FLOODED CLASSROOMS INSPIRING ENVIRONMENTAL EDUCATION

Dever-Tod K (GHD Ltd)

Te Kukuwai o Toa breathes life into central Porirua as the land is returned to its natural, pre-reclamation state, re-integrating native fauna and flora into the area. The first of its kind for the region, this multipurpose asset provides the local community with an interactive learning environment.

Abstract

Evident by seasonal school closures and issue of public health notices, development in central Porirua has exacerbated flooding events and smothered the once-abundant Te Awarua-o-Porirua Harbour.

A newly constructed wetland (gifted the name Te Kukuwai o Toa by local iwi Ngāti Toa) transcends stormwater flood attenuation. By augmenting an existing greenspace, the urban community is connected to the natural environment through an environmentally sensitive solution.

35,000 native plants have been established to improve the health of the harbour and immediately attracted indigenous fauna into the new ecological heart of central Porirua.

The wetland provides an outdoor, interactive classroom, for three kura that encompass the wetland perimeter. Contributing to a range of important topics, the public asset offers education on the area's physical and cultural history, local species, and sustainable stormwater management.

These kura, no longer prone to shutdowns, now have dry classrooms and nature at their doorstep to inspire the next generation to make better decisions for our environment.

Key Words

Wetland, flooding, stormwater treatment, education

Introduction

Flooding and water pollution are interconnected issues prevalent globally. Land development near water bodies, converting natural topography into flat, impermeable landscapes, has created vulnerable communities, and destroyed aquatic ecosystems. These problems will be exacerbated by climate change and addressing them has never been more critical.

Recent disasters in Auckland in January and Cyclone Gabrielle have brought this nation's underlying vulnerability into flooding to the headlines again. Floods are the most frequent and costly natural disaster to occur in Aotearoa New Zealand (McSaveney, 2017) with river flooding costing our residential property sector more than $100 million on average annually (Corelogic, 2022). Big or small, each rainfall event washes contaminants from developed surfaces into the receiving water environment, affecting local populations of all species. A 2020 government report found that nearly 60% of New Zealand's rivers carry pollution above acceptable levels (Ministry for the Environment & Stats NZ, 2020), and 99% of river lengths in urban areas.

Following consecutive severe flooding events in 2015 and 2016, flood mitigation for the low-lying Porirua CBD was investigated, considering existing stormwater quality issues degrading Te-Awarua-o-Porirua. The **PCC Central Stormwater Upgrades – Stage 1** project was a $15 million investment by Wellington Water Ltd (WWL) on behalf of Porirua City Council (PCC) into the health of the harbour and its communities. The stormwater upgrades, completed in June 2022, include a new urban wetland, a high-capacity stormwater pipeline with outfall to the harbour, drainage upgrades at Porirua School, and two new earth bunds.

Through early identification of co-benefits, the outcome of the project extended beyond flooding alleviation and stormwater treatment. Transformation of a swampy sports field into a scenic park has introduced native species back into central Porirua and encourages the community to connect with nature. The recreational space now provides an outdoor classroom to facilitate learning about the land's rich history and integrated stormwater management.

The project's success epitomises the benefits of working in a collaborative format that extends well beyond the engineering community. Engagement of a diverse group of specialists and close relationships with local stakeholders were integral in delivering a thoughtfully designed asset that will benefit Porirua's communities for generations to come.

Background

Land use history

Te Awarua-o-Porirua was formed when postglacial sea levels rose, inundating two river valleys and providing an estuarine habitat for species to flourish for centuries. From the 15th century, a succession of iwi thrived along the harbour's abundant shores, benefitting from the healthy environment that hosted a plentiful source of food and resources. Takpūwāhia became the centre of Ngāti Toa settlement from the mid-19th century, at a similar time to early European settlers. The 1855 Wairarapa earthquake caused the harbour's shoreline to rise, and the shoreline adapted to host brackish coastal wetlands.

A coastal road connecting Titahi Bay with the rest of Porirua was constructed in the early 20th century, severing the connection between freshwater and the harbour. Ensuing commercial and residential development was supported through confinement of waterways into piped systems, construction of water-tight, levelled surfaces and infilling of tidal flats and margin wetlands. Reclamation activity removed important habitat for freshwater and marine life (Ammundsen, 2015) and reduced the natural absorptive barrier that protected the harbour and provided resilience to adjacent communities. The reclaimed land adjacent to the Takpūwāhia village became the site of Porirua city's CBD.

Degradation of Te-Awarua-o-Porirua

Decades of human activity adjacent to Te-Awarua-o-Porirua contributed to the gradual decline in health of the once-bountiful estuary, indicated by public health warning signs starting to appear at the harbour's shore from the late 1970s (Porirua City Council, 2012). Studies from the late 1990s confirmed that urban stormwater outfalls and the Porirua Stream were the primary sources of contaminants. A 2009 study identified the Semple Street harbour outfall (in Porirua's CBD) as one of the most significant contributors, with elevated levels of particulate heavy metals, nutrients, and

hydrocarbons present in proxime intertidal sediments (Sorensen & Milne, 2009).

