reference to the DOC discussion paper regarding which species could be translocated to Wainuiomata.[1]
4. Review of the document with experienced practitioners in the field, including people who know the catchment intimately.

Costs and resource have been assessed in consultation with the working group.

3. Precedents and comparable experience

There are five fully ring-fenced community sanctuaries which have successfully translocated sensitive threatened species onto the mainland.

Sanctuary Mountain/Maungatautari is 3,400 ha located in farmland near Cambridge. Many species have been successfully translocated on to the mountain, including tīeke, hihi and takahe, which are the most sensitive to predation. Kokako, kākā and NI brown kiwi have also been established and kākāpō are planned

[1] Appendix C. Assessment of Possible Benefits to Biodiversity. DOC Terrestrial Science

to be released there. Maungatautari is an excellent analogue for Wainuiomata due to its size, although it does not contain the rimu-dominant habitat found at Wainuiomata, which is critical for the establishment of a kākāpō breeding population. In addition, Maungatautari is isolated within a farmland landscape, unlike Wainuiomata which is adjacent to large areas of contiguous forest.

There are four other fully ring-fenced community sanctuaries in New Zealand which have been operating for some time. These include.

Zealandia (Wellington City). 225 ha. Fence 8.6 km. Fenced 1999. Eradication 1999. Sixteen species reintroduced, including hihi, tīeke, kiwi pukupuku, tuatara, kākā, red crowned kākāriki, NI robin and giant weta. Zealandia is in a largely urban environment within the city's green belt.

Bushy Park. Wanganui. 100 ha. Fence 4.8km. Fenced 2005. Eradication 2005. Tīeke, hihi and NI robin present. Bushy Park is isolated within a farming landscape.

Orokonui. (Near Dunedin). 307 ha. Fence 9km. Fenced 2007. Eradication 2007. SI Robin, SI kākā, Haast tokoeka kiwi, tuatara, lizards, takahe present. Orokonui is in a peri-urban location with some connectivity to nearby forest.

Rotokare (near Stratford). 250 ha. Fence 8.2 km. Fenced 2008. Eradication 2009. Tīeke, hihi, NI robin, kiwi present. Rotokare is isolated within a farming landscape.

Brooke Waimarama. (Nelson). 690 ha. Fence 14.4km. Fenced 2016. Eradication 2017. The reintroduction programme is just beginning. Like Wainuiomata, Brooke is adjacent to a large contiguous forest zone.

The conclusion is that it is feasible to reintroduce a range of sensitive threatened species to the fenced area. Predator fencing is a proven technology which has been operating for twenty-two years and has allowed the successful reintroduction of even the most threatened species.

4. Objective

The objective of this operation is to.

Reintroduce representative indigenous fauna to the fenced area.

The highest priority will be those critically endangered species for which the catchment will provide sufficient quality habitat to significantly alter their threat status in the medium term. These are.

- kākāpō *(Strigops habroptilus)*,
- rowi kiwi (*Apteryx rowi*) and/or kiwipukupuku (*Apteryx owenii)*, and
- hihi/stitchbird, (*Notiomystis cincta*). See section 2.3 Biodiversity value for the rationale behind this.

The catchment has been assessed by DOC Terrestrial Science and the recovery groups for its suitability for these three species and has been declared suitable.

We expect that this objective will be actively pursued as a priority as soon as the catchment is declared safe.

There are six to eight other representative species which are absent from the catchment and region that will benefit from the safe habitat. (See Appendix one and below). As safe habitat of this quality and size is rare and valuable, it is imperative to optimise the use and value from it and to realise its potential fully over time.

This requires a systematic long-term programme of species re-establishment.

5. Reintroduction potential of representative species

Representative means ‘of the location’. As is standard practice, only species which were historically found in the Wellington region will be reintroduced to the catchment.

See Appendix B for a full list of fauna representative of the Wellington region.

As with most of the Remutaka range, fauna species have been considerably depleted since European settlement and few nationally endangered species reside in the catchment. The general locality was notable for being the last stronghold of the huia (last official sighting in the Tararua 1907). The last sighting of kākāpō in the North Island was reportedly in Whiteman’s Valley on the north boundary of the catchment in 1905[2]

A summary of the current state of the representative vertebrate forest fauna for the catchment is included in Section 2.3 Biodiversity value. See Appendix B[3] and C[4] for a full assessment of the vertebrate forest fauna in the catchment.

This indicates that, in addition to the three high priority species, the catchment has the potential to re-establish over thirty species. Two bats, twelve forest birds, three freshwater birds, eleven reptiles, one amphibian, five freshwater fish, plus a yet to be determined number of mega-invertebrates and threatened plants.

In reality it will be much less than that as the methods to establish some species (e.g., bats) do not exist, the habitat may be marginal or prove to be unsuitable (freshwater birds) and further lizards and plants may be found or emerge when pests are eradicated.

The DOC assessment of ten to twelve priority species is a start point and can be built on in the future.

6. Issues with species reintroduction

Relevant issues which govern species reintroductions in fenced areas are as follows.

Intact forested areas. The proximity of intact contiguous forest to the fenced area is an advantage for migration of robust and established species beyond the fence. However, it can present difficulties for reintroductions by encouraging unwanted early migration from the founder population, thus reducing the chances of the species settling into territories and establishing breeding pairs. Most eco-sanctuaries are in isolated patches, and it is not clear how mobile species will respond to release in a large, densely forested and well-connected area such as Wainuiomata.

Variability amongst species. Species vary in the ease of procurement of stock, the costs and complexity of translocation and the degree of public and iwi engagement. Some such as kākāpō will have enormous public interest, complex iwi engagement and substantial post release requirements. However, they are relatively simple to procure and will not migrate out of the catchment. Kokako are difficult and expensive to catch and transfer and can move some distance on release, whereas kiwi are easy to capture and establish. Some species require multiple transfers, others need a single release. Some can be released and left alone. Others will demand close order management. This makes it difficult to forecast the costs of a programme until the species and priorities are known.

Time. Species reintroductions take time to execute and can require very long timeframes for populations to establish and grow to carrying capacity. Reintroductions are generally seasonal and mostly small scale – seldom involving more than fifty individuals. Reintroductions depend on the availability of stock and sometimes require quarantine periods for captured animals. Small founder populations and natural loss will often mean low growth rates and a slow initial build up until exponential growth eventually kicks in, which

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[2] P. Jansen pers. comm.
[3] Appendix B. Wellington Representative Fauna
[4] Appendix C. Assessment of Possible Benefits to Biodiversity. DOC Terrestrial Science

can take many years for most species. Wainuiomata is a huge catchment, and it could take up to thirty years for some species to reach carrying capacity – kiwi being a good example. This means that planners (and stakeholders) need to take a long-term view.

Permitting and engagement. Most threatened species are subject to a recovery plan and all species require an assessment and permitting process. All will require iwi leadership, with several iwi often involved, which will take time and resources to enable and support. Public engagement and communication is also important for many high-profile species. Species reintroductions are attractive to philanthropic donors and sponsors. While this can substantially defray costs it also requires careful management.

The implications are that Wainuiomata will need to have a well thought out and well-resourced programme for species recovery to ensure the objective is achieved. Each release needs to be meticulously planned, well-resourced and rigorously executed to ensure success.

7. Developing a species recovery plan and programme

An essential early task is to develop a comprehensive Species Recovery Plan which will guide the process.

- A detailed ten-year plan will be prepared which will set out the species to be reintroduced, the order of priority, the timetable, risk management and the resources and cost required. The priority will be set by such things as the urgency for new habitat for some species, the need to raise public support, intra-species competition, available funds and sponsorship, etc. The plan needs to be flexible enough to take advantage of opportunities as they occur and be adjusted when things don't go as expected.
- Each species reintroduction will have its own comprehensive project plan which will last until the species is breeding and secure. This project plan will detail the process for that species and assess the risks and costs.
- Species reintroductions will require a carefully thought out and executed programme which could take ten to fifteen years depending on available resources and the success rates of various species. Up to twelve species could be reintroduced to the catchment over this time.
- It can be assumed that the species programme will not get underway fully until there is confidence in the catchment's security, at which point the monitoring can be reduced and the resource saving can go towards species management tasks.
- Incursion monitoring and species monitoring, and management can be integrated to a considerable extent. Volunteers can be used for aiding with routine tasks (feeding, monitoring, banding, etc). Species work is popular with volunteers.

