REVERSING RECLAMATION TO ENHANCE TE AWARUA-O-PORIRUA AND RESTORE RESILIENCE TO ITS COMMUNITIES

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ABSTRACT

Low-lying central Porirua has experienced devastating flooding events in recent years. Exacerbated by urbanisation, these floods have forced major disruption to the local communities whilst costing ratepayers millions in damage repairs. Each event washes harmful contaminants from the industrial developments adjacent to Te Awarua-o-Porirua Harbour, plaguing the heart of Porirua City.

Following severe flooding in 2015, Wellington Water (Client) on behalf of Porirua City Council (Owner) engaged a team of stormwater experts through their consultancy panel to determine the optimal solution for the vulnerable area.

The land once hosted natural wetlands, providing sustenance and protection to the Ngāti Toa community of Takapūwahia. Decades of development saw the connection between the fresh and marine waters severed, and conversion of the natural, resilient coastline into flood-prone commercial land. This paper describes the history of the region that inspired the solution to the city's modern woes.

This paper outlines the design objectives, construction, and anticipated future outcomes for stormwater infrastructure constructed in central Porirua.

The new assets address four key areas of concern. Te Kukuwai o Toa - a newly constructed wetland in the Porirua CBD attenuates heavy rain fall events and naturally treats contaminated stormwater, increasing the area's resilience and enhancing the natural environment. A 1200 mm stormwater pipeline constructed around the wetland perimeter, provides additional capacity and redundancy to the previously overwhelmed system. This pipe extends from new mega sumps out to a duckbill check valve at the harbour outfall. Additional stormwater bunds protect two adjacent low-lying areas, including Porirua School, that historically floods multiple times per year.

This paper recounts how effective collaboration with Council and iwi partners was integral in delivering a thoughtfully designed community asset. The success of the partnership with Ngāti Toa was reflected in the name for the wetlands, which was gifted by Ngāti Toa Rangatira and formally unveiled at a dawn opening ceremony and blessing in June 2022.

The paper discusses the dramatic improvements experienced by the local community since the project's completion. The project's success has included local kura and social services being able to operate independently of the weather.

A high degree of collaboration between the stormwater designers and project managers (GHD), wetland designers (Morphum), and Wellington Water, alongside partners Ngāti Toa and Porirua City Council, enabled the completion of a stormwater solution that will benefit communities far beyond alleviating flooding. This includes the creation of a public green space in a CBD, a wide range of education opportunities, and cultural involvement. This paper describes how these benefits will empower the community to connect with the natural environment, the history of the land and the importance of sustainable stormwater management.

Through reversing reclamation and the implementation of modern stormwater technologies, this project has restored resilience to the community and created benefits that will continue to be recognised for generations to come.

KEYWORDS

Wetlands, flooding, resilient communities, stormwater treatment

PRESENTER PROFILE

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1 INTRODUCTION

Flooding and degradation of natural water bodies are prevalent and interconnected issues threatening the ongoing commercial viability of regions globally. Vulnerability to flooding has been increased through the conversion of natural topography near water bodies into flat, impermeable landscapes and land reclamation to support population growth. This development destroys the ecosystems previously protecting the land and providing communities with sustenance, and creates low-lying, flood-prone areas for inhabitation. With climate change expected to exacerbate these issues, ensuring the resilience of communities has never been more critical.

Instigated following consecutive severe flooding events in 2015 and 2016, 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 Te Awarua-o-Porirua 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. The new system increases redundancy and capacity in the existing piped stormwater network, shields vulnerable low-lying areas from devastating flooding and treats stormwater to prevent further degradation of Te Awarua-o-Porirua.

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 multi-use asset that will protect and benefit Porirua's communities for generations to come.

2 PROJECT BACKGROUND

2.1 HISTORY

2.1.1 LAND 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.

2.1.2 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.

2.2 FLOODING

On 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.

3 PROJECT OVERVIEW

3.1 PRELIMINARY DESIGN

3.1.1 PRELIMINARY INVESTIGATIONS

The original driver for this project was to reduce flooding in Central Porirua following the events of 2015 and 2016. 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.

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. From this point in the investigation phase, stormwater quantity and quality became the dual foci of this project. Improving the health of the harbour is an important objective for Te Rununga o Ngāti Toa Rangatira who strongly supported the inclusion of stormwater quality measures into the project.

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.

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

3.1.2 DESIGN COLLABORATION

GHD's early engagement to ascertain concerns and priorities of key stakeholders meant feedback was integrated into the design from the start, ensuring the best outcome for the affected communities. This feedback included support for solutions offering stormwater treatment and ecological improvement for the area, and objection to concepts involving stormwater directed towards Takapūwāhia or modification to the location of Porirua's School entrances. The 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.

3.2 IMPLEMENTED DESIGN

3.2.1 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.