In 2012 PCC released the Porirua Harbour and Catchment Strategy and Action Plan, identifying the need to improve the quality of stormwater discharges into the harbour from the CBD and upstream industrial areas.

Flooding

On the May 14 2015, a 1-in-100-year storm event occurred where 33.6 mm of rain fell within 30 minutes in Central Porirua. The intense rainfall washed debris into the stormwater system, blocking pipes and causing damaging secondary overflows to inundate businesses in the downstream CBD area. Takpūwāhia was one of the worst affected residential areas where the waist-deep waters entered houses and disrupted the operation of social services and kura (schools).

Significant flooding occurred once more on May 5 2016, forcing evacuation and closure of six local schools, including Porirua School for the third time in two and a half years (Dando & Fallon, 2016). This event was the catalyst for investigation into suitable flood mitigation measures for the vulnerable area.

Preliminary investigations

A study by Three Waters Limited in 2016 identified several options for flood mitigation in the Porirua CBD and recommended that a mixture of conveyance and detention measures be used. Concurrently, a study by Morphum Environmental Ltd (Morphum) highlighted the opportunity to integrate water quality elements with flood mitigation infrastructure. The study recommended that a wetland be constructed in Elsdon Park to treat stormwater from the Semple Street outfall catchment.

In 2017 WWL engaged GHD to review the conceptual arrangements and develop the design for a schedule of stormwater upgrades in collaboration with Morphum and WWL's hydraulic modelling team. Elsdon Park was identified as an optimal place to formalise flood attenuation and improve flood flows through a new high-capacity pipeline. This presented the ideal opportunity to co-locate a constructed wetland with a dedicated flood detention area and a new pipeline to the harbour as a cost-effective bypass to protect the wetland in high flows.

GHD's early engagement with key stakeholders to ascertain concerns and priorities meant that feedback was integrated into the design, ensuring the best possible outcome for the affected communities. This preliminary stage provided a strong foundation for ongoing effective collaboration between the pipeline/flood designers and project managers (GHD), wetland designers (Morphum), and WWL to progress the design alongside partners Ngāti Toa and PCC.

The project successfully secured funding from the Ministry for the Environment from the Freshwater Improvement Fund in 2017.

Central stormwater upgrades

Wetland

The new urban wetland in Elsdon Park treats the most polluted 'first flush' of stormwater from a 42 hectare urban catchment carried by the Urukahika Stream (piped). The wetland provides water quality treatment, attenuation of frequent rainfall events and flood storage capacity during infrequent rainfall events.

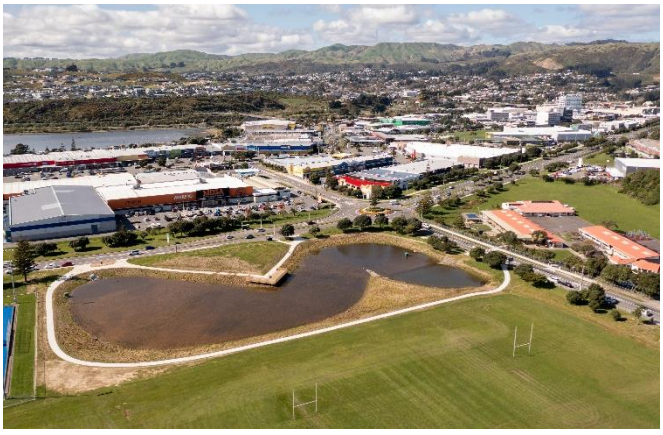

Figure 1. Te Kukuwai o Toa, the new urban wetland in central Porirua (captured by Mark Tantrum Photography).

The wetland is designed to function in various flow conditions and can receive flows up to 300 litres per second. This flow rate limits peak velocity in the wetland to protect treatment processes. Flows that exceed this are directed into the bypass pipeline via an inlet diversion manhole.

The wetland inlet diversion conveys flows for treatment into the forebay through a buried inlet pipe. A sunken manhole adjacent to the diversion manhole provides preferential capture of coarse gravel and dissipates energy before flows are discharged to the wetland inlet pipe.

The permanent water level within the wetland is enabled by using a geosynthetic clay liner (GCL), which extends across the full footprint of the wetland. The wetland level is controlled by a weir in the wetland outlet manhole, connected to the wetland outlet pool by a submerged pipe.

