“BICYCLES, STORMWATER AND BIOENGINEERING… THE ALEXANDRA STREAM ENHANCEMENT PROJECT”

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ABSTRACT

Integrated Catchment Management Planning (ICMP) is a lot more than just stormwater pipes and receiving environments. Increasingly it is about planning to meet less tangible social and amenity objectives, while achieving water quality, ecological and flood management outcomes.

The Alexandra Stream Enhancement Project is located in the Oteha Valley, North Shore City. This project involves the integration of a major public cycle-way project with stream restoration, wetland enhancement and stormwater infrastructure improvements. It represents a unique opportunity to achieve community outcomes through the implementation of low impact design principles.

This paper documents the process, philosophy and technical innovations that have underpinned this project and discusses the institutional capacity requirements. In particular it will address the following key elements:

- How ICMP is used to deliver quadruple bottom line outcomes,
- Methods used in identifying issues and enhancement opportunities,
- Innovative approaches to water quality improvement, e.g. Bioenegineering techniques used in the restoration of wetlands and enhancement to offline treatment systems,
- The collaborative approach to planning between Transport, Parks and Three Water Departments.

KEYWORDS

Integrated catchment management planning, water quality, cycle-way, bioengineering

1 INTRODUCTION

This paper details the process, procedures and design philosophy’s used in the development of management options and designs for the Alexandra

Stream restoration project as part of the Oteha Integrated Catchment Management Plan.

The aim of the project was to evaluate options to improve water and habitat quality of the Alexandra Stream. These options have been considered in conjunction with the proposed cycle-way that is intended to run along the Stream.

The ICMP identified a number of enhancement and optimization opportunities within the Alexandra Stream corridor including:

- Contaminant management and removal,
- Erosion management and remediation,
- Ecological enrichment,
- Amenity enhancement and;
- Improvement to public access.

These objectives have been developed from the North Shore City Council's (NSCC) stormwater strategy and are endorsed through the combined catchment integrated catchment management plan for the area.

The relevant outcomes sought for the Oteha stormwater catchment, and this enhancement project included:

- To provide mitigation measures to enhance ecological values,
- To improve public access within the stream corridor,
- To ensure sediment control requirements are met,
- To minimise quantities of zinc entering the receiving environment,
- To recognise and protect heritage and cultural values of the stream and environment,
- To manage stream erosion,
- The use of low impact design and other on-site mitigation methods for new development or redevelopment to reduce contaminant discharge at source, manage stream erosion and protect stream health.
- Protection against future stream bank erosion and damaged native vegetation,
- Maintaining and/or enhancing amenity and ecological values by retaining existing native riparian vegetation where practicable, implementing new planting and ongoing weed management.
- Protection and enhancement of existing wetland's and its/their associated natural treatment capability by restoring and maintaining in a more natural condition.
- Enhancement of general stream ecology by other means where appropriate, for example by habitat enhancement.
- Minimising in-stream works as far as practicable
- Encouraging current and future community involvement in stream management.
- Mitigation of the effects of erosion at Council outfalls,
- Removal of mitigation of man-made barriers to fish associated with Council infrastructure.

The Alexandra Stream was classified as a category 2 stream through the ICMP planning process. This classifies the stream as being of moderate ecological and social value and as such has been identified as a watercourse with enhancement potential.

2 LOCATION AND PROJECT DESCRIPTION

The Alexandra Stream drains a 270Ha area and flows in a south-north direction for approximately 5km (mostly within reserve land) from the headwaters in the Unsworth Reserve through to it's confluence with the Oteha Stream at Bush Rd, Albany (see Figure 1).

