THE CROFTFIELD LANE WETLAND REHABILITATION – A DIAMOND IN THE ROUGH

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ABSTRACT

A constructed wetland in the heart of North Shore's industrial Wairau Valley was decommissioned in 2006 to aid in the removal of the invasive Alligator Weed, which had taken hold in the wetland. This provided an opportunity to plan for and design the rehabilitation of an improved wetland that not only met contaminant removal objectives, but also aimed to simplify any ongoing operational considerations regarding weed management, reduce flood risk, improve access, enhance the ecology and provide the community with a park-like experience. This paper will review the site issues and rehabilitation objectives, discuss the landscape-led concept options approach and highlight the method of producing an integrated, multiple-benefit storm water project.

KEYWORDS

Integrated catchment management planning, landscape planning, storm water, contaminants, wetland, weed management, amenity, and multiple benefits.