Flows that exceed the wetland discharge rate, cause the wetland water level to rise by up to 350 mm, engaging the surplus event detention volume (EDV of 2,870 m^3). Infrequent flood storage is engaged by the flood surcharge manhole which allows the wetland to fill further by backwatering. This enables an additional 7,900 m^3 of storage above the event detention level (EDL). This flood storage volume will draw down via the surcharge manhole and wetland outlet as rainfall decreases to the permanent water level, typically over a 24-hr period.

The wetland basin is heavily vegetated to support a variety of treatment processes, including a complex mix of physical, biological, and chemical processes to treat stormwater before it reaches the harbour. Over 35,000 locally eco-sourced aquatic, riparian and terrestrial native species were planted across the wetland footprint, 20,000 of which were supplied by local community nursey Te Rito. The wetland uses banded bathymetry to enforce a uniform velocity across the wetland's cross-sectional area. This increases the contact between stormwater and vegetation and prevents the formation of stagnant zones or short circuiting. This integration of natural systems (by way of vegetation and biota) necessitates a program of proactive maintenance rather than solely relying on reactive maintenance.

High-capacity stormwater bypass pipeline

A new 1200 mm diameter reinforced concrete pipeline provides additional capacity and redundancy to the existing system, conveying high flows diverted from the wetland that would damage vegetation. The 500 m long pipeline extends from two new Hynds Megapit sumps in Awarua St outside Porirua School, capturing flows from the existing network using a penstock valve, and out to a harbour outfall. The pipe is expected to discharge up to 2268 litres per second in a 1-in-100 year storm event.

Geotechnical investigations identified a risk of lateral spread (horizontal movement of ground towards a free face) at the harbour foreshore following an earthquake. To address this, 'Hylock Joint Restraints' by Hynds were installed in the pipe in the downstream pipe section. The pipe outfall arrangement includes a concrete wingwall modified to fit a Tideflex one-way check valve whilst still allowing fish passage. This prevents beach sediment migration into the pipeline, minimising local erosion, whilst still providing the necessary pipe flushing to reduce ongoing maintenance.

Bunding and drainage upgrades

Bunding was constructed to protect two low-lying areas adjacent to the wetland. A 100 m long sheet-piled earth bund was constructed to the north of the wetland to prevent secondary flow from entering the properties in Ngatitoa Street, Takapūwāhia.

To the south of the wetland, the footpaths bordering Porirua School were raised slightly to divert runoff from the road surface into the new mega sumps. A new 130 m long section of 300 mm diameter pipe was constructed to connect the school drainage network to the wetland. This pipe was directionally drilled, minimising disruption associated with traditional trenched construction.

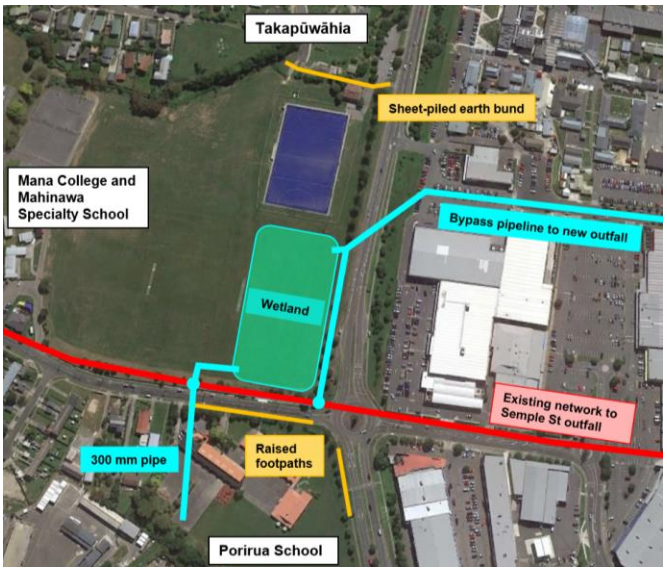

Figure 2. Schematic overview of new Central Porirua stormwater upgrades.

Engagement during construction

Design collaboration

The original design for the wetland inlet structures included an open channel running along the southern perimeter of the adjacent sports fields. Following meetings with Mana College representatives on site, this was redesigned to be a buried inlet pipe to reduce health and safety concerns with the channel location.

The final design originally included a gravel path along the eastern and northern perimeters, with short sections of raised timber boardwalk in two areas. Following consultation with PCC and Ngāti Toa in early April, the path was redesigned to extend around the entire perimeter, providing a full walking loop of the wetland. This increases the extent of access to all parts of the park for the community. The path material was also reconsidered, and it was decided that the path would be primarily constructed of concrete for ease of access and less ongoing maintenance.

The original design for the timber viewing platform included multiple levels accessed by steps. At the request of PCC this was revised and amended to be one level, flush with the concrete path to improve accessibility for the public.

Advice was sought from Ngāti Toa regarding plant selection and design of visual features, including the coating for concrete structures and proposal for creation of timber platforms. It is expected that additional features will be added by the local iwi to enhance visual amenity and cultural connection with the site.