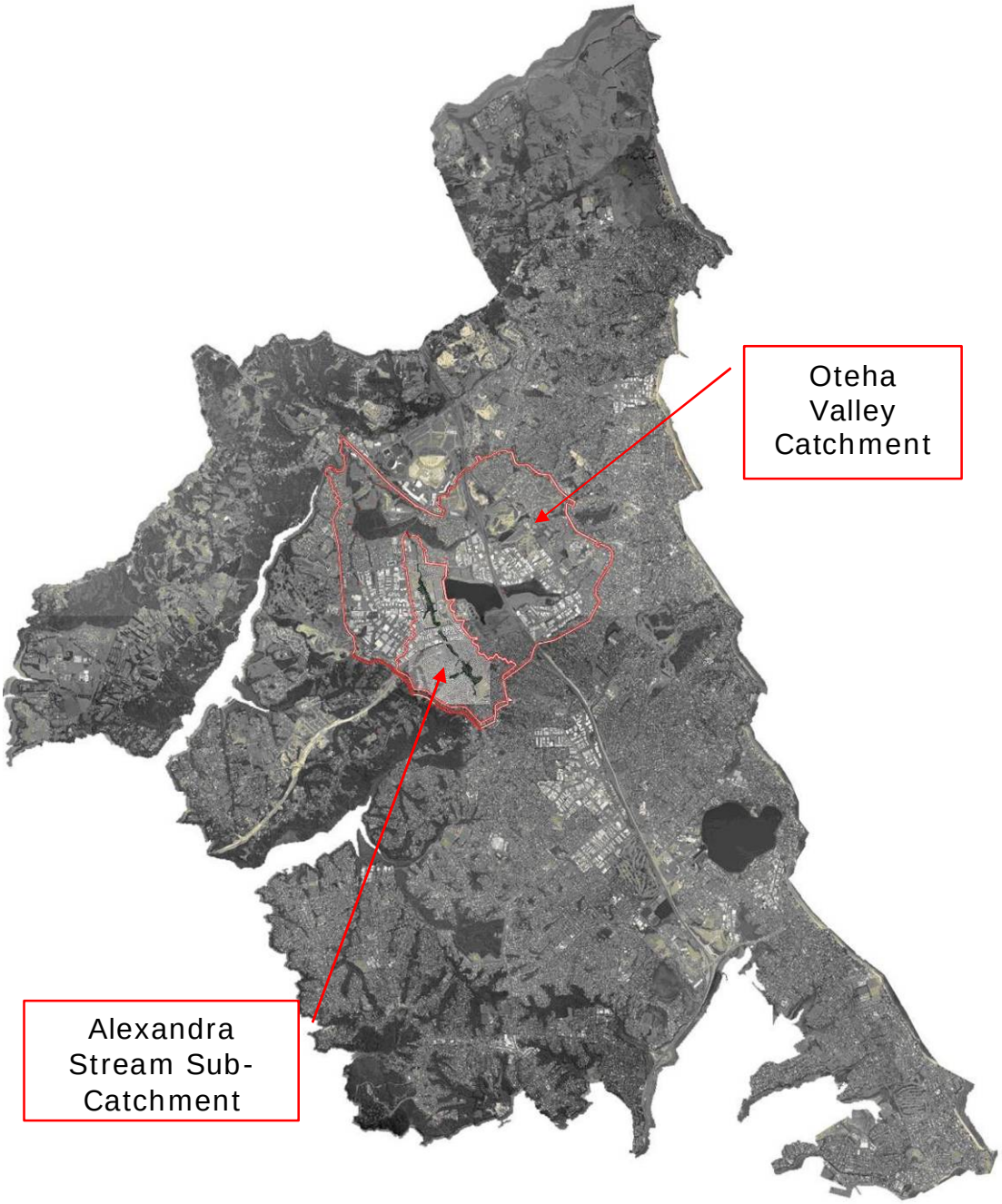
The Alexandra Stream corridor is almost entirely within a thin strip of reserve land. The upper main corridor is surrounded by residential development. This has resulted in alteration of the form of the stream through piping, culverting and the creation of stormwater control ponds.

The land use adjacent to the upper-middle section of the stream is dominated by industrial/commercial development. This is where the majority of contaminants are being generated in the catchment. Adjacent land use in the lower section of the stream is composed of a mixture of reserve, residential and education land.

Alexandra Stream shares some of the natural character of Oteha Valley Stream. It has a well formed channel in the lower main section with remnant totara trees supporting the stream banks. The lower-middle section of the stream borders the Rosedale treatment ponds. This section is zoned for recreation and includes a substantial wetland area known as the Alexandra Lower Wetland.

The Alexandra Stream Enhancement Project involves a series of sub-projects, including riparian weed management and planting, erosion mitigation, flood plain modification to encourage contaminant removal, a stormwater swale for contaminant removal, a stormwater pond upgrade and the provision of an off-road recreational and commuter 'share with care' cycle path.

