CREATING FUTURE RESILIENCE IN AUCKLAND'S STORMWATER PONDS

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ABSTRACT

Large stormwater assets such as ponds require major renewal works commonly at 20 to 30 year intervals primarily to remove sediment captured as part of their water quality treatment function. Auckland Council currently has 487 stormwater ponds within its stormwater asset register. As such, major pond renewals represent a significant capital expenditure to the Council.

As a means of gaining greater benefit from pond renewal work, Pattle Delamore Partners (PDP) on behalf of Auckland Council, has been undertaking conceptual assessments to determine if a pond can be redesigned to provide an improved multifaceted benefit to: the pond performance; the catchment wide stormwater network performance; and the surrounding community. The outcomes of these assessments are to ensure best outcomes are provided to achieve Auckland Council's vision of creating 'Water Sensitive Communities'.

PDP's approach for pond redesign requires multifaceted consideration of pond, catchment and community objectives, such as: improved water quality performance; enhanced ecological diversity and connectivity; cultural recognition; integrated transport corridors, enhanced social enjoyment; and others.

This paper discusses two recent conceptual stormwater pond redesigns undertaken in the suburbs of Unsworth Heights and Point England. Discussion is provided on the assessment approach to the pond redesigns, the various drivers that were used to inform each preferred pond redesign, how each driver were integrated into assessments, and the resultant conceptual design that has now been presented to relevant local boards for consultation.

KEYWORDS

Stormwater ponds, Renewal works, Conceptual design, Auckland

PRESENTER PROFILE

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1.0 INTRODUCTION

Stormwater ponds are a common stormwater management technique used to reduce land development effects and manage flood risk within the Auckland region. Many of the older ponds were constructed before any regional design guidance had been provided. In 1992, Auckland Regional Council released design guidance documents for pond construction, operation and maintenance with updates in 2003 (Beca, 1992; Auckland Regional Council, 2003). As a result of the transition in best practice pond design over time, a high variability in pond performance is common within Auckland (Livingston et al., 1997).

Auckland Council currently has 487 stormwater ponds within its stormwater asset register. Like all stormwater treatment devices, ponds require maintenance. Given the number of ponds within the region, the maintenance or renewal cost associated with ensuring ongoing stormwater treatment performance is achieved, is a significant potential capital expenditure to the Council. As a result of this cost, Pattle Delamore Partners Limited (PDP) on behalf of the Auckland Council have been undertaking conceptual assessments to determine if a pond can be redesigned during the main pond desilting (pond renewal) to provide an improved multifaceted benefit to: the pond performance; the stormwater network performance; and the surrounding community.

The pond renewal process offers an opportunity to implement many of the Stormwater Department's strategic objectives: safe communities, supporting growth, healthy and connected waterways, that together support the overall goal of achieving a Water Sensitive Community. Also, in utilising opportunities to work with other Council departments (Parks), CCO's, Local Boards and Community Groups, collaborative outcomes are achieved. Efficient business and prioritised investment is addressed by incorporating design that includes future Operation and Maintenance needs and delivers reduced whole of life costs. The pond renewal event is the best time to incorporate redesign that addresses all of these drivers.

This conference paper introduces a redesign (renewal) options assessment method developed by PDP and Auckland Council, and demonstrates its application to two ponds. The method is used to objectively identify the redesign option that best represents the first four strategic objectives, and aims to add the most value to the stormwater catchment and receiving environment, the local community, the pond and catchment ecology, and cultural value of the area. As these are developed in to business propositions, the financial benefits will be further examined to ensure best value for expenditure in both the renewal and the future operation and performance of the asset.

2.0 METHODOLOGY

The pond redesign method was developed as a way of assessing redesign options for the Unsworth Reserve Ponds (Section 3.0). The method has since been used and developed for further redesign assessments for the Omaru Pond (Section 4.0).

The method looks at the performance of the stormwater pond and alternative stormwater management systems against objectives for the redesign in a matrix style assessment. Key components of the method are:

- Developing **redesign objectives** that consider both site specific drivers, and Auckland Council Stormwater strategies (Auckland Council Stormwater Unit, 2014).

- Developing redesign objectives that address any known operational issues experienced by the device throughout its current working life.