8. Partner support

It can be assumed that DOC will be able and willing to provide technical and logistic support for the species programme as required. This will be especially important for facilitating and resourcing the higher priority species which have funding avenues for translocation.

9. Timing

No species work can commence until the catchment has been declared free of pests and there is full confidence in the effectiveness of the fence, the biosecurity procedures and the incursion and response system. In the best scenario, the first reintroductions are likely to occur in the second year after the all-clear has been given (year eight or nine of the overall programme).

10. Resource and cost estimates

- As identified in 6 above the high variability amongst species makes it difficult to forecast what resource would be required until a detailed plan has been developed. This can only be done when the team is in place.

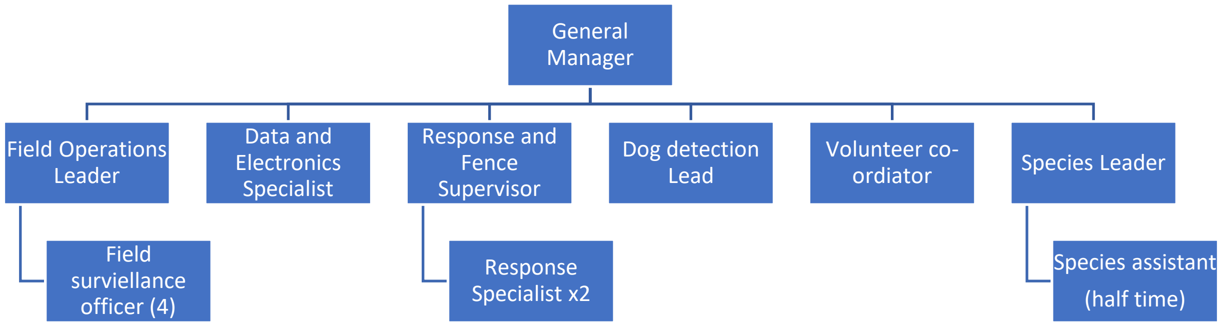
- It would be undesirable to build a large onsite team of species specialists as in due course when the fence and biosecurity are proven, the field team can be redeployed to assist in species work. Much routine species work (e.g., monitoring of species presence) will be integrated into routine field tasks such as lines maintenance or automated with the network.
- Translocations result in short intensive bursts of work which is best handled by specialist contractors. There will be little call for ecosystem restoration activities such as planting and due to the size and quality of the habitat, activities such as feeding will only be required short term to assist establishment of populations.
- A species team of one and a half, including a leader and a part time contractor, will be established after the eradication. This team can be augmented by using any downtime in the other teams and by partner agency staff.
- A species translocation can cost as much as $300,000 and as little as $50,000 depending on many factors. Some species will require a series of translocations and considerable post release care. Others will require one release and little after-care. Some species will be funded via DOC and the recovery groups, and some will attract sponsorships.
- For this study, it is assumed that a maximum of two species can be reintroduced each year for the last two years of phase one (the first ten years) with at least three releases per annum at an average of $75,000 per release; total per annum $225,000.
- These costs would include permitting and engagement, travel and capture costs, veterinary services and treatment, and such equipment (radio transmitters, holding aviaries, feeding stations, etc) and materials (bands, food, consumables, etc) that were needed for each species.
- Sponsorships, donations, and other funding sources can be assumed to provide an additional contingency or 'top up'.

Following are the resource requirements and cost estimates for the ongoing operation of the sanctuary.

Human resource

- A Species Team Leader to plan and co-ordinate the whole programme and supervise the various projects.
- A half time species specialist to back up the Species Leader.
- This team can tap into the shared resource of the communications and fundraising staff, data and electronics specialist and the volunteer co-ordinator.
- As confidence in the security of the catchment increases and the surveillance programme is reduced, the field team can be deployed to assist on species management tasks.

Post eradication operating structure.



Facilities and equipment

The species team will be able to tap into the pool of vehicles, communications, and field equipment available to the other teams. The funds for translocations will cater for other specific species materials and resource costs.

Cost summary

Costs are estimated for the ongoing operation as follows. See cost sheet for details.

Operating costs two years

Phase	Units and explanation	Per annum
Ongoing species management operations (from year eight onwards)	Labour. 1.5 at $10,416 per person per month (GW standard cost rate) Project funds 3 projects per annum @ $75,000 per project.	$187,488 $225,000
	Totals	$412,488

11. Risks and contingencies

Risks lie with the eradication and with the surveillance and incursion response. Because of the nature of species management, specific risks are associated with each project and would be identified in the project plans.

12. Conclusions

The following conclusions have been drawn from this study.

1. It is feasible to reintroduce a range of sensitive threatened species to the fenced area. Predator fencing is a proven technology which has been operating for 22 years and has allowed the successful reintroduction of even the most threatened species.
2. The catchment has been assessed by DOC Biodiversity and found suitable for three priority species: kākāpō, kiwi and hihi. DOC has determined that establishing populations of these birds in Wainuiomata could significantly change their threat status.
3. The catchment has the potential to allow over time the reintroduction of a further seven to ten species of birds, invertebrates, plus various fish, reptiles and threatened plants.
4. This requires a long-term species recovery plan and programme. Each species requires its own project plan and the approach for each will vary a lot.
5. No reintroductions can be undertaken until the catchment is declared secure and there is confidence in the incursion response system. This is unlikely to be before year eight.
6. Because of the variability amongst species, it is difficult to project resource requirements but a team of one and a half species specialists would be required with an annual project budget. Total costs are assessed as approximately $415K per annum.
7. Risks with species reintroduction vary between species and will be assessed at the time with each species.

James R. Lynch

Project Advisor

APPENDIX P:

Managing the Halo

Wainuiomata Sanctuary Feasibility Study

Paper No:	**Appendix P**
Title:	**Managing the 'Halo'**
Date:	**20th October 2021**
Authors:	**James R. Lynch**
Reviewed by:	**Angus Hulme-Moir** DOC**. Amanda Cox** GW. **Geoff Cameron.** RCT

1. Introduction

We assume that, with a fence in place, species populations will in time increase to carrying capacity inside the enclosed area and migrate outside the fence into the wider forested landscape. Ideally this wider area should be managed to make it more 'bird safe' and increase populations across the Remutaka ranges. This 'halo' effect is not well understood but is known to occur.

Questions for this study are as follows.

1. What are the likely effects on surrounding habitats and communities?

2. What opportunities are there for future partnerships to improve the wider outcomes?

Note. There has not been sufficient time in this study to explore this issue fully. Here we raise the issue for resolution and action in the future.

2. The 'halo effect' from fenced sanctuaries.

The term 'halo effect' was described by the author in relation to the Karori Sanctuary proposal in 1995[1] and expanded on in 2012 by Sir Paul Callaghan[2].

The 'halo effect' refers to the migration of species which is expected to occur from a secure predator-free zone into the surrounding, less secure, habitat. Little research has occurred into migration from fenced areas. The most notable and recent has been in Wellington City, where a significant increase in diversity and abundance of indigenous birds has been recorded in the city environs over the last two decades. This has been attributed to the influence of Zealandia[3]

However, the increase has been restricted to largely four species (tui, kererū, kākā, and red-crowned kākāriki), with other species, still present in Hutt/Porirua/Kapiti, struggling to establish in the city (korimako/bellbird, pōpokatea/whitehead, miromiro/tomtit) and more sensitive species resident in Zealandia but not present in the wider region (toutouwai/robin, hihi/stitchbird, tīeke/saddleback), largely being restricted to Zealandia and its immediate surrounds. As predator control increases around Wellington city, these less robust species are expected to increase in abundance.

However, the presence of a large population of feral and domestic cats in the city represents a significant threat, the exact impact of which is not well known. It is also unclear as to what effect the patchy and largely secondary growth habitat in the city would have on fauna carrying capacity.

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[1] Lynch, J. (1995) Back to the future. Karori-from reservoir to wildlife sanctuary. Forest & Bird. Issue 275.
[2] Callaghan, Sir Paul. (2012) The Zealandia vision for a predator free NZ. You Tube.
[3]. McArthur, N.; Flux, I.; Harvey, A. (2021). State and trends in the diversity, abundance, and distribution of birds in Wellington City. Client report prepared for Greater Wellington Regional Council, Wellington.