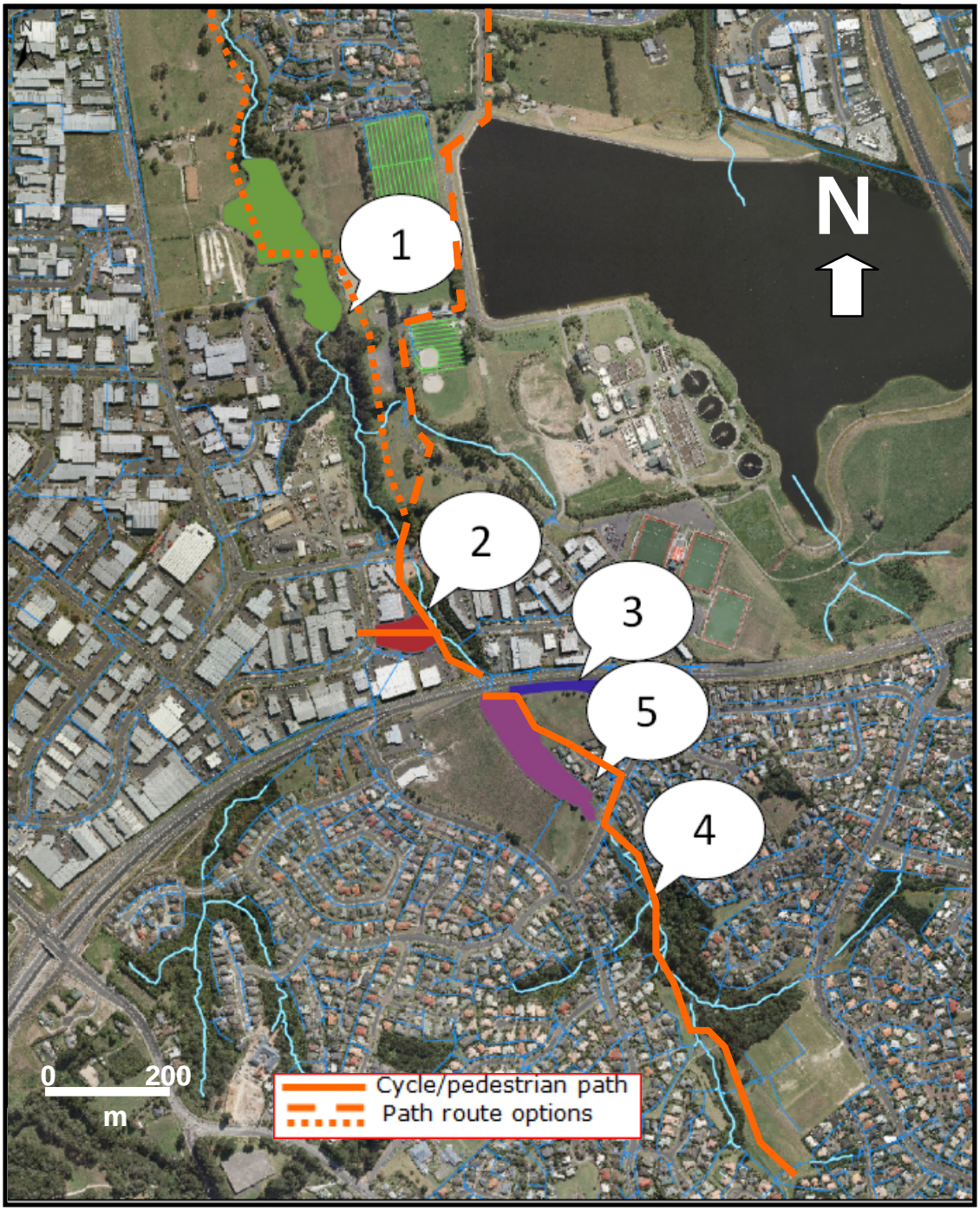
Figure 1: Map of North Shore City identifying the Alexandra Stream Sub-catchment of the Oteha Valley catchment.



There have been 5 main project sites selected for detailed investigation, options assessment and design along the length of the Alexandra Stream (see Figure 2). They include:

1. Alexandra Wetland
2. Omega Pond and Omega Reserve
3. Rook Reserve Swale
4. Barbados Wetland
5. Rook Reserve Reach (re-vegetation

Figure 2: Map of Alexandra Stream Enhancement Project areas



The Alexandra Stream Enhancement Project is currently in the planning phase, with construction of the cycle-way and stormwater projects proposed over the 10/11 and 11/12 construction seasons.

3 PROJECT PHILOSOPHY

The Alexandra Stream Enhancement Project is supported by some key environmental data and assessments that have identified restoration opportunities. These include a complete stream and asset assessment undertaken by an engineer and ecologist. This involved physically walking the entire length of the waterway assessing all built and natural structures including:

- Stormwater outfalls,
- Cascades and waterfalls,
- Stream morphology,
- Riparian features,
- Erosion and stability.

Critical in meeting the objectives and achieving the outcomes of the ICMP was to be able to take a holistic approach to opportunity identification. This involved, for instance, considering the ecosystem services provided by the stream system and how they might align with regulatory requirements and guidelines for the management of contaminants. This approach resulted in a number of semi-modified wetlands being recognized for their contribution to the removal of contaminants. Subsequently investigations were initiated to define design options that might enhance this recognized function through the use of bioengineering techniques.

Other related benefits such as amenity improvement and social engagement, economic development, ecological enhancement, cultural sensitivity, educational components, etc were also considered early in the project development.

A traditional stormwater management approach would have excluded many of these enhancement opportunities because they would have been considered outside the scope of the standard stormwater management envelope. NSCC has taken a holistic approach to stormwater enhancement opportunities focused on achieving multiple benefits.

The holistic approach adopted during the development of the Alexandra Stream Enhancement Project resulted in several opportunities arising, which through an integrated approach with other departments, would enhance the project. Some of these included:

- Amenity and social engagement – public access and vegetation enhancement. NSCC engaged the Unitec Landscape Architect Department to provide a contextual analysis of the stream corridor that assisted in identifying and prioritizing such opportunities. For example, identifying areas along the stream corridor where the

public may interact with the stream through either visual or aural experience.

- Ecological enhancement – the stream walk identified opportunities for extending both the extent and quality of the riparian margin early in the process.

- Cultural involvement – NSCC has an Iwi Liaison Group (including representatives from hapu across the NSCC area) who were consulted with over this project. Iwi showed an interest in plant species selection and were keen to be involved in the development of any educational messages planned along the cycle-way.

- Educational benefits and cultural understanding – Given some the innovative approaches to stormwater management it was seen worthwhile to include interpretive signage along the path. These sign boards would explain the purpose of the stormwater treatment methods, the Low Impact Design approach and would also incorporate cultural messages around the traditional uses of the various plant species present (as discussed with Iwi).