- Developing **redesign options** that provide: improvement of the device against one or more of the redesign objectives; are consistent with the stormwater management needs for the catchment; all while aiming for a realistic capital and future ongoing operational expenditure for Auckland Council.

- Assessing each redesign option against the redesign objectives in a matrix assessment. Reviewing the relative performances across each redesign objective to identify the redesign option that gives multifaceted improvement to the pond performance; the catchment wide stormwater network performance; and the surrounding community.

Full financial assessment of the options will be undertaken during business case preparation as the project passes through a project management Gateway process.

2.1 REDESIGN OBJECTIVES

Development of redesign objectives formed the basis for the overall redesign assessment. The redesign objectives were agreed upon by both PDP and Auckland Council at the start of the assessment. They were determined by desktop reviews of the pond and catchment, past Auckland Council staff knowledge and catchment investigations, previous community consultations, site visits etc.

Redesign objectives were commonly developed based upon an understanding of:

- Pond performance, including key quantitative components such as: hydraulic performance, dead and live storage volumes, maintenance issues, outlet capacities and condition; and more qualitative information such as: public perception, complaints, amenity, cultural recognition, and ecological value.
- Catchment values and performance such as: ecological value and connectivity, upstream and downstream network/stream quality, current and future landuse, expected high concentration contaminants or any high risk contaminants to the catchment.
- Local community perceptions and values.

Once the objectives for the redesign were identified, they were then aligned with the Auckland Council Stormwater Department's (SWD) strategic objectives defined within the Auckland Council Stormwater Unit Strategic Direction (Auckland Council SWD, 2014).

The purpose of doing this was to ensure Auckland Council stakeholders recognise how the proposed redesign option fits with the department's overall strategic direction. This is important given the consultation, internal Auckland Council endorsement, and significant expenditure required for such projects. The Auckland Council SWD Strategic Direction objectives include:

- Safe communities through reduced risk to communities, including people, property, and infrastructure.
- Supporting growth by ensuring that new and redeveloped areas are serviced by effective stormwater management.

- Healthy and connected waterways by utilising Auckland's natural water bodies such as streams, aquifers, and harbours for stormwater management, while reducing the adverse effects of stormwater runoff and enhancing the community connection with waterways.
- Collaborative outcomes including cultural consideration through Mana Whenua engagement and involvement in decision-making.
- Efficient business is achieved by implementing the Asset Management Strategy and improving internal processes.
- Prioritised investment occurs through streamlined delivery of the renewals capital expenditure and operation and maintenance budget, with all projects being evaluated and controlled through the Gateway process.

2.2 REDESIGN OPTIONS

For each of the ponds assessed, up to five redesign options were derived.

Site specific constraints including legal boundaries, land form (contours), existing infrastructure, and land use (significant vegetation, recreational uses) were identified to develop redesign options within the site limitations.

Some common upgrade options for the pond redesigns were: the addition of a sediment forebay; restoration of the pond to the natural waterway; converting an existing online pond to an offline pond; and upgrading the pond to a wetland or to include some wetland planting areas. Integration with existing public facilities and walkways; pond and stream bank revegetation; fish passage inclusion; improved linkages with the receiving environment, and other factors were also included in the redesign options.

Options developed were hydrologically and hydraulically modelled based on the preliminary concept designs. This allowed the redesign options to be further refined while maintaining an understanding of each option's functional stormwater quality and quantity performance. Financial assessment between options has not been undertaken at this time.

2.3 POND REDESIGN OPTION ASSESSMENT

Each redesign option was assessed against each site specific objective defined for the subject pond.

Quantitative assessments were used whenever possible. These were often comparisons of the expected water quality treatment that each option would provide or the water quantity peak flow management provided by the device. This was determined by modelling the proposed option hydrologically using the program HEC-HMS.

Qualitative assessments were used to determine the relative value of each of the proposed options against the remaining objectives. To simplify complicated comparisons, the objectives were often broken down into different components to allow each of the redesign options to be assessed on its individual merits.

To assess cultural considerations, objectives contained with the Auckland Council Mauri Model were used. The Mauri Model is a tool that provides key cultural performance indicators to allow pond redesign to encompass Iwi perspectives.