The experience from Zealandia demonstrates that the ‘halo effect’ does occur around a fenced area but only for the more robust species, and only if backed up by widespread predator control. The benefit for less robust species could be limited by the continuing presence of unmanaged predators (cats) or the quality of habitat, but this is not yet proven.

Most fenced sanctuaries are either in urban or peri-urban situations or are surrounded by farmland and/or partly by water (peninsulas), the exception being the more recently (2016) established Brooke-Waimarama Sanctuary, which is adjacent to the Mt Richmond Forest Park in Nelson. It is too early to draw any lessons on migration from Brooke-Waimarama.

This means that in most cases, the opportunity for migration into high quality habitat is limited.

3. The opportunity

Wainuiomata represents a unique opportunity to locate a large, fenced area immediately adjacent to a large scale (40,000 ha), contiguous, and lowland beech/podocarp forest habitat and leverage the advantage of any ‘halo effect’.

The forested areas have good connectivity and approximately half is unmodified by logging or fire. The rest is secondary growth. Unlike the city, cats are in low numbers although possum and ungulate browsing is a problem. Generally, the habitat is much superior to Wellington City.

It can be expected that as species populations establish inside the fenced area, they will in time reach carrying capacity and begin to migrate out of the sanctuary into the surrounding habitat.

If this habitat is well managed to minimise the abundance of predators and pests, populations of certain species could establish in the wider ranges and maintain themselves over time with seasonal ‘top-up’ via continuing migration from Wainuiomata. This could result in a major increase in abundance of resident indigenous species and range extension for a number of previously absent but extant species.

4. Which species could benefit?

The experience from Zealandia and other mainland island operations is that the more robust, deeply endemic species will benefit the most from such a programme.

A number of species currently resident in Wainuiomata could immediately benefit and migrate out of the catchment and populate surrounding habitat. These include tui, korimako/bellbird, kererū, yellow crowned kākāriki, titipounamu/rifleman and pōpokatea/whitehead. These species have a good chance of survival in managed habitat. Kererū could do particularly well in the wider Remutaka.

Miromiro/tomtit and toutouwai/NI robin compete for habitat, and it will depend on how well the miromiro fares when and if toutouwai are established.

Kārearea/falcon are likely to benefit from an increased abundance of prey birds.

The population of NI brown kiwi will continue to expand their range as they have done since 2006.

Experience from Zealandia[4] shows that some species are likely to reduce in number. These include the less deeply endemic species, including tauhou/silvereye, pīwakawaka/fantail and riroriro/grey warbler. These birds do not fare well in competition with the deeper endemics.

Several species planned for reintroduction could fare well beyond the fence if the habitat was well managed.

[4] Miskelly, C. (2018). Changes in the forest bird community of an urban sanctuary in response to pest mammal eradications and endemic bird reintroductions. Museum of New Zealand Te Papa. Notornis 2018.

Kākā have an expanding population in Wellington City, Pūkaha/Mount Bruce and a healthy population on Kapiti Island but are not common in Remutaka. Pairs are now sighted on a regular basis, but an established population is not present. Kākā could establish a large resident population in Wainuiomata (up to 750 breeding pairs). Kākā juveniles are vulnerable in the first two weeks of life and females are vulnerable on the nest, but in a fenced area they can breed prolifically and increase rapidly in numbers. Widespread stoat and possum control is required to sustain kākā and if this was achieved the Remutaka could accommodate a very large kākā population.

There is a small population of kōkako at Pūkaha/Mount Bruce and a growing population on Kapiti Island, but this species has been absent from the Remutaka since the 1920's. Kōkako is another species that does well in managed habitat, as evidenced by the steady recovery of many mainland populations. Wainuiomata has been assessed by the kōkako recovery group as being ideal breeding habitat for kōkako with potential carrying capacity of up to 500 breeding pairs[5]. As with kākā, kōkako could become widespread and relatively abundant across the Remutaka with large scale intensive rodent management.

Red-crowned kākāriki may become established in the catchment, depending on their relationship with the resident yellow crowned species. If they do establish, they may repopulate the nearby habitat. This would require rodent control

Toutouwai/NI robin could establish in the catchment depending on the relationship with miromiro/tomtit. If they do establish and breed successfully, they may well become widespread in the Remutaka. However, toutouwai are very sensitive to ground predation and would require an intensive management regime to succeed.

Another possibility is pateke/brown teal (now regarded almost as a 'bush duck'). With management, they may do well in the numerous creeks in the Remutaka.

Of the three high priority species, kākāpō and rowi kiwi will be contained inside the fence. Hihi/stitchbird and tīeke/saddleback are unlikely to survive in substantial numbers beyond the fence unless rats and mustelids can be controlled permanently at sub-5% density.

The conclusion is that as many as ten to twelve species could establish and/or increase their abundance across the Remutaka if a landscape scale management programme accompanied the Wainuiomata project. Local populations could be established for four species which are currently absent from the Remutaka Range.

5. Potential area of interest

There is approximately 40,000 hectares of potential public lands which could form the area of interest. These include:

Remutaka forest park (DOC)	23,000 hectares
Pakuratahi forest (future water reserve)	8,000 hectares
Orongorongo Water Collection Area (GW)	4,000 hectares
East Harbour Regional Park.	2,250 hectares
Various Hutt CC reserves	500 hectares
Brookfield scout camp	250 hectares

See below for a map of the area.

[5] Flux, IA. (2012). A Preliminary Assessment of a Greater Wellington (GWRC) Proposal to Reintroduce North Island Kōkako (*Callaeas wilsonii)* to Wainuiomata Mainland Island.

6. Current management

DOC (Kapiti Wellington and Wairarapa) has responsibility for the 23,000-hectare Remutaka Forest Park. DOC reduced pest management in the Remutaka some time ago. However, effort is placed into visitor facilities in the park as this is one of the more well patronised areas in the region. DOC works closely with Taranaki Whänui and key restoration groups who lead large scale (8,000 ha) stoat control.

Greater Wellington (GW) manages several sites as Key Native Ecosystems (including Wainuiomata catchment) and they manage Pakuratahi forest, the East Harbour Regional Park and the Wainuiomata/Orongorongo Water Collection Area as resources allow. These sites collectively encompass 17,600 hectares.

A number of community groups have been very active in the Remutaka and its environs for several decades, including the Remutaka Conservation Trust, MIRO, MOA Conservation Trust and the Friends of Baring Head.

Brookfield Scout Camp manage a 250-hectare property on the western boundary of the catchment as a predator-free zone.

DOC has initiated a programme to co-ordinate the private and public landowners on the south coast (the 'hem' of the Remutaka).

The above represents a solid base to build on and there is interest in undertaking an integrated management approach to the wider Remutaka. Given the size of their lands, DOC and GW would need to be the major actors in any such arrangement.

7. National priority and predator-free NZ

DOC policy is to set up and manage nationally ten large predator-free zones in due course. The Remutaka is not one of those ten.[6]

Predator Free 2050 Ltd. have expressed tentative interest in supporting a landscape scale initiative if Wainuiomata proceeds. Their policy requires a partnership approach and co-funding. A site viewing and meeting with PF 2050 Ltd representatives was planned but could not proceed because of Covid 19 restrictions. This is to be rescheduled.

No substantive concept plan to define the area of interest, partners and objectives or tentative costings has been undertaken. This should be done if Wainuiomata proceeds.

Fully investigating this topic falls outside the scope of this study. However, if Wainuiomata proceeds, integrated management of the Remutaka should be considered in association with DOC, GW, the NGO's working in the area and Predator-Free 2050 Ltd.

8. Conclusions

The conclusions of this study are as follows.

1. This issue is not an immediate priority and has not been fully investigated.

2. Once the catchment is secure, and assuming species are well established, it is likely that many species will migrate from the catchment into the surrounding habitat. This is known as the 'halo effect'.

3. As many as ten to twelve species could establish and/or increase their abundance across the Remutaka if a landscape scale management programme accompanied the Wainuiomata project. Local populations could be established for four species which are currently absent from the Remutaka Range.

4. The success of this migration will vary greatly according to each species. Some will establish without further management; some will require management of the surrounding area and others will not survive outside the fence.

5. There is approximately 40,000 hectares of potential habitat in the Remutaka Range that could form the migratory 'halo' of the sanctuary.

6. There is some management being done now in the wider Remutaka, including GW, DOC and several community groups. There is a willingness to integrate this activity and possibly expand it, to capitalise on the Wainuiomata opportunity. Predator Free 2050 Ltd are willing to look at this prospect.