3.1 INTEGRATION

This holistic approach goes beyond simply stormwater management and has included the integration of the objectives of other Council departments. The NSCC Transport section has developed designs for a cycle-way that run in parallel with the stormwater planning process. The Alexandra Stream corridor is identified as a green cycle route in the NSCC Parks Department's Recreational Cycling Network Plan and is aligned with the NSCC Transport's Strategic Cycling Plan.

Both Council departments recognized the opportunity to combine planning resources to work towards achieving overlapping project objectives. In addition design resources and technical expertise have been combined.

The cycle-way alignment interacts with several of the stormwater projects planned for the Alexandra Stream corridor and there has been considerable integration between the two planning teams to ensure the best stormwater and transport outcomes are attained, while maximising cost savings and minimising disruption to the environment and the community.

The design development phase of this project has been inclusive and iterative. In order for this process to be successful it required open collaboration, great communication and a willingness to share contracts, outputs, budgets etc.

Improvements already identified by this integration include: putting the community in better contact with the environment through cycle route selection, incorporating stream enhancement works with the cycle-way to provide for enhanced amenity, seeking to reduce runoff caused by the cycle-way, and selecting plant species, which will enhance stormwater

capture and sediment retention, thereby reducing the cycle-way's environmental footprint.

Aside from the holistic and integrative approach adopted, the successful scoping of large scale projects such as the Alexandra Stream Enhancement Project requires a comprehensive vision for the catchment area, combined catchment or even on a city-wide scale. NSCC developed combined catchment ICMP's as part of the network consenting process. These ICMP's specify the objectives for each catchment and provided the focus for the Alexandra Stream Enhancement Project. The contextual analysis undertaken by Unitec also helped to provide project focus.

3.2 LOW IMPACT DESIGN AND SOFT ENGINEERING

There has been a transition towards more soft engineering practices as part of stream restoration projects. This is lead by a drive to encourage natural processes through mimicking nature. While gabion walls and concrete structures may be appropriate at times, these structures are now often being replaced by compost filled geotextile socks, point bars and Newbury rock riffles. Not only are these 'soft' engineering structures effective, but they are also often less expensive to install and maintain. Some soft engineering methods (e.g. compost filled socks) can also be installed in remote locations with limited environmental impact and they blend into the landscape, which attracts community endorsement.

NSCC have adopted a soft engineering approach to the Alexandra Stream Enhancement Project. Innovative approaches to water quality improvement, e.g. Bio-engineering techniques are to be used in the restoration and enhancement of off-line wetland treatment systems.

The Transport section also followed this philosophy through efforts to incorporate low impact design into the design of the cycleway. It is proposed that low fines concrete be used for the hard surface (where practical) in addition to wooden boardwalks, which will assist in reducing the environmental footprint of the cycle-way.

3.3 BEST PRACTIBLE OPTION

All too often, opportunities for stormwater-related improvements (particularly stormwater treatment in brown-field catchments) are ignored because they don't meet guideline levels for contaminant removal. The Auckland Regional Council's Design Guideline manual for Stormwater Treatment Devices (TP10) requires 75% sediment removal. The identification of new locations for stormwater treatment devices in brown-field catchments such as in the Oteha Valley relies heavily on available opportunity, as does retrofitting existing treatment devices. More often than not, these new or upgraded devices can't achieve the levels of contaminant removal set out in TP10, however this does not mean they should be discarded. Following a treatment train approach with Best Practical Option (BPO) principles will provide for the best available contaminant removal for the catchment. This is the approach sought through the Alexandra Stream Enhancement Project.

4 PROJECT SITES

Five key project sites have been identified for stormwater-related enhancement along the Alexandra Stream corridor. A summary of each project is provided below:

4.1 ALEXANDRA WETLAND

The Alexandra Wetland is located in the lower reach of the Alexandra Stream between Paul Matthews Rd and Rosedale Rd and is one of the largest natural wetland areas in North Shore City (see Figure 3). The wetland area expands to a significant floodplain at the widest section, immediately downstream of a BMX track. Floodplains provide a contaminant removal function through the deposition of sediment from stream flows.

The main objectives for the Alexandra Wetland area include:

- Reduction of sediment deposition within the stream channel;
- Reduction of contaminant loadings on downstream environments;
- Improve habitat and local amenity with riparian vegetation enhancement; and
- Prevent adverse impacts on in-stream habitat including temperature and dissolved oxygen effects.
- Improved public access

Figure 3: Concept image of Alexandra wetland, including weir and boardwalk

The key part of this enhancement project involves placing a Newbury Rock Riffle into the main stream channel that will divert frequent storm flows onto the flood plain. The flood plain will be separated on either side from the main stream channel by the use of bunds running parallel to the stream channel thus creating offline wetlands for water quality treatment. The frequent rainfall storms which the wetlands target to capture generate high levels of contaminant runoff from roads and surrounding industrial land use. Contaminants such as sediment, zinc, copper and hydrocarbons

will be encouraged to settle out of the water column in the planted impoundment areas.

The intention of the project is to maximise the use of soft engineering materials and methods in order to minimise the impacts of the work and maximise the benefits set out in the objectives listed above. Access through the wetland area from Rosedale Park is currently being investigated. This may form part of an alternative cycle-way route from Paul Matthews Rd through to Rosedale Rd.