The wetland is designed to function in various flow conditions and can receive flows up to 300 L/s. This flow rate limits peak velocity in the wetland to protect treatment processes. Flows within this range are conveyed 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. Flows that exceed 300 L/s are directed into the bypass pipeline via the inlet diversion manhole.

The permanent water level within the wetland is enabled 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. When inflows exceed the wetland discharge rate, the wetland water level rises 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-hour 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.

Photograph 1. The new urban wetland in Elsdon Park (Te Kukuwai o Toa), photo captured 10 months after the completion of construction (Mark Tantrum Photography, 2023).

3.2.2 HIGH-CAPACITY STORMWATER BYPASS PIPELINE

A new 1200 mm diameter reinforced concrete pipeline provides additional capacity and redundancy to the existing system and conveys 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 sections at the downstream end of the pipeline.

The pipe outfall arrangement includes a concrete wingwall modified to fit a Tideflex Check Valve and allow fish passage. Fish passage elements were also included in the wetland outlet manhole to maintain the important ecological connection between the piped Urukahika Stream and the estuary. The 'maintenance-free' check valve prevents beach sediment migration into the pipeline, minimising local erosion, whilst still providing the necessary pipe flushing to significantly reduce ongoing maintenance.

3.2.3 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.

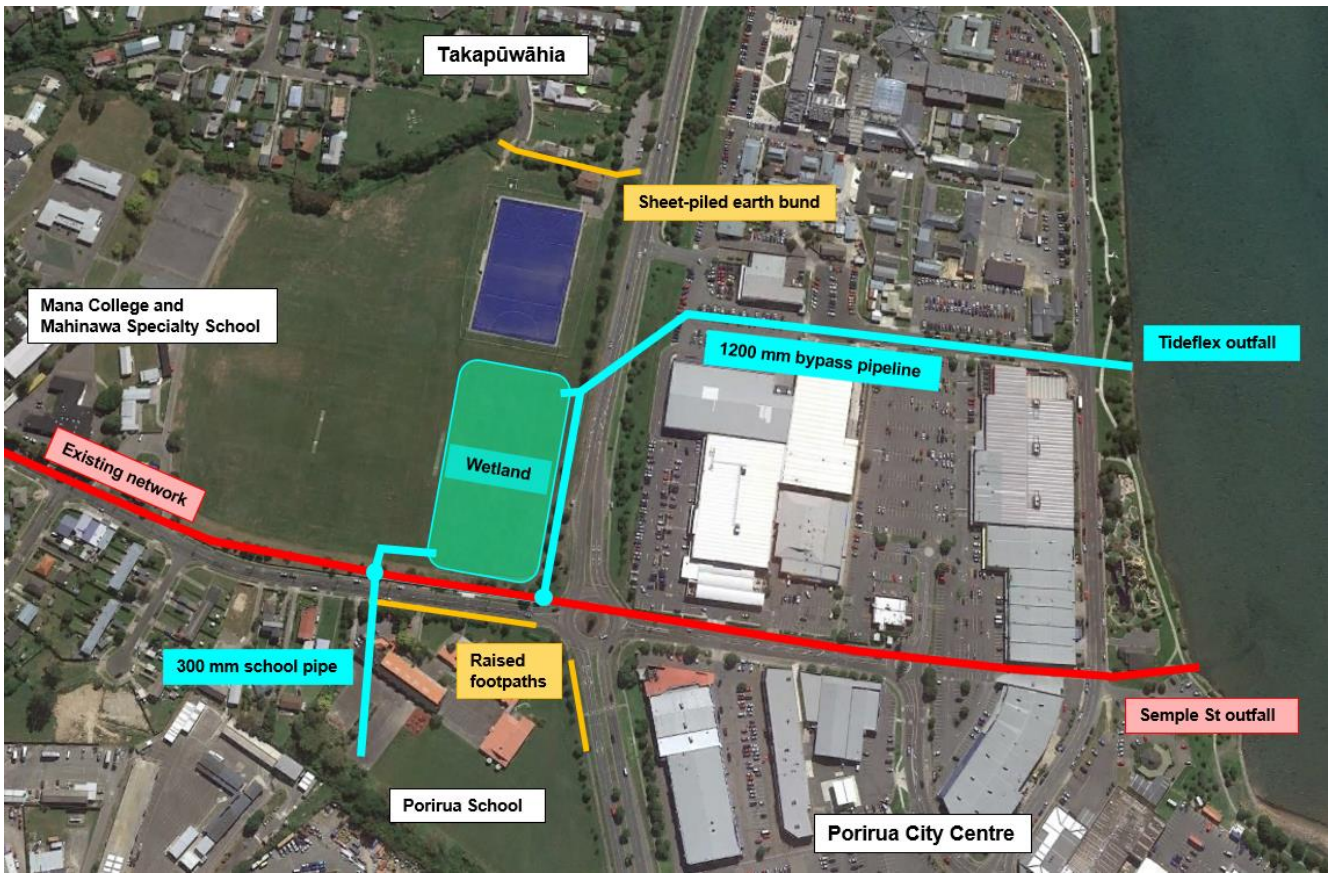

Figure 1. Schematic diagram of PCC Central Stormwater Upgrades - Stage 1.