7. Fully investigating this topic falls outside the scope of this study. However, if Wainuiomata proceeds, integrated management of the Remutaka should be considered in association with DOC, GW, the NGO's working in the area and Predator-Free 2050 Ltd.

J. Lynch

20th October 2021

[6] Appendix C. Detailed assessment of the Wainuiomata proposal. DOC Terrestrial Science.

APPENDIX Q:

Eradication Method and Cost

Wainuiomata Proposed Predator Fence Eradication

Proposed resource plan and costing requirements for Mammal Eradication

Glen Falconer, September 2021

Greater Wellington
Te Pane Matua Taiao

Proposed Wainuiomata Predator Fence small mammal post eradication detection network plan – Option 1

To ensure eradication has been successful following the aerial application of brodifacoum baits, a network of devices will need to be installed and checked, and any surviving populations dealt with quickly. The network will need to be such that it give confidence that every surviving animal would be detected within their home range.

Lines will be created at 75m intervals (as per GIS mapping plan and marked out with gps) on an 82 magnetic baring across the Valley. They will utilise the existing lines with the Mainland Island area, and adding to these and following the same baring. There is opportunity to re-orientate some of these lines nearer the treatment plant to suit the steep face above Georges Creek with proposed fence line. Lines will be marked in both directions with permanent plastic marker triangles/rectangles at very frequent intervals, and cut, mostly by hand tools, so access is free for staff with back packs to follow and get through efficiently.

Along these lines, a detection site will be established every 50m (measured with hip chain cotton). This is likely to contain devices such as a tracking tunnel/multi use device, wax tag and chewcard for closing out the eradication, use with ongoing surveillance and for any incursion work in the future. At every 100m interval (every second 50m spaced detection device) will be a double set run through BT200 Stainless steel trap and wooden box. These will be used again for closing out the eradication, and ongoing surveillance and for any future incursion work, helicopter deployment assistance will be required due the bulk and weight of these, suggest an electronic multi-hook on long line at strategic spots. The trap boxes will be fitted with motolures and some will have reporting nodes, they will be initially opened up for hedgehogs, and will also be future proofed for native parrot interference (such as weka and kea proof stainless steel ends) by purchasing strong stainless steel ends and baffles for installation later. On installation these will be locked open and plate screwed down.

A network of baited cameras will be in place for closing out the eradication, ongoing surveillance and for any future incursion work. Trail cameras (black flash/sd cards) will be set up on an internal 500m internal grid, focusing on terrain and topography suited for best detection sites. Hi-spec baited cameras will be spaced 500m around inside the boundary fence, these cameras will be most likely thermal and may transmit any detection encounters.

Aerial brodifacoum operation will be carried out in accordance with “Operating Plan 63 Aerial and Hand Broadcast Application of Pestoff® Rodent Bait 20R (V9014) for the Intended Eradication of Rodents from Specified Areas of New Zealand” https://pestoff.co.nz/wp-content/uploads/2019/05/20R-Operating-Plan-63-121219.pdf with two applications each of Pest off 20R at 12kg per hectare. All conditions of the operating plan need to be complied with, and require various assessments and approvals before baiting can occur.

Once eradication is confirmed, and for ongoing surveillance, the lines with cameras and perimeter cameras will be checked monthly. All devices and traps on these lines will be rebaited and kept active. A 70% portion of the rest of the network (based on best habitat and trap sites for target species) will be checked on a regular basis (3 monthly) and a portion will contain trap nodes that will alert if triggered. Other parts of the network will be used on random audits and when needed for incursion response. All cut lines will need to have a maintenance programme, so if an incursion occurs these areas can be accessed quickly without delay and operational activities deployed.

Pre aerial eradication baiting: All lines and devices (including traps and cameras) will need to be established and installed 1-2 months before any aerial eradication baiting occurs. All animals needing collars need to be caught and collared.

Post aerial eradication baiting: One month following the last application of the eradication aerial baiting, all devices (50m detection sites, 100m traps, cameras) need to be activated and checked every week for the first 2 months, then monthly for 3 months minimum. Running alongside this will be a team targeting any mop up control on any detections and surviving populations for various pest species (possums, cats, ungulates, hedgehogs, rats, mice?) for a further 6 months post eradication aerial baiting. Reduce servicing of devices to monthly when no detections have been found for 1 month of weekly checks, his could be done in groups of lines or blocks of areas.

The use of dogs is going to be very important to proving eradication and the ongoing maintenance sweeps to ensure the area remains pest free. It is proposed there is a rat and mustelid dog on site as part of the incursion team, and contract dogs brought in to carry out checks and respond to incursion events on regular intervals. Dogs would need to be selected and trained up by someone 12 months ahead of when they will be required to join the project, this will need some planning and potentially additional resourcing. Another thing to consider is the need for dogs that are not part of the conservation dog programme already that might need to be trained up, such as hedgehog dogs.

Risks:

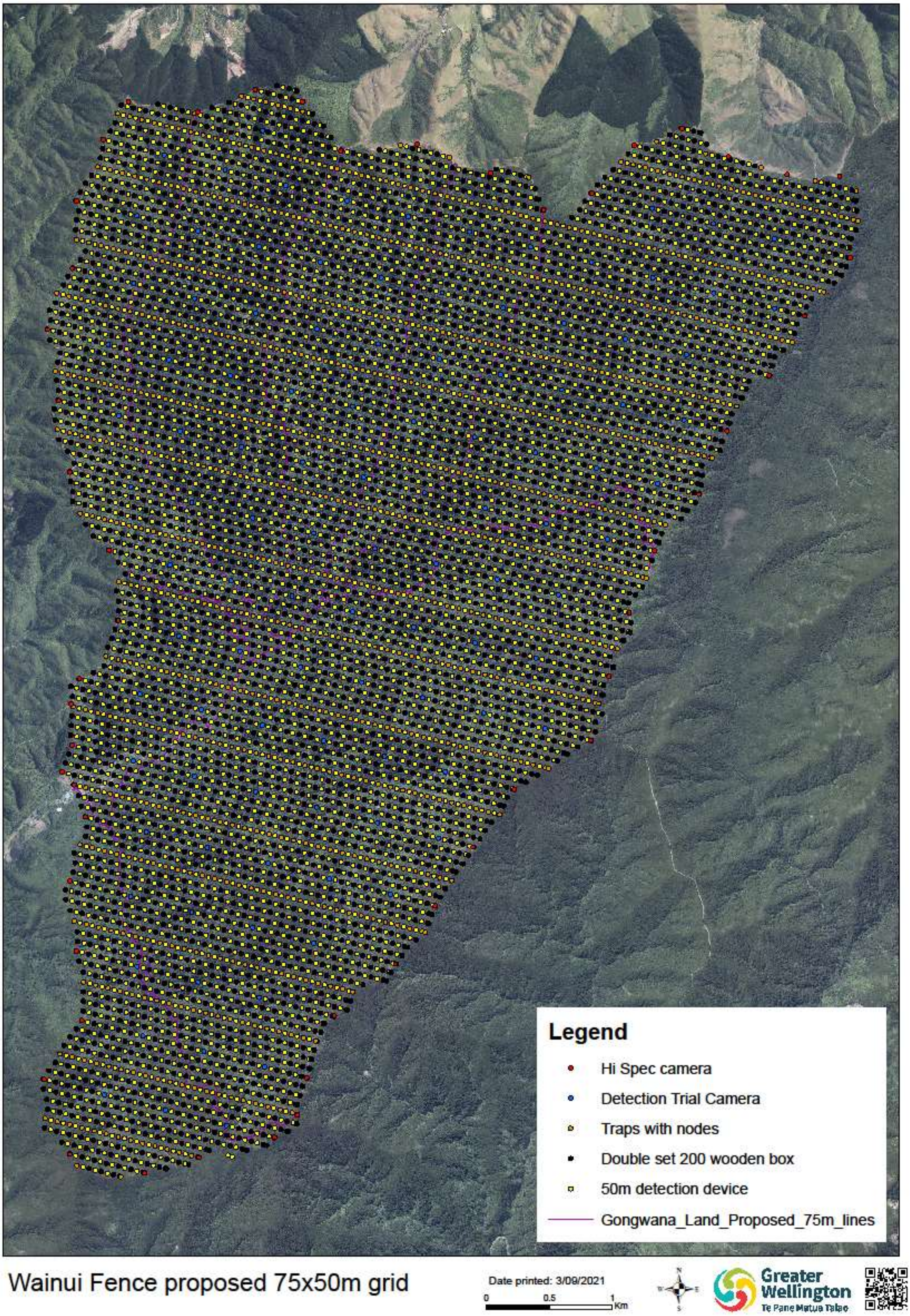
- Currently aerial operations do not require resource consent, but there is proposed to be RMA reforms, and there is a risk this could be brought back in and face extensive additional consenting requirements which could affect the start date and ideal timing for water supply purposes and including all pest species
- If there is delay in starting the phases of this plan (fence not finished, mast year suddenly) then the resource cost and capacity will need to be revisited, and this could result in the loss of some valuable and key staff which would really jeopardise the operation as its planned
- If timing of the aerial operation and the subsequence weekly checks clashes with hedgehog hibernation, then this require extra resource to what is planned here to undertake a significant hedgehog eradication operation, this could mean an extension to weekly or monthly checks for a further 3-6 months
- If there is an toxin applied outside the fence and stock are exposed some mitigation for withholding periods will need to be considered as a contingency