4.2 OMEGA POND

The Omega Pond is located adjacent to Omega Street and discharges into the Alexandra Stream between State Highway 18 and Paul Mathews Drive. The Pond was constructed in 2000 as part of the Unsworth Views and North Harbour Industrial Estate development. The original design function of the pond was as a detention pond, however a large amount of sediment has built up on its bed since it was originally constructed. Consequently in its current state it has very little effective detention volume.

The catchment draining to the pond is almost entirely dense industrial/ commercial and road surface, which contributes a considerable amount of heavy metal contaminants to the Alexandra Stream and Lucas Creek receiving environment.

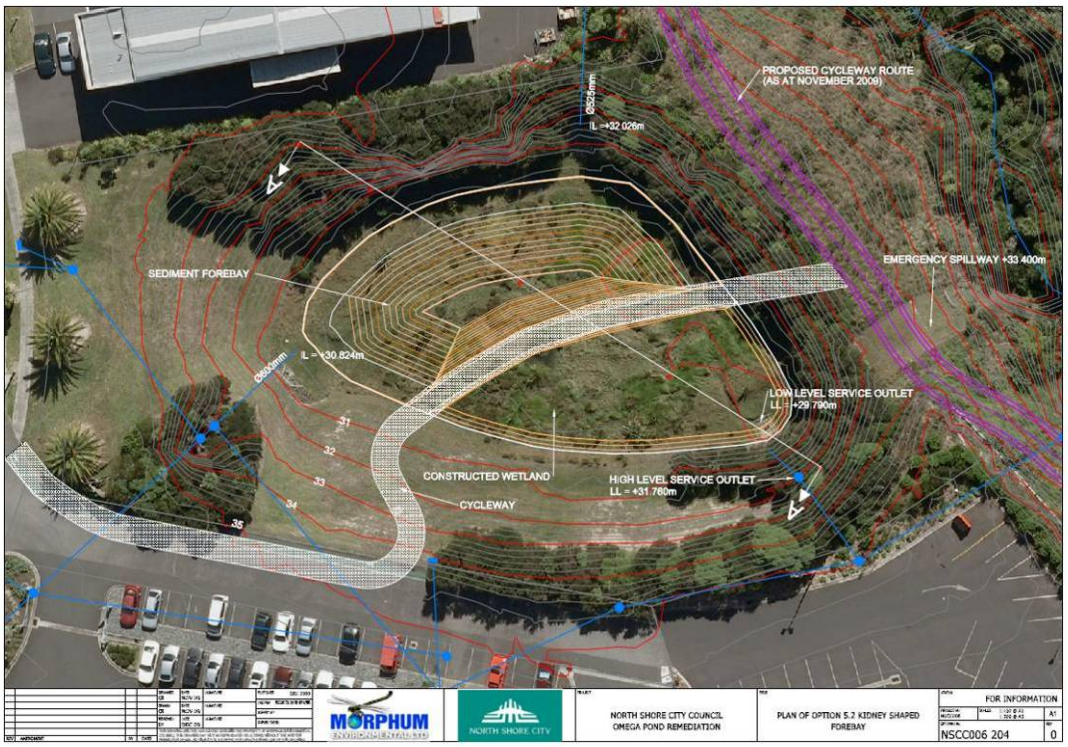
The pond already has good vegetative cover over the surface of the deposited sediment which can be broadly described as wetland plant species. This has resulted in increased amenity value. The pond is surrounded by native seedlings and maintained grassed areas which are used for passive recreational purposes.

Although water quality functionality was not part of the original design intention for the pond, the options investigation identified that installation of a sediment fore-bay, removal the built up of sediment and wetland planting would result in the pond having a significant water quality function.

A number of possible configurations were considered, however it was decided that a fore-bay at the western side would be most effective and require the minimum amount of on-site works. These enhancement works will provide improvements in sediment and dissolved contaminant removal efficiency as well as amenity enhancement. The fore-bay and wetland will be separated by an earth bund weir and as it is not proposed to change the outlet structures, the flood storage volume of the pond will not be affected.

The cycle-way preliminary designs also indicate the desire for an access point in the general location of Omega Pond. The incorporation of the cycle-way in the overall design of the pond has the added advantage of providing an access link from a business district to the cycle-way as well as a chance for people to interact more closely with the wetland environment (see Figure 4**Error! Reference source not found.**).

Figure 4: Omega Pond concept design



The 220m section of stream in the Omega Reserve (adjacent to the pond) between State Highway 18 and Paul Matthews Drive will also receive weed management and enrichment planting of native species.

4.3 ROOK RESERVE SWALE

The Rook Reserve Swale project is located on reserve land immediately to the south of State Highway 18. The objective of the swale is to enhance an existing overland flow path to provide a water quality treatment function.