3.2.4 DESIGN COLLABORATION

The wetland design was improved following detailed design stage through several iterations of consultation with Te Rūnunga o Toa Rangatira and Porirua City Council Parks team. This engagement resulted in changes to the landscaping design to increase public safety and accessibility, prevent crime, enhance park usability and reduce the cost of ongoing maintenance. Changes included increasing the extent of footpaths to wrap around the entire wetland, inclusion of a large grassed 'outdoor classroom' area, painting the concrete structures dark green and revising the viewing platform design to be one-level, flush with the concrete path.

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

3.3 COMMUNITY ENGAGEMENT

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.

Photograph 2. Scallop shell in wetland basin excavation (Farrant, 2022).

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.

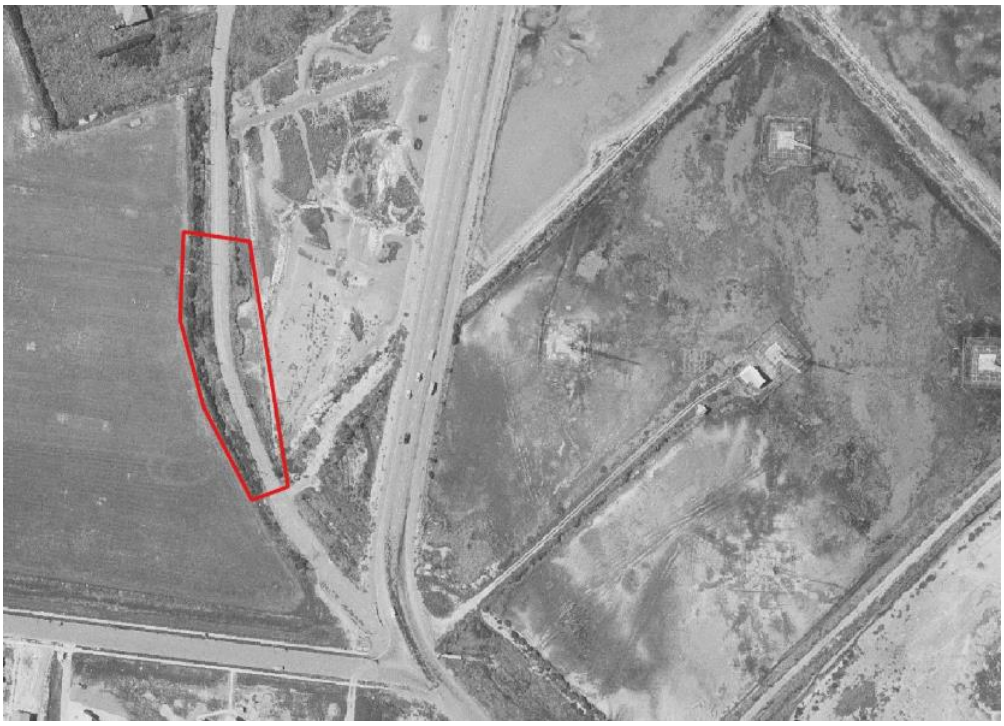

Figure 2. Historic road section discovered shown in 1959 aerial SN1`530 K 1 CC-30 BY (Dodd, 2022).

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 native species selected by Ngāti Toa have further enhanced the ecological aspects of the urban area surrounding the wetland.

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 main sign, designed and unveiled by the iwi, includes the name, site history and overview of the wetland function. The large ceremony, including a karakia, was open to the public and attended by many local community members.

3.4 COMMUNITY OUTCOMES

Since completion of the works, the two 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. 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 this project for Ngāti Toa. Mātuku, kotuku, paradise shelducks, pūkeko and frogs have been frequenting the wetland since opening.

Photograph 3. The pair of paradise shelducks that live at Te Kukuwai o Toa (Mark Tantrum Photography, 2023).

PCC and Ngāti Toa are using the newly constructed 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.

4 CONCLUSIONS

Collaboration between the project team and key local community stakeholders has enabled the successful implementation of thoughtfully designed stormwater infrastructure that delivers far beyond flood alleviation. The new stormwater system and wetland constructed in Central Porirua helps to protect Te Awarua-o-Porirua and its communities, whilst enhancing the social, cultural, and ecological aspects of the area.

The new greenspace attracts native species and enables the urban community to connect with the natural environment. Designed to facilitate learning, the wetland will encourage our communities to make better decisions for our environment for generations to come.

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