Resource about 249 working days in a year (minus leave 25 AL and 10 sick leave)

If it takes 130 days to service the entire network, then to do this in one month would take 10 staff full time each month. Weekly checks would need 32 staff (35 for contingency)

Summary costs of small mammal and ungulate eradication, costs all exclude gst

Pre operation	**$**	**Aerial operation costs**	**$**	**Post operation (12 months)**	**$**	**Ongoing**	**$**	**Totals**	**$**
Labour	1,666,560	**Labour**	479,136	**Labour**	3,572,688	**Labour**	1,499,904	**Labour**	7,218,288
Materials	**3,712,808**	**Materials**	857,400	**Materials**	**475,682**	**Materials**	460,988	**Material**	5506878
Total	**5,379,368**	**Total**	**1,336,536**	**Total**	**4,048,370**	**Total**	**1,960,892**	**Total**	**12,725,166**
								Contingency (not added)	**1,500,000**



Wainui Fence proposed 75x50m grid

Material needed to point of eradication

Pre aerial operation

Equipment needed	Unit	cost each $	Total
Nails (1620 5kg pack)	120	40	4800
Plastic Markers (Pink Rectangles)	236000	.10	23600
Pink tape	500	4	2000
Marker pens etc			2000
Track cutting supplies (loppers, tools, packs, other equipment etc)			30,000
GPS, phones, etc	46	2000	92000
Truck radios, including portable	14	6893	96,502
Portable radios outside truck allocation	32	1855	59,360
Spare radio batteries	46	300	13,800
Permanent Vehicles	5	45,000	225,000
LUV's	5	20,000	100,000
Hire vehicles for 6 months estimate only	9	5000	45,000
Depot set up	1	50000	500000
Technology (laptops, printers, screens, desks, chairs)	20	$5000	100,000
Poison stores and equipment stores (containers)	4	8000	32,000
Trap boxes (with hedgehog sized holes in ends and baffles)	4589	65	298,285
BT200 traps	9178	34	312,052
detection tunnels	9000	14	126,000
Trail camera	106	399	42,294
Trail camera SD card	250	30	7500
Camera security case	106	115	12,190
Trail camera tripod?	106	15	1,590
Trail camera battery replacement (per annum)	106	32	3,392
Hi – spec camera (cacophony)	52	3300	171,600
Hi Spec Camera spare battery	52	350	18,200
Hi spec camera data storage/camera plan/per ann	52	559	29,068
Motolure cameras	158	125	19,750
Motolure trap box	4589	125	573,625
Motolure replacement lure(per annum)	4747	8	37,976
Non aerial 20R brodifacoum bait (100grams per visit)	1000	4.5	4,500
Brodifacoum Final block bait	800	12.5	10,000
Various other baits and devices			30,000
Operational signage (include. Heli signage)			1000
Remote sensing nodes for trap boxes	808	100	80,800
Remote sensing lowra repeaters	6	3000	18,000
Telemetry or GPs Radio mammal collars (cats, stoats, weasels, possum, hedgehogs) estimate	40	400	16000
Dog housing kennels	10	200	2000
Dog gear and boxes etc	1	2000	2000
Trap securing devices - Short waratah, tex screws, block of wood etc	2000	5	10,000
Replacement gear (200 x box traps, 400 traps x 1000 detection tunnels)	1	55,000	55,000
Extra gear for specific risk areas and incursion (200 x box traps, 200 x rat bait stations, 200 victor traps and boxes, 100 leghold traps, 50 cage traps)	1	43,300	43,300
Chewcards	129600	0.34	44,064
Peanut butter Wax Tags (be better to hire someone to make them as we need them)	129600	1.10	142,560
Misc equipment (Plastic bags, other lures, general equipment) $10,000 per month	12	10,000	120,000
Estimated freight	1	100,000	100,000
Helicopter trap deployment			30,000
Ungulate DNA surveying (300 samples @ $80 each)			24,000
Total			**3,712,808**

Aerial bait and materials

Aerial 20R bait first application 3310ha 12kg/ha + 50 % overlap and contingence	50,100	4.5	225,450
Freight 1st application	50	250	12,500
Aerial 20R bait 2nd application 3310ha 12kg/ha + contingence	50,100	4.5	225,450
Freight 2nd application	50	250	12,500
Bucket calibration	4	3000	12,000
Transport bait storage aerial site	2	6000	12,000
Bait storage	1	12,000	12,000
Helicopter application costs 1st application approx. (need to check) (0.8t/hr @ $3k/hr)	50	3000	150,000
Helicopter application costs 2nd application approx. (need to check)	50	3000	150,000
Ground baiting bait after aerial	3000	4.5	13,500
Water testing and collection			10,000
Stock exposure contingency			10,000
Security for aerial days			12,000
Total			**857,400**

Post aerial operation

lure for mustelid traps 258600 baits (goodnature blood lure)	6465	8.5	54,952
Peanut butter	100kg	$6	600
Trap box ss plates/baffles for ongoing non-target exclusion	4589	30	137,670
Misc equipment (Plastic bags, other lures, general equipment) $10,000 per month	12	10,000	120,000
Hi spec camera data storage/camera plan/per ann	52	559	29,068
Trail camera battery replacement (per annum)	106	32	3,392
Contractor detector dogs			50,000
Fencing contractors to fix big fixes			40,000
Thermal helicopter searches for ungulates			40,000
Total			**475,682**

Ongoing materials

lure for mustelid traps 258600 baits (goodnature blood lure)	6465	8.5	54,952
Peanut butter	100kg	$6	600
Motolure replacement lure(per annum)	4747	8	37,976
Replacement gear (200 x box traps, 400 traps x 1000 detection tunnels)	1	55,000	55,000
Hi spec camera data storage/camera plan/per ann	52	559	29,068
Trail camera battery replacement (per annum)	106	32	3,392
Misc equipment (Plastic bags, other lures, general equipment) $10,000 per month	12	10,000	120,000
Toxic baits			10,000
Trap/tunnel replacement			50,000
Contractor detector dogs			50,000
Fencing contractors to fix big fixes			40,000
Camera replacement			10,000
Total			**460,988**

Resource needed in FTE resource and when needed

Pre aerial labour cost

	-12 month	-11 month	-10 month	-9 month	-8 month	-7 month	-6 month	-5 month	-4 month	-3 month	-2 month	-1 month	Aerial
Project Leader	1	1	1	1	1	1	1	1	1	1	1	1	
Field Operations Leader	1	1	1	1	1	1	1	1	1	1	1	1	
Ungulate team	0	0	0	0	0	0	1	1	7	7	7	7	
Aerial Ops team	2	2	2	2	2	2	2	2	2	2	2	2	
Line Prep team	6	6	6	6	6	6	6	6					
Install devices	0	0	0	0	0	0	0	0	5	5	5	5	
Install traps	0	0	0	0	0	0	0	0	10	10	10	10	
Install cameras	0	0	0	0	0	0	0	0	0	1	2	0	
Collar animals	0	0	0	0	0	0	0	0	0	2	2	2	
Data and Electronics Specialist	0	0	0	0	0	0	0	0	0	1	1	1	
Hand baiting and aerial team	0	0	0	0	0	0	0	0	0	0	0	6	
Total FTE	10	10	10	10	10	10	11	11	15	19	20	24	
Costs $	104,160	104,160	104,160	104,160	104,160	104,160	114,576	114,576	156,240	197,904	208,320	249,984	