While the existing overland flow path is generated by water within the reserve itself and considered to have relatively low levels of contaminants it was identified that stormwater runoff from a number of catch-pits on the adjacent State Highway 18 and sub-division to the east could be captured and treated by the swale. The run-off from these two areas currently enters the Alexandra Stream untreated. This surface water is considered to have high concentrations of suspended solids, heavy metals and hydrocarbon contamination. These factors are important as contaminant management is an objective of the catchment management plan. The swale has been designed to improve water quality, blend into the local landscape and to increase the amenity value of Rook Reserve (see Figure 5). In order to find a compromise between the conveyance and cost effectiveness of a swale and the function of a rain garden, a 300 mm layer of living earth soil mix forming the base of the swale was incorporated into the design. Also, as check dams were required due to the slope of the site, an opportunity was identified to increase the area of

swale by the construction of terraced channels running parallel to the land slope (see Figure 6).

Figure 5: Rook Swale concept design showing swale alignment, proposed location of cycle-way and terraced drainage

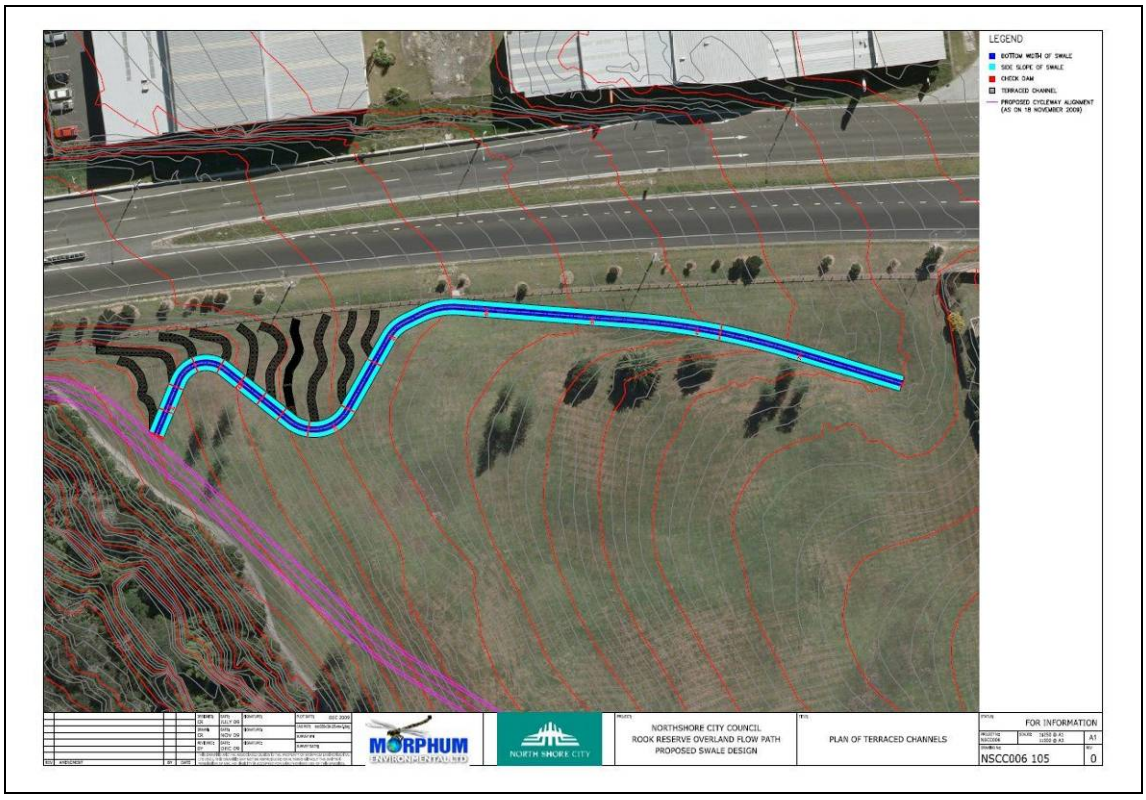
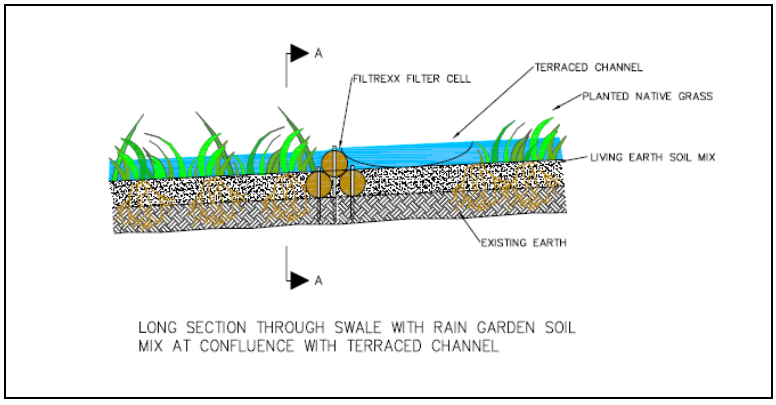


Figure 6: Rook Swale concept design showing long section through swale at the point intersection of the swale and terraced channel



This will provide a stormwater storage capacity and act to retain moisture that will support the recommended plantings. Additionally the increase in vegetation and surface area will increase the contaminant removal function of the swale and provide additional amenity.