Community connectedness

Prior to construction of the wetland commencing, a ceremony opened with a karakia (blessing/prayer) was held by Ngāti Toa Rangatira and widely attended by key project stakeholders and local groups and was followed by food and networking at the adjacent local hockey clubrooms. This event provided opportunity for the wider project team to connect with the local community that will benefit from the wetland. Another ceremony was held for the start of planting at the wetland site which provided key local stakeholders an opportunity to see progress on site and pose questions to the project team.

During construction, the contractors (E Carson and Sons) removed layers of reclamation fill and uncovered beds of old scallop shells, long since lost to Te-Awarua-o-Porirua. Coincidently the base of the excavations in the sediment forebay was precisely at the level where remarkably preserved wetland grasses had been buried many years ago. These discoveries will support future education regarding the history of the land.

Excavation of the wetland basin further revealed an historic road formation, determined to be the original alignment of Titahi Bay Road, abandoned following the creation of Elsdon Park in 1963 (Dodd, 2022). An immediate stop works order was issued whilst a Section 45 approved archaeologist together with iwi representatives investigated the discovery. Excavation in the proximity of the historic road was stopped for five weeks in total. The discovery, made possible by the prioritisation of cautious excavation over construction efficiency, enabled the iwi a glimpse at the stories told by kaumātua of the historic road. The discovery was shared throughout the community and enabled them to connect with the history of the land.

A volunteer working bee run by Te Rūnunga o Toa Rangatira was held with local community groups, schools, and project stakeholders in September 2022 to plant the Ngatitoa Street flood bund and adjacent stream area.

The formal gifting of the name by ‘Te Kukuwai o Toa’ by Ngāti Toa Rangatira was revealed at the wetland opening ceremony, held during Matariki celebrations in June 2022. The large ceremony, including a karakia, was open to the public and attended by many local community members.

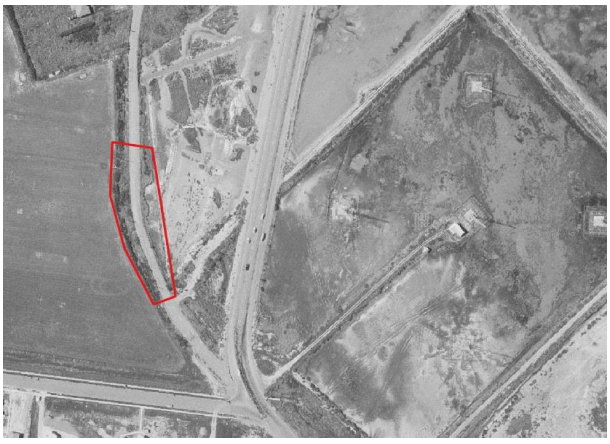

Figure 3. Historic road section discovered shown in 1959 aerial SN1530 K 1 CC-30 BY (Dodd, 2022).

Community Outcomes

Since completion of the works, the two previously flood-prone areas adjacent to the wetland have not experienced any flooding, allowing kura and social services to continue, unaffected by the weather.

There has been significant rise in public use of the recreational space since transforming the historically boggy sports field into its pre-reclamation state. Groups of all ages have been observed enjoying the new park, especially children and families using the looped path to learn how to ride a bike and warm up for sports games.

Many streams in Porirua have been fully or partially piped, resulting in a disconnection between the community and the freshwater environment. The wetland opens a new opportunity and space for public to be more in touch with nature. Attracting native wildlife back to the land and enhancing urban biodiversity was a key aspiration for Ngāti Toa. Mātuku, kotuku, paradise shelducks and frogs have been seen frequently at the wetland since opening.

PCC and Ngāti Toa are using the construction of the wetland as an opportunity to engage with residents and businesses in the catchment to help them understand and reduce their impact on the environment. This will involve personal visits, brochures, and posters to explain how everything we allow into the stormwater ends up in the wetland, and how their own actions can reduce contamination.

These parties are also working with schools and pre-schools to develop an educational programme. The school groups will be encouraged to use the wetland as a living classroom. The design of bilingual interpretive signage to support these programmes is underway and will include topics such as identification of native species, the wetland's stormwater function and the history of the land.

Conclusion

Collaboration between the stormwater designers and project managers (GHD), wetland designers (Morphum), and Wellington Water, alongside partners Ngāti Toa and Porirua City Council, has led to the successful implementation of a thoughtfully designed stormwater asset that delivers beyond simple flood alleviation. The new urban greenspace helps protect Te-Awarua-o-Porirua and encourages the community to connect with the natural environment, the historic land decisions, and understand integrated stormwater management.

The solution to the flooding woes of three central Porirua schools is a unique asset that brings nature to their doorstep and provides a multi-use interactive classroom to educate and inspire generations to come.

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