Av 21 days/month x 8 hours = 168 hours per person x $62 = $10,416/person/month

Post aerial labour cost

	Aerial	+1 month	+2 month	+3 month	+4 month	+5 month	+6 month	+7 month	+8 month	+9 month	+10 month	+11 month	+12 month
Project Leader	1	1	1	1	1	1	1	1	1	1	1	1	1
Field Operations Leader	1	1	1	1	1	1	1	1	1	1	1	1	1
Ungulate team	1	1	1	1	1	1	7	7	7	7	1	1	1
Aerial Ops team	2	2	2	2	1	1	1	0	0	0	0	0	0
Hand baiting and aerial team	6	0	0	0	0	0	0	0	0	0	0	0	0
Data and Electronics Specialist	1	1	1	1	1	1	1	1	1	1	1	1	1
Response and fence team	3	3	3	3	3	3	3	3	3	3	3	3	3
Field staff training to do weekly service all lines	29	35	35	35	35	0	0	0	0	0	0	0	0
Monthly service all lines	0	0	0	0	0	10	10	10	10	0	0	0	0
Collar animals	2	2	2	0	0	0	0	0	0	0	0	0	0
Monthly and 3 monthly device and camera check	0	0	0	0	0	0	0	0	0	5	5	5	5
Dog handler and floater between teams	0	0	2	2	2	2	2	2	2	2	2	2	2
Field FTE Totals	46	46	48	46	45	20	26	25	25	20	14	14	14
	479,136	479,136	499,968	479,136	468,720	208,320	270,816	260,400	260,400	208,320	145,824	145,824	145,824

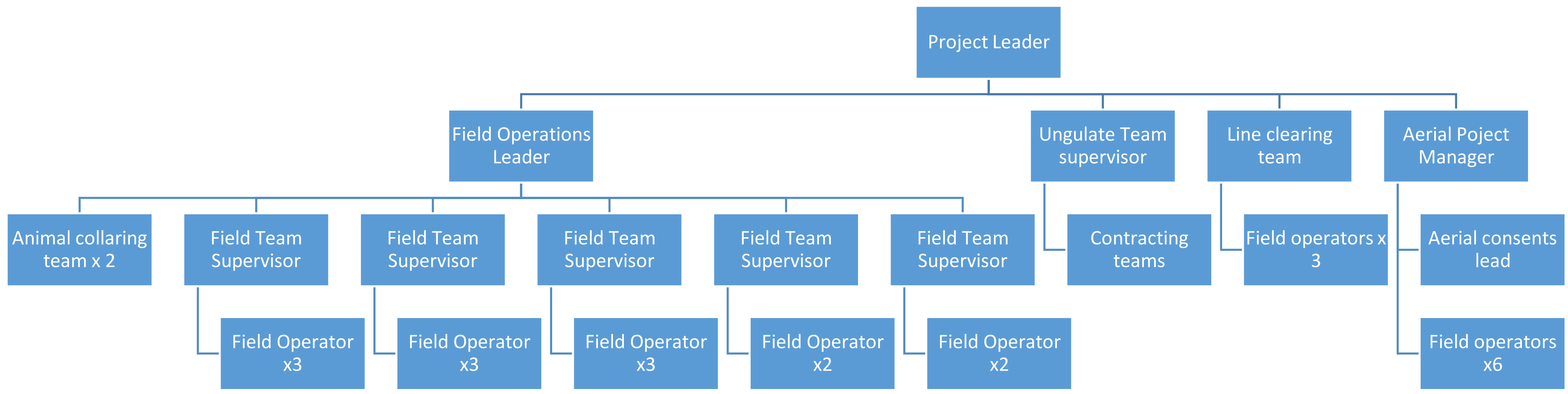
Av 21 days/month x 8 hours = 168 hours per person x $62 = $10,416/person/month

Ongoing annual operations labour cost

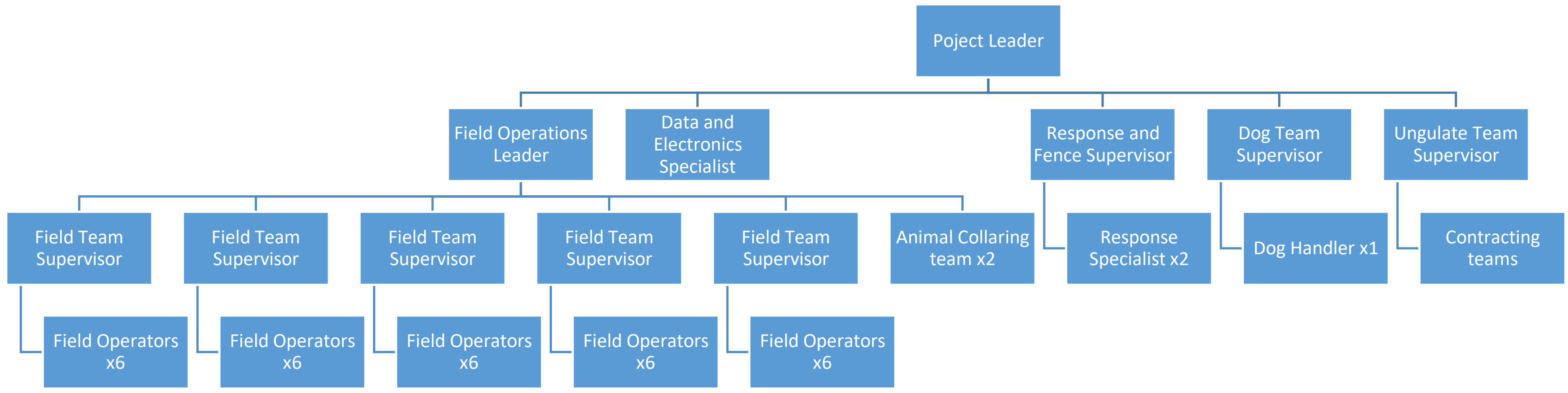
	1 month	2 month	3 month	4 month	5 month	6 month	7 month	8 month	9 month	10 month	11 month	12 month
Project Leader	1	1	1	1	1	1	1	1	1	1	1	1
Field Operations Leader	1	1	1	1	1	1	1	1	1	1	1	1
Data and Electronics Specialist	1	1	1	1	1	1	1	1	1	1	1	1
Response and fence team	3	3	3	3	3	3	3	3	3	3	3	3
Volunteer coordinator	1	1	1	1	1	1	1	1	1	1	1	1
Monthly and 3 monthly device and camera check	4	4	4	4	4	4	4	4	4	4	4	4
Dog handler and floater between teams	1	1	1	1	1	1	1	1	1	1	1	1
Total FTE	12	12	12	12	12	12	12	12	12	12	12	12
Costs $	124,992	124,992	124,992	124,992	124,992	124,992	124,992	124,992	124,992	124,992	124,992	124,992