4.4 BARBADOS WETLAND

The Barbados wetland is located in the Unsworth Reserve, a short distance upstream of Barbados Drive. The total area of the wetland is approximately 0.24 Ha and includes the main channel of the Alexandra Stream. The Alexandra Stream has a flow restriction at the downstream end of the wetland in the form of a culvert under Barbados Drive. The culvert acts to throttle high flows such that during large flow events the entire wetland is submerged by water.

The wetland currently contains a diverse range of wetland plants including rushes, raupo, manuka, cabbage trees, coprosmas, kahikatea, tree ferns and flax. The wetlands proximity to the remnant bush reserve on the upstream side, further contributes to the significance of the area. No fish records exist within the wetland area, although common bully and banded kokopu have been recorded both up and downstream.

Just above the wetland, flows from the upper Westminister sub-catchment confluence with the main Alexandra stream. During normal (low flow) conditions all stream flows are via the main channel. During small storms, such as the WQS event, flows overtop the channel banks at the confluence point and flow over a low flood plain area into the southern end of the wetland before re-entering the main stream channel just upstream of the Barbados Road culvert.

As the spill point occurs at the confluence this provides an opportunity to enhance stormwater treatment of the currently untreated Westminister sub-catchment through minor modifications to the spill point and floodplain (see Figure 7). An options analysis was carried out to identify the most appropriate method of capturing a larger portion of the flows from the Westminster sub-catchment and providing treatment to these flows. The design concept involves increasing the frequency of inundation of the flood plain area, increasing the available storage volume and controlling the flow. This will be achieved through:

- Removing 500mm of deposited sediment from the wetland area.
- Constructing an earth bund around the impoundment perimeter to create a maximum water depth of 500mm.
- Reducing the bank height and excavation of a conveyance channel to increase the frequency of stormwater spilling out of the main channel and onto the wetland.
- Removing blackberry and other weed species and re-plant the area with wetland species.
- Integration of the proposed cycle-way to provide access through and increased amenity in the wetland.

It is proposed that the cycle-way will bridge the main stream approximately 40m upstream of the Barbados Drive culvert. It was decided that the existing boardwalk route would not be used and it would be more effective for the cycle-way to run through the eastern side of the wetland as this would allow for greater amenity value for the people using the cycle-way (see Figure 8).

Figure 5: Barbados Wetland concept design showing plan view of the proposed works

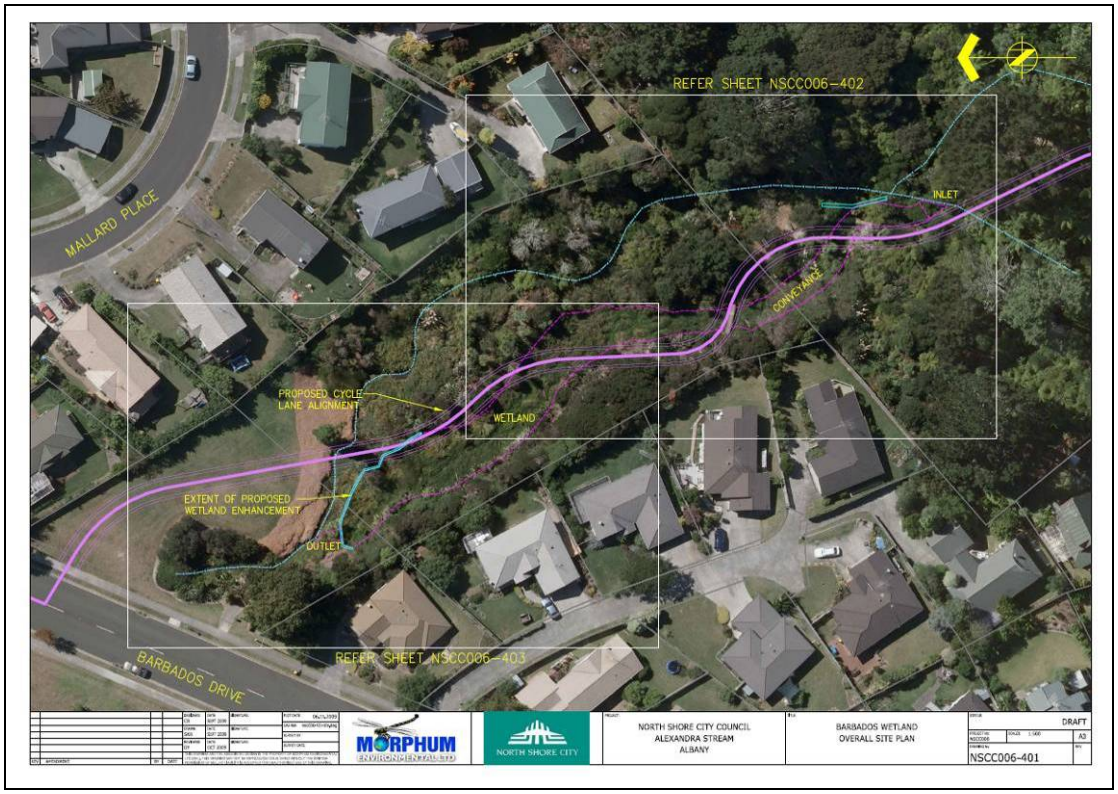


Figure 6: Barbados wetland concept showing planted wetland (foreground) and boardwalk.