Through the process of considering the relative 'achievement' or 'success' of each of the proposed redesign options against the site specific objectives, we identified a preferred pond redesign option. Furthermore, this methodology also identified when an objective was not being fully met by the selected pond redesign option. This was seen as an opportunity to further explore the redesign to provide greater improvement for the selected pond option within the preliminary design phase of the upgrade.

3.0 CASE STUDIES

The following section provides a summary of two case studies where PDP and Auckland Council applied the above methodology to determine improvements to existing stormwater treatment ponds.

3.1 UNSWORTH PONDS

Unsworth Reserve contains a series of three stormwater ponds (Unsworth Ponds); the Upper Wet Pond, the Middle Wet Pond, and the Lower Dry Pond (refer to Fig. 1). The ponds were constructed in the 1990's in conjunction with the Unsworth Heights subdivision.

Figure 1: Aerial photograph of the Unsworth Ponds.

The conceptual redesign assessment was viewed by Auckland Council as a way to address findings in a previous report, which identified that the Unsworth Ponds were undersized when compared with TP10 design guidelines. (Morphum Environmental Limited, 2012; Auckland Council, 2003). Auckland Council also wanted to achieve the following with the redesign:

- Improve the amenity in a reserve that had recently been upgraded with modern facilities including a cycle way.
- Address issues associated with stream bank erosion along the receiving Alexandra Stream.
- Reduce contaminant loadings in the receiving Alexandra Stream; in particular, temperature pollution.

3.1.1 REDESIGN OBJECTIVES

The initial project scope from Auckland Council identified three redesign objectives:

- Increasing the size of the stormwater device to meet the sizing recommended by the TP10 guidelines.
- Improvement of the reserve's amenity to add further value to the new cycleway.
- Improve water treatment, in particular temperature management, for the receiving environment.

To identify any additional objectives for redesign, PDP developed a hydrological model of the Unsworth Ponds catchment, conducted a site walkover and a desktop review of the Unsworth Ponds and their associated catchment.

This investigation identified the following additional objectives for the redesign:

- Improving water quality by addressing erosion issues identified in the stream receiving environment thereby reducing sediment load.
- To improve fish passage between the receiving stream and the Unsworth Ponds. Perched outlets were observed, which limits ecosystem connectivity within the catchment.
- Maximising the proportion of the catchment to be treated. Many outlets to the Unsworth Ponds drained to the lower pond, and part way through the ponds. This is expected to reduce the treatment performance for these networks.
- Addition of a forebay to the pond to provide a concentrated place for coarse sediments to collect, and high velocities to dissipate. The Unsworth Ponds do not appear to have a forebay.
- Adding value to a well perceived stormwater asset by adding vegetation and more signage. Unsworth Reserve is a good example of well integrated stormwater devices with the use of public signs containing information and complementary vegetation.

These objectives were summarised into five redesign objectives. These were stormwater quality treatment; stormwater quantity management; habitat provision and ecosystem

connectivity; and maximisation of treated catchment. Note that each redesign option included adding in a forebay, and integration of the existing cycleway.

3.1.2 UPGRADE OPTIONS

Given that the Unsworth Ponds are considered favourably by Auckland Council, the focus of the upgrade was to improve the Unsworth Ponds rather than overhaul the design. All redesign options looked to upgrade the pond partially or fully to a sinuous wetland system.

Reviews of the surrounding infrastructure and natural features revealed that the following site constraints limited the area available for upgrade:

- The west boundary line of Unsworth Reserve.
- Wastewater and stormwater infrastructure within Unsworth Reserve.
- The newly constructed cycleway running on the east of the Upper and Middle Pond, and on the west of the Lower Dry Pond.
- Existing contours of the site.

Given the constraints and redesign objectives, three redesign options were investigated:

- Option 1: Single sinuous wetland (Fig 2(1)).
- Option 2: Series of sinuous wetlands (Fig 2(2)).
- Option 3: Wetland and pond in series (Fig 2(3)).

(1) *(2)* *(3)*

Figure 2: Layout of Unsworth Reserve Upgrade Options: (1) A Single Sinuous Wetland, (2) A Series of Sinuous Wetlands, (3) A Wetland and Pond in Series (Auckland Council, 2016).