Av 21 days/month x 8 hours = 168 hours per person x $62 = $10,416/person/month

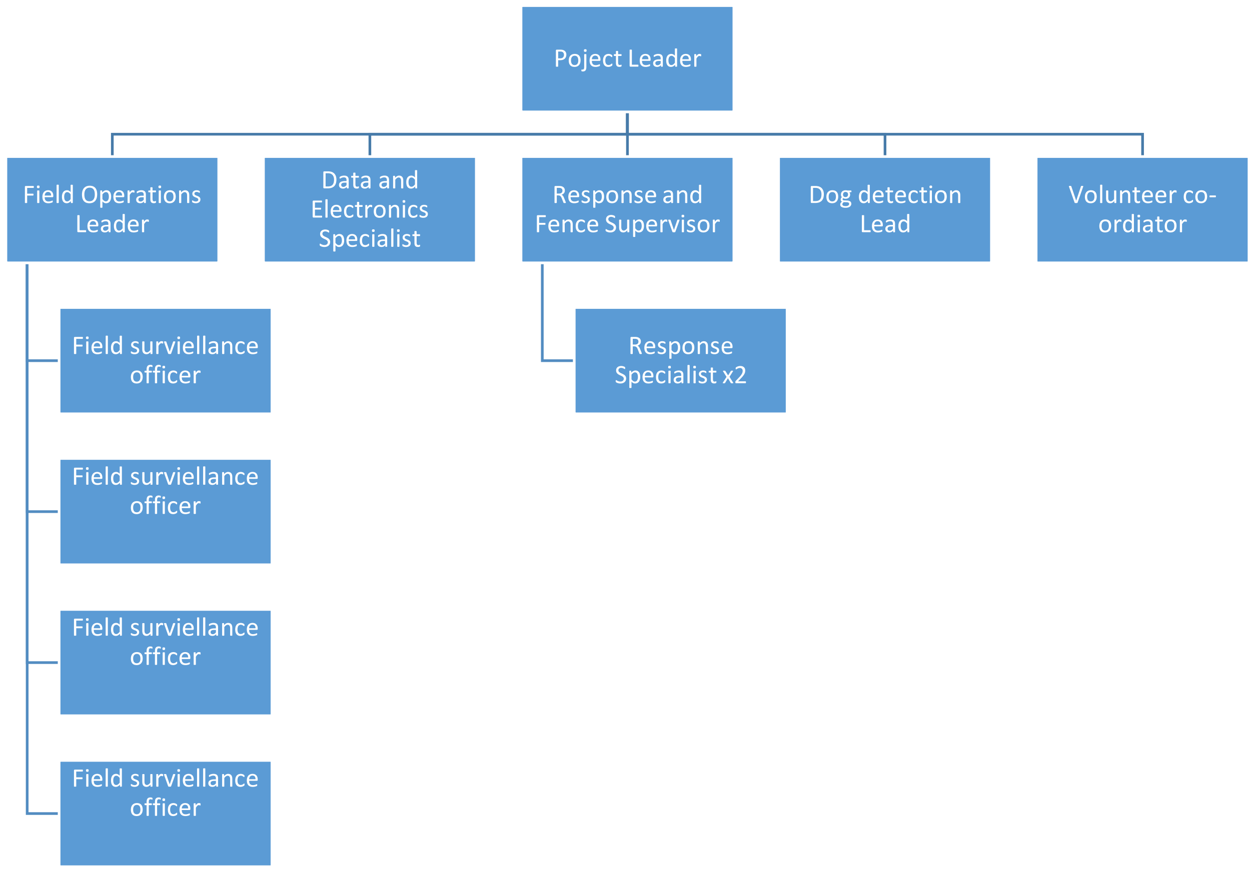
Pre aerial proposed structure



Proposed staff structure post aerial first 12 months



Ongoing staff structure



Workings

Plan for small mammal mop-up and proof of freedom	sites per day per person	Misc project costs	total devices	Lure pieces (mayonnaise, blood lure, peanut butter, meat)	Prefeed bait kg	traps boxes required	Detection devices required	Cage traps required	20R bait kg	Tracking card	Wax tags	Chew cards	person days needed	total hours	total labour cost
Line cutting and marking 471493m @ 250m per person per day, 1886 person days, working in pairs that is at least 4 staff for an entire year (still to take out WMI lines)				0					0	0	0	0	1886	15,088	123,504
Capture and collar animals 2 FTE for 6 months, 3 months prior to aerial operation, 3 month post		16,000		0				100	0	0	0	0	252	2016	124,992
Install detection tunnels pre aerial	40			0			9000		0	0	0	0	225	1800	111,600
Install DOC200 traps in trap tunnels pre aerial, traps locked open, motolure installed	8			0		4589			0	0	0	0	574	4592	284704
Install hi-spec cameras	10		52	0					0	0	0	0	6	48	2976
Install camera/Motolures	5		106	0					0	0	0	0	22	176	10,912
First tunnel activation (week 4 after aerial) - all detection tunnels to have tracking card, activate traps, activate motolure, activate trap nodes, place waxtag and chewcard, activate camera				14000					0	9000	9000	9000	130	1040	64,480
1st tunnel check (week 5 after aerial) - all detection tunnels to new card, refresh waxtag and chewcard if needed, clear traps, re-lure, check camera				14000					0	9000	9000	9000	130	1040	64,480
Full time response team of 3 to follow up with toxic baiting in detection tunnels within 200m of detection and follow up daily, full time resource dedicated to this. If not needed then fence checks, or detection tunnel checks.				300					50	500	500	500	15	120	7440
2nd tunnel check (week 6 after aerial) - all detection tunnels to new card, refresh waxtag and chewcard if needed, clear traps, re-lure, check camera				14000					0	9000	9000	9000	130	1040	64,480
Full time response team of 3 to follow up with toxic baiting in detection tunnels within 200m of detection and follow up daily, full time resource dedicated to this. If not needed then fence checks, or detection tunnel checks.				300					50	500	500	500	15	120	7440
3rd tunnel check (week 7 after aerial) - all detection tunnels to new card, refresh waxtag and chewcard if needed, clear traps, re-lure, check camera				14000					0	9000	9000	9000	130	1040	64,480
Full time response team of 3 to follow up with toxic baiting in detection tunnels within 200m of detection and follow up daily, full time resource dedicated to this. If not needed then fence checks, or detection tunnel checks.				300					50	500	500	500	15	120	7440
4th tunnel check (week 8 after aerial) - all detection tunnels to new card, refresh waxtag and chewcard if				14000					0	9000	9000	9000	130	1040	64,480

needed, clear traps, re-lure, check camera.															
Full time response team of 3 to follow up with toxic baiting in detection tunnels within 200m of detection and follow up daily, full time resource dedicated to this. If not needed then fence checks, or detection tunnel checks.				300					50	500	500	500	15	120	7440
5th tunnel check (week 9 after aerial) - all detection tunnels to new card, refresh waxtag and chewcard if needed, clear traps, re-lure, check camera				14000					0	2000	2000	2000	130	1040	64,480
Full time response team of 3 to follow up with toxic baiting in detection tunnels within 200m of detection and follow up daily, full time resource dedicated to this. If not needed then fence checks, or detection tunnel checks.				300					50	500	500	500	15	120	7440
6th tunnel check (week 10 after aerial) - all detection tunnels to new card, refresh waxtag and chewcard if needed, clear traps, re-lure, check camera.				14000					0	2000	2000	2000	130	1040	64,480
Full time response team of 3 to follow up with toxic baiting in detection tunnels within 200m of detection and follow up daily, full time resource dedicated to this. If not needed then fence checks, or detection tunnel checks.				300					50	500	500	500	15	120	7440
7th tunnel check (week 11 after aerial) - all detection tunnels to new card, refresh waxtag and chewcard if needed, clear traps, re-lure, check camera.				14000					0	2000	2000	2000	130	1040	64,480
Full time response team of 3 to follow up with toxic baiting in detection tunnels within 200m of detection and follow up daily, full time resource dedicated to this. If not needed then fence checks, or detection tunnel checks.				300					50	500	500	500	15	120	7440
8th tunnel check (week 12 after aerial) - all detection tunnels to new card, refresh waxtag and chewcard if needed, clear traps, re-lure, check camera.				14000					0	9000	9000	9000	130	1040	64,480
Full time response team of 3 to follow up with toxic baiting in detection tunnels within 200m of detection and follow up daily, full time resource dedicated to this. If not needed then fence checks, or detection tunnel checks.				300					50	500	500	500	15	120	7440
9th active areas tunnel check (week 13 after aerial) - all detection tunnels to new card, refresh waxtag and chewcard if needed, clear traps, re-lure, check camera				14000					0	2000	2000	2000	130	1040	64,480
Full time response team of 3 to follow up with toxic baiting in detection tunnels within 200m of detection and follow up daily, full time resource dedicated to this. If not needed then fence checks, or detection tunnel checks.				300					50	500	500	500	15	120	7440