The stormwater and cycle-way integration also allowed extensive bank slumping and erosion (which exists on the true right side of the stream at the bridging point) to be remedied for the benefit of both projects. It is proposed to resolve this erosion through meander restoration and the introduction of point bars and riffles.

4.5 ROOK RESERVE REACH (RE-VEGETATION)

This site is located in the Barbados and Rook Reserves between Barbados Rd and State Highway 18. The area identified for re-vegetation is approximately 380m long and it slopes down on both sides into the Alexandra Stream. The mean riparian extent is approximately 15 metres and this extends 100 % along the length of the site. There is existing access via a public path on the true right bank and on the true left bank via an open field where a future development is planned.

Weed infestations are common throughout the reach, particularly brush wattle. The fast growth and subsequent collapse of this species appears to be exacerbating erosion. Exposed root bowls and limbs tend to block the channel with woody debris creating turbulence and further bank erosion.

Figure 7: Rook Reserve Planting Plan

The vision for the Rook Reserve reach of the Alexandra Stream is to see improvement in stream and riparian ecological functions incorporating a range of wildlife habitats and indigenous species. Additionally the recreational amenity values should be preserved and enhanced. Site specific objectives have been developed after field investigations were carried out. These objectives are intended to reflect the existing situation at site including topographical restrictions and the species assemblage present. They include:

- To remove large woody trees with minimal environmental impact.
- Canopy replacement by managed removal and planting of natives to restore canopy and Planting of open areas
- Remove large exotics and replace with natives;
- Establish a 15m riparian margin from the stream edge;
- Remove large weed infestations greater than $5m^2$;

The subject site has been broken down into different zones based on vegetation types and the restoration potential and a planting plan has been developed (see Figure 9).

4.6 CYCLE-WAY

The cycle-way/pedestrian walkway is a key component to this project as it will provide public access into the stream environment. Much of the construction work will be bordering streamside vegetation, within densely vegetated areas and around significant trees. Several sections of path pass through areas considered for landscape modification. Consenting requirements needed to be considered carefully and this resulted in some design constraints.

Both plans identify routes through parks and reserves – the 'green network' - and reflects Council's long-term aim of providing an integrated cycling network.

The upgraded footpath through the Alexandra Stream corridor will provide a safe off-road north–south connection through the underpass under State Highway 18. The path will connect the Unsworth residential catchment in Glenfield with the North Harbour Industrial Estate and Rosedale Park. As such it is attractive to both commuter and recreational cyclists and pedestrians.

5 LESSONS LEARNT

Many lessons were learnt in the planning phase of this project, mostly relating to issues around conflicting philosophy and integration. Below are some of the key lessons learnt:

- Open and frequent communication (including consultants) is important to keep everyone involved abreast of planning developments. Opportunities for integration and therefore cost savings during the project can be lost through duplication of tasks (e.g. sharing geotechnical data).

- Identifying, accepting and documenting responsibilities early records broad task allocation and accountability. This will help to ensure tasks are completed on time by the appropriate person. Adhering to this process reduces the risk of tasks slipping off the radar.

- Expect some philosophical differences in approach to stormwater management between stormwater and transport planners/consultants. These may center around BPO versus TP10 approach. Attempt to identify and resolve these issues early.

- During the options identification and development phase, the feasibility assessment often requires an element of design. This is because although options had been identified they require further

design feasibility assessment involving the development of models and calculations to test the option.

- Expect difficulties in integrating different timeframes and drivers from multiple projects (e.g. attempting to bring a wastewater upgrade forward to combine with the construction of a proposed boardwalk downstream of Paul Matthews Drive).

- Include representation from the stormwater capital works team and stormwater operations early in the process to get agreement on design concepts.

6 CONCLUSIONS

Integration between Transport and Stormwater departments in a council environment is essential for the success of these types of projects. Identifying opportunities for integration is often the most significant issue to resolve. North Shore City Council is only beginning to develop a more integrated approach to stormwater and transport projects. Therefore avenues for integrated planning and open communication between stormwater and transport departments need to be encouraged. This is particularly relevant in the current Auckland environment where geographic barriers and organization boundaries resulting from the new 'super city' council structure will need to be overcome.

Institutional knowledge is imperative if we want to produce robust catchment management plans that maintain their effectiveness. Without the correct technical knowledge it is very difficult to achieve the outcomes set out in high level planning documents.

In order to maximize the benefits of a stormwater project, a holistic approach is required. This involves unlocking the overall potential of a stormwater project early in the planning process through the identification of related ecological, amenity, other social and cultural issues.

Stormwater management in brown-fields catchments requires a BPO approach rather than strict adherence to TP10 guidelines. This is because retrofitting stormwater devices or finding new locations large enough to provide some benefit is largely opportunity based.

Contaminant management under a BPO approach requires innovation and a treatment train design to maximize benefits. The use of soft engineering techniques provides additional amenity and can be less expensive and easier to install than traditional engineering methods. Bio-engineering should be adopted more often for stormwater projects with high public exposure.

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