3.1.2.1 OPTION 1: SINGLE SINUOUS WETLAND

Option 1 proposed that the Unsworth Ponds be converted into a single sinuous wetland. A forebay for the wetland was to be created in the footprint of the existing upper pond. This met the TP10 minimum surface area requirement of 10% and volume requirement of 15% WQV (Auckland Council 2003). The main wetland would extend across the Middle Pond and the Lower Dry Pond creating a long continuous sinuous wetland. The section of cycleway that runs across the bund (dividing the existing Middle Pond and Lower Dry Pond) would be removed and reconstructed as a bridge across the proposed wetland creating water shading and integration of the cycleway with the wetland.

The single sinuous wetland option would involve rerouting some of the pond inlets up to the proposed forebay via pipes, swales, or similar method. It was anticipated that one or more networks may not be able to be re-routed up to the forebay. In this case, these networks would enter lower down the wetland via a settlement chamber or pre-treatment chamber in lieu of a forebay.

3.1.2.2 OPTION 2: SERIES OF SINUOUS WETLANDS

Option 2 proposed that the Unsworth Ponds be converted into a series of sinuous wetlands. A forebay for the wetlands was to be created in the footprint of the existing upper pond. This met the TP10 minimum surface area requirement of 10% and volume requirement of 15% WQV (Auckland Council 2003). The first wetland was to sit approximately in the existing footprint of the Middle Pond and the second wetland was to be constructed in the location of the Lower Dry Pond. The cycleway was to be maintained, and run across the bund between the two proposed wetlands.

The series of sinuous wetlands proposed a reduced catchment to be piped to the forebay, with some networks entering into the lower sinuous wetland via a settlement chamber or pre-treatment chamber in lieu of a forebay.

3.1.2.3 OPTION 3: WETLAND AND POND IN SERIES

Option 3 proposed that the Unsworth Ponds be converted into a sinuous wetland and pond in series. Due to the layout of the existing stormwater network and to limit erosion of sediments within the dry pond, the existing Upper Pond and Middle Pond would be converted into a single sinuous wetland. The Lower Dry Pond would be converted into a wet pond which would provide quantity control and additional quality treatment for the catchment. Earthworks would be required to expand the Lower Dry Pond, to remove and replace the bund between the Upper and Middle Ponds to form the wetland forebay, and to modify the bathymetry of the Upper and Middle Pond to form a sinuous wetland.

The wetland proposed to serve a smaller catchment that would exclude runoff from the Unsworth Reserve park area and from approximately 1 ha that currently drains to the Lower Dry Pond. This was in recognition that the park land use would yield runoff with low contaminant concentrations. It would also minimise the requirement for rerouting a number of existing piped flows.

The proposed wetland alone would not conform to TP10 design guidelines as it would provide inadequate extended detention. However, in combination with the proposed wet pond, this treatment train system provided the best environmental gains. The combination of devices in the system met and exceeded TP10 guidelines for water quality treatment and extended detention water quantity volume (Auckland Council, 2003).

3.1.3 CONCEPTUAL REDESIGN ASSESSMENT

The conceptual redesign assessment for the Unsworth Ponds evaluated each of the proposed redesign options against the redesign objectives of: stormwater quality treatment, stormwater quantity management, habitat provision and ecosystem connectivity, maximisation of treated catchment. The assessment found that Option 3, the sinuous wetland and pond in series option, provided the most multifaceted benefits to the Unsworth Reserve.

For each redesign option, the expected long term TSS removal percentage was estimated using TP10 design procedures (Auckland Council, 2003). Option 3 provided the most significant water quality treatment providing an estimated long term removal within the wetland alone of 73% TSS. The pond component is intended to provide water quantity control. However, this device alone provides 75 % TSS removal for the flows it receives (refer to Table 2).

Table 1: Summary of Estimated Water Quality Performance of the Upgrade Options.

	Option 1	**Option 2**	**Option 3**	
			Wetland	Pond
Permanent Pond Volume	4,000	3,000	3,700	3,900
TSS Removal with No Extended Detention	61%	57 %	60 %	61%
TSS Removal with Extended Detention	75 %	69 %	73 %	75 %

The sinuous wetland component was also expected to provide added treatment benefit to its catchment. This is achieved with alternative contaminant removal processed such as: physical filtration processes through dense wetland vegetation; chemical removal processes via pH buffering in different planting and depth zones; and biological uptake through the wetland plants. This additional benefit was recognised, but not quantified in the conceptual redesign.

The pond component of Option 3 was expected to provide improved water quantity management above what was provided by the other redesign options. Hydrological modelling of this device showed a reduction in peak discharge from the pond during a water quality storm, a 2 year ARI rainfall event and a 10 year ARI rainfall event. This would promote a more natural velocity regime to the receiving environment, reducing stream bank erosion risk and sediment loading on the stream.

All of the proposed upgrade options were expected to provide similar habitat enhancement. The wetlands would have a high diversity of wetland planting, and habitat zones within the varying water depths. All of the proposed options could readily incorporate fish passage to improve ecosystem connectivity.

The Sinuous Wetland and Pond in Series was proposed as the preferred option. Whilst not conforming to a typical Auckland Council (2003) TP10 design, the overall treatment system will provide a high level of quantity and quality treatment.

3.1.4 ONGOING REDESIGN WORK

This option is currently being assessed as a business case through Auckland Council's internal procedure. The Unsworth Ponds redesign is proposed to be further developed

and improved using a proof of concept/preliminary design phase. This will aim to analyse and improve upon aspects of the design against the objectives to develop a high value stormwater asset for the Auckland Council Stormwater Department and the general public of Unsworth Heights.

3.1.5 ASSESSMENT FINDINGS

The Unsworth Pond options assessment was straight forward in that all options had similar ecology, community and amenity benefits with incorporation of wetlands. These benefits are usually very challenging to quantify and compare. With these being similar in all options, the assessment became more quantifiable being comparisons of stormwater quality and quantity management.

3.2 OMARU POND

Figure 3: Aerial Photograph of Omaru Pond (Auckland Council, 2016).

Omaru Pond is an online stormwater treatment pond located in the Point England Reserve, Point England. Omaru Pond is sited in the lower Omaru Creek catchment, less than 1 km from the downstream coastal receiving environment, with tidal influence zones in close proximity to the pond outfall. The pond was constructed in 2002 by widening the existing stream channel to the south (determined from aerial photography).

Auckland Council expressed their desire to redesign Omaru Pond to improve stormwater quality treatment in anticipation of intensified development within the upper catchment. Omaru Stream is recognised as having some of the most elevated contaminant concentrations within the Auckland region (Holland and Buckthought, 2015). Community feedback on Omaru Pond indicates there are concerns with algal blooms and odour during the summer months (M. Iszard *per comm*, 2015).

3.2.1 REDESIGN OBJECTIVES

Auckland Council's brief identified three objectives for redesign of Omaru Pond (water quality, habitat provision, and amenity). To identify additional objectives, PDP developed a hydrological model of the Omaru Pond catchment; conducted a site walkover; and undertook a desktop review of the Omaru Pond and its catchment. PDP also considered

previous Auckland Council consultation with the Point England community. The following redesign opportunities were identified:

- Providing a high level of water quality treatment to create a future proof device that is prepared for increased urbanisation and development within the catchment as indicated by the 190 ha special housing area (SHA).
- Addressing community feedback on the pond including complaints about algal blooms and odour issues.
- Adding in a high flow bypass to improve the Omaru Pond to an offline device.
- Relocation of the low flow outlet to minimise short circuiting in the Omaru Pond.
- Enhancing biodiversity by adding high value habitat and improving ecosystem connectivity between the upstream and downstream environments.
- Providing improved cultural value of the Omaru Pond to local Iwi through the application of objectives defined within the Auckland Council Mauri Model.
- Increasing community perception of the Omaru Pond and the Point England Reserve. Enhancing existing community and cultural value, as was demonstrated by local schools running native replanting programs.
- Improvement of the Omaru Pond hydraulics that currently cause significant backwater effects well outside the extent of the pond itself.
- Improvement of the undersized culverts below Elstree Avenue; or mitigation of erosion caused by the undersized culverts throttling of peak flows that occur during the 2, 5 and 10 year ARI (Department of Building and Housing, 2011; Aecom, 2015).

These opportunities were developed and summarised into a set of four redesign objectives: water quality treatment, amenity, habitat improvement, and cultural wellbeing.

Improvement of hydraulic issues was not assessed within the redesign assessment because the issue was not isolated to Omaru Pond alone; instead it was flagged to be addressed during the detailed design phase of the redesign.

3.2.2 UPGRADE OPTIONS

Four redesign options were considered for Omaru Pond. The options were quite varied in nature, and reflected the range of drivers identified for the redesign.

These redesign options were developed with consideration of the following constraints that limit the area available for redesign:

- Existing wastewater pump station and other wastewater infrastructure on site.
- Reserve boundaries to the west (Elstree Avenue) and south (Point England School).
- The Glen Innes Aquatic Centre and the Glen Innes Family Centre to the northeast.

The following site infrastructure and attributes do not constrain the potential development. However, removal of the following was minimised with the development of the redesign options:

- Existing abandoned or to be abandoned stormwater infrastructure on site.
- Pedestrian footpaths and bridges.
- Replanted areas (community work in the area) and significant trees.

Redesign options considered were:

- Stream restoration.
- Forebay inclusion.
- High flow bypass inclusion.
- Wetland pond.

3.2.2.1 STREAM RESTORATION

The Stream Restoration option proposed to restore Omaru Pond to a stream that follows the original alignment. The redesign option would regrade the stream to a natural cross section; containing features such as a thalweg with woody/stoney debris, flood plains and riparian planting.

The Stream Restoration option removed control structures, creating a natural habitat with no ecological barriers. High quality habitat was to be developed with the redesign. This was via flood plain and riparian margin planting; in stream pool and riffle sequences; and woody and stoney debris. The biodiversity is likely to change significantly with the loss of the pond habitat and the gain of a high quality stream habitat.

The Stream Restoration option was expected to be perceived as a loss of amenity to the Point England community. This was due to the loss of a large open water body and reduced access to the water's edge.

This option provides no water quality treatment function. However, improvement to odour, algal growth, and anaerobic conditions would be expected from a more natural flow regime.

The stream restoration option was intended to be integrated with public park facilities including a cycleway, viewing platforms and seating areas.

3.2.2.2 FOREBAY

The Forebay redesign option proposed to install a forebay in the upstream area of Omaru Pond. In addition, the low flow outlet was to be relocated next the high flow outlet weir.

The forebay redesign option provided a targeted area for maintenance works as the majority of sediments will settle the forebay. As such, dredging frequencies in the main pond should be reduced. This would save operational costs and protect the main pond ecosystem from the disruption of more frequent sediment dredging.

The existing low flow outlet would be relocated adjacent to the existing overflow structure. This would help minimise short circuiting of flows which was considered to occur in the current pond layout.

3.2.2.3 HIGH FLOW BYPASS

The High Flow Bypass concept proposed constructing a high flow bypass around the southern boundary of the existing pond. This option reconfigured the high and low flow inlets and outlets to make Omaru Pond become a partially offline pond. The redesign option also included a forebay as in the Forebay option. The high flow bypass was to convey flows exceeding the ponds water quality treatment volume.

Due to the large flows expected from the catchment, a bypass designed to TP10 guidelines required a large cross sectional area (Auckland Council, 2003). Construction of the bypass was expected to require consultation with Watercare to obtain their approval for earthworks over or near the wastewater line on site (which is approximately 3 to 4 m deep). Alternatively, consultation with Watercare could be conducted to align future wastewater works (i.e. the renewal of this section of wastewater pipe) with the construction of this option.

The bypass grade and side slopes were to be less than 1:4. The high flow bypass was proposed as a grassed swale which would blend into the grassed reserve areas when it was not operational. It could have also been incorporated into reserve features like a pedestrian path.

3.2.2.4 WETLAND POND

In this option it was proposed to construct a forebay and a stream channel bypass like the previous High Flow Bypass option. Additional works included: adding in headlands to Omaru Pond; reconfiguring the bathymetry to extend the flow paths; and creating wetland areas. The Wetland Pond flow path would loop around the headland and join into the stream bypass adjacent to the high flow bypass.

Positioning of the Wetland Pond outflow right next to the high flow bypass overflow from the forebay would recreate a permanent watercourse and "daylight" an existing piped low flow bypass. This was to be constructed as a stream containing features like a thalweg with woody/stoney debris, interlinking riffle/pool sequences incorporating fish passage for non-climbing species, along with flood plains and riparian planting along the stream banks.

The bathymetry and planting changes in this option were expected to provide further improvement to the water quality treatment system. The bathymetry of the Wetland Pond was banded. It would be developed to have high and low wetland marsh areas and deep transverse pools. The wetland marsh areas and replanted bank areas would provide improvement in biological contact and associated biological treatment. The banded bathymetry would encourage diffuse flows and minimise the risk of flow short circuiting to help improve stagnation and odour issues.

The deep transverse pools would further encourage diffuse flows and minimise short circuiting. The deep transverse pools provide additional volume to increase the hydraulic retention time, which may further improve stormwater treatment.

3.2.3 CONCEPTUAL REDESIGN ASSESSMENT

The conceptual redesign assessment for the Omaru Pond evaluated each of the proposed redesign options against the redesign objectives of: stormwater quality treatment, amenity for the community, habitat provision, and cultural wellbeing. The assessment found that the Wetland Pond upgrade option provided the most enhanced multifaceted benefit to Point England Reserve.

Water quality treatment performance was assessed for each device using sedimentation theory. The assessment also used qualitative comparisons of the expected treatment of the upgrade options of key contaminants: total zinc and total copper, this was based on Auckland Council's Proposed Auckland Unitary Plan (PAUP) design effluent quality requirements (DEQRs) (Auckland Council, 2013).

The Wetland Pond option provided the best water quality performance of the different options. It was expected to have high long term TSS removal, which is enhanced with filtration processes through dense wetland vegetation.

The Wetland Pond redesign also provided the greatest improvement to amenity. This was through the provision of large revegetated areas supporting a variety of native vegetation types. The Wetland Pond option also retains open water aspects of the existing pond (which is already valued by the community), with good access to the banks and integrated pedestrian and cycleways, viewing platforms and other facilities.

All options proposed allowed for the integration of artwork, and community participation in the redesign and revegetation phases.

Significant ecological improvement was anticipated with the creation of high quality and diverse wetland habitats, and stream habitats in the high flow bypass. The upgrade proposed full fish passage through the pond, encouraging the migration of native species.

The Wetland Pond option was expected to add more cultural value to the Point England reserve. This resulted from a diverse range of native vegetation for cultural harvest and use, and good accessibility to the local community for cultural practices. Better water quality treatment for more pristine waterways, moving towards water quality suitable for rites of tohu would also be achieved, along with improved water quality discharging to the final receiving environment of Tamaki estuary. Local Iwi were expected to be involved in the redesign process for the preferred option, allowing them to develop designs that would best incorporate cultural value into the upgrade.

The priority of this redesign was water quality. As such, the assessment recommended the Wetland Pond upgrade option was progressed to a detailed design phase. During the design phase, the following issues should be resolved:

- Maximising the water quality performance of the option.
- Provision of fish passage with appropriately designed inlet and outlet structures, and opportunities for further habitat improvement.
- Incorporation of pedestrian and cycle paths, seating, viewing platforms, rubbish bins, and other public facilities.
- Erosion protection for the area directly downstream of Elstree Avenue culverts.
- Risks and opportunities associated with modification of the system hydraulics.

Figure 4 presents an illustration of the proposed Wetland Pond option for Omaru Pond.

Figure 4: Illustration of the proposed Wetland Pond option for Omaru Pond.

4.0 CONCLUSIONS

PDP and Auckland Council have developed a conceptual redesign assessment methodology for stormwater treatment ponds. The method is a way to develop redesign concepts for stormwater ponds as they come up for significant renewal works, or as they are identified as being in need of significant improvement. The conceptual redesign assessment is based around a matrix options assessment. The conceptual redesign method is simplified as:

- The development of redesign objectives based around addressing the drivers for redesign, while keeping in line with the Auckland Council Stormwater Department's strategic objectives defined within the Auckland Council Stormwater Unit Strategic Direction (Auckland Council Stormwater Department, 2014).

- Development of site specific redesign options that are developed to meet the objectives.

- Conceptual options assessment using a matrix system that assesses the performance of each option against the redesign objectives.

The method has been used successfully to develop redesign options that provide multifaceted benefits to the stormwater device, the catchment and the community. Examples of this include developing the Unsworth Ponds to a sinuous wetland and pond in series, and developing a wetland pond upgrade for Omaru Pond.

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