10th active areas tunnel check (week 14 after aerial) - all detection tunnels to new card, refresh waxtag and chewcard if needed, clear traps, re-lure, check camera				14000					0	2000	2000	2000	130	1040	64,480
Full time response team of 3 to follow up with toxic baiting in detection tunnels within 200m of detection and follow up daily, full time resource dedicated to this. If not needed then fence checks, or detection tunnel checks.				300					50	500	500	500	15	120	7440
11th active areas tunnel check (week 15 after aerial) - all detection tunnels to new card, refresh waxtag and chewcard if needed, clear traps, re-lure, check camera				14000					0	2000	2000	2000	130	1040	64,480
Full time response team of 3 to follow up with toxic baiting in detection tunnels within 200m of detection and follow up daily, full time resource dedicated to this. If not needed then fence checks, or detection tunnel checks.				300					50	500	500	500	15	120	7440
12th active areas tunnel check (week 16 after aerial) - all detection tunnels to new card, refresh waxtag and chewcard if needed, clear traps, re-lure, check camera				14000					0	9000	9000	9000	130	1040	64,480
Full time response team of 3 to follow up with toxic baiting in detection tunnels within 200m of detection and follow up daily, full time resource dedicated to this. If not needed then fence checks, or detection tunnel checks.				300					50	500	500	500	15	120	7440
13th tunnel check (week 20-23 after aerial) - all detection tunnels to new card, refresh waxtag and chewcard if needed, clear traps, re-lure, check camera.				14000					0	9000	9000	9000	130	1040	64,480
Full time response team of 3 to follow up with toxic baiting in detection tunnels within 200m of detection and follow up daily, full time resource dedicated to this. If not needed then fence checks, or detection tunnel checks.				300					50	500	500	500	60	480	29,760
14th tunnel check (week 24-27 after aerial) - all detection tunnels to new card, refresh waxtag and chewcard if needed, clear traps, re-lure, check camera.				14000					0	9000	9000	9000	130	1040	64,480
Full time response team of 3 to follow up with toxic baiting in detection tunnels within 200m of detection and follow up daily, full time resource dedicated to this. If not needed then fence checks, or detection tunnel checks.				300					50	500	500	500	60	480	29,760
15th tunnel check (week 28-31 after aerial) - all detection tunnels to new card, refresh waxtag and chewcard if needed, clear traps, re-lure, check camera.				14000					0	9000	9000	9000	130	1040	64,480
Full time response team of 3 to follow up with toxic baiting in detection tunnels within 200m of detection and follow up daily, full time resource dedicated to this. If not needed then				300					50	500	500	500	60	480	29,760

fence checks, or detection tunnel checks.															
16th tunnel check (week 32-35 after aerial) - all detection tunnels to new card, refresh waxtag and chewcard if needed, clear traps, re-lure, check camera				14000					0	9000	9000	9000	130	1040	64,480
Full time response team of 3 to follow up with toxic baiting in detection tunnels within 200m of detection and follow up daily, full time resource dedicated to this. If not needed then fence checks, or detection tunnel checks.				300					50	500	500	500	60	480	29,760
Depending on the timing of the aerial operation, if hedgehogs are not exposed to aerial bait then more intensive trapping would need to continue on the monthly check for up to another 4 month, week 36-52; **this is a per service amount**				300					50	500	500	500	60	480	29,760
Week 36 - No detections of small mammals hopefully, then move to biosecurity maintenance Rest of costs and labour per service				0					0	0	0	0	0	0	0
Monthly biosecurity check - tunnel check– On trail camera lines all detection tunnels to new card, refresh waxtag and chewcard if needed, clear traps, re-lure, check camera				1500					0	1100	1100	1100	26	208	12,896
Full time response team of 3 to follow up with sprung traps from node lines, responding to camera activations on fence, toxic baiting if needed, checking all devices and cameras on fence line, full time resource dedicated to this. If not needed then fence checks, or help with detection tunnel checks.				300					50	500	500	500	60	480	29,760
Three monthly full device and tunnel check of 70% of network that has proved to be located in ideal habitat - all detection tunnels to new card, refresh waxtag and chewcard if needed, clear traps, re-lure, check camera and node operation, replace batteries and card				14000					0		6000	6000	100	800	49,600
Totals				**258900**					**900**	**121100**	**127100**	**127100**	**5841**	**46,728**	**2,085,184**

Literature review of impacts of brodifacoum-, cholecalciferol- and diphacinone-based baits on waterways and soil.

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Brodifacoum

Water

- Brodifacoum is extremely insoluble in water (<10mg/L water at pH 7) (Eason and Wickstrom 2001).
- Brodifacoum likely binds to organic material (Eason and Wickstrom 2001, Fisher et al. 2011).
- If bait entered waterways a limited amount of the brodifacoum in them would enter solution. The brodifacoum is more likely to remain bound to the bait or to other organic particles present in the water or sediment (Eason and Wickstrom 2001, Fisher et al. 2011).
- No Brodifacoum residues were found in water sampled in small streams in different parts of Red Mercury Island one month after aerial distribution of Talon 20P cereal pellets at 15 kg/ha (Morgan and Wright 1996).
- No Brodifacoum was found in water or soil samples from Lady Alice Island in a study of the aerial application of cereal-based pellets (Ogilvie et al. 1997).
- No Brodifacoum was found in any of the 217 water samples from Maungatautari Reserve, four water samples from Little Barrier Island, or from the four drinking water samples from Motutapu Island after aerial application of the cereal-pellet bait, Pestoff Rodent Bait 20R, containing 20ppm brodifacoum, applied at 15kg/ha (Fisher et al. 2011).
- No Brodifacoum was detected in samples of lake water or sediment two days (n = 17) or two weeks (n = 10) after 28 bags (700kg of 20ppm brodifacoum bait, a total of 14g of active ingredient) fell from a container into Lake Kirirua on Anchor Island in Dusky Sound, southwest Fiordland (Fisher et al. 2012).

Soil

- Brodifacoum is effectively immobile in soil (Eason and Wickstrom 2001, WHO 1995).
- Bait disintegrates into soil where it is slowly degraded by microorganisms (Eason and Wickstrom 2001).
- Half-life of brodifacoum in soil varies from 12-25 weeks (84-175 days) depending on soil type and climatic factors, especially rainfall (Eason and Wickstrom 2001, Fisher et al. 2011, US EPA 1998, WHO 1995).
- In leaching studies, 2% of brodifacoum added to soil leached more than 2cm in four soil types (WHO 1995)
- Brodifacoum could persist in soil in localised areas, immediately around baits (Ogilvie et al. 1997).
- No Brodifacoum residues were found in soil sampled at nine sites one month after aerial distribution of Talon 20P cereal pellets on Red Mercury Island (Morgan and Wright 1996).
- No Brodifacoum residues were found in five soil samples collected under bait-stations loaded with Talon 50WB wax-coated cereal blocks or at five sites sampled equidistant between bait stations at one and nine months after establishment of the bait stations on Coppermine Island (Morgan and Wright 1996).
- No brodifacoum was found in soil under Talon bait (Booth et al. 1999).
- Residual concentrations of the brodifacoum based Pestoff Rodent Bait 20R were found to be present in soil samples from underneath degrading bait pellets on Little Barrier Island. Levels of brodifacoum had decreased to near the limit of detection by ~100 days after application (Fisher et al. 2011).
- Only soil erosion will transfer disintegrating bait to waterways (Eason and Wickstrom 2001).

Cholecalciferol

Water

- Cholecalciferol is practically insoluble in water (Marshall 1984).
- There are no published field trials on the fate of cholecalciferol in soil or water (Eason and Wickstrom 2001).

Soil

- Cholecalciferol leaches from cereal baits very slowly and trace amounts were found in soil immediately underneath disintegrating Campaign baits (Booth et al. 1999).
- Cholecalciferol concentrations in Feracol baits decline faster in wetter than drier sites. Averaged across a wet (West Coast) and a dry (Mackenzie Basin) site, baits retained 75% of their cholecalciferol content after one month, 50% after eight months and about 30% after 11 months. The risk of poisoning non-target species stretched to 14 months at the dry site and 22 months at the wet site (Thomas and Ross 2007).

Diphacinone

Water

- Diphacinone has a low solubility in water (17 to 30 ppm) (US EPA 1998, WHO 1995).
- Surface water contamination may occur in less-permeable areas and in areas near water bodies. The mechanism for diphacinone to reach surface waters would likely be via adsorption to eroding soil rather than dissolution in runoff water (US EPA 1998).
- Surface water contamination would only occur through the movement of eroded bait or soil particles into waterways, and not by dissolution in runoff (Eisemann and Swift 2006).
- Although no adsorption coefficient is available, most diphacinone is expected to be partitioned in the suspended and bottom sediments instead of in the water column (US EPA 1998).

Soil

- Diphacinone is expected to be immobile in soil and, based on laboratory studies, is expected to be bound very tightly with soil in the field. Most of the chemical would remain in the topsoil and the potential to reach the ground water is very low (US EPA 1998).
- Half-life of diphacinone in soil lab tests is 30 days under aerobic conditions and about 60 days under anaerobic conditions (WHO 1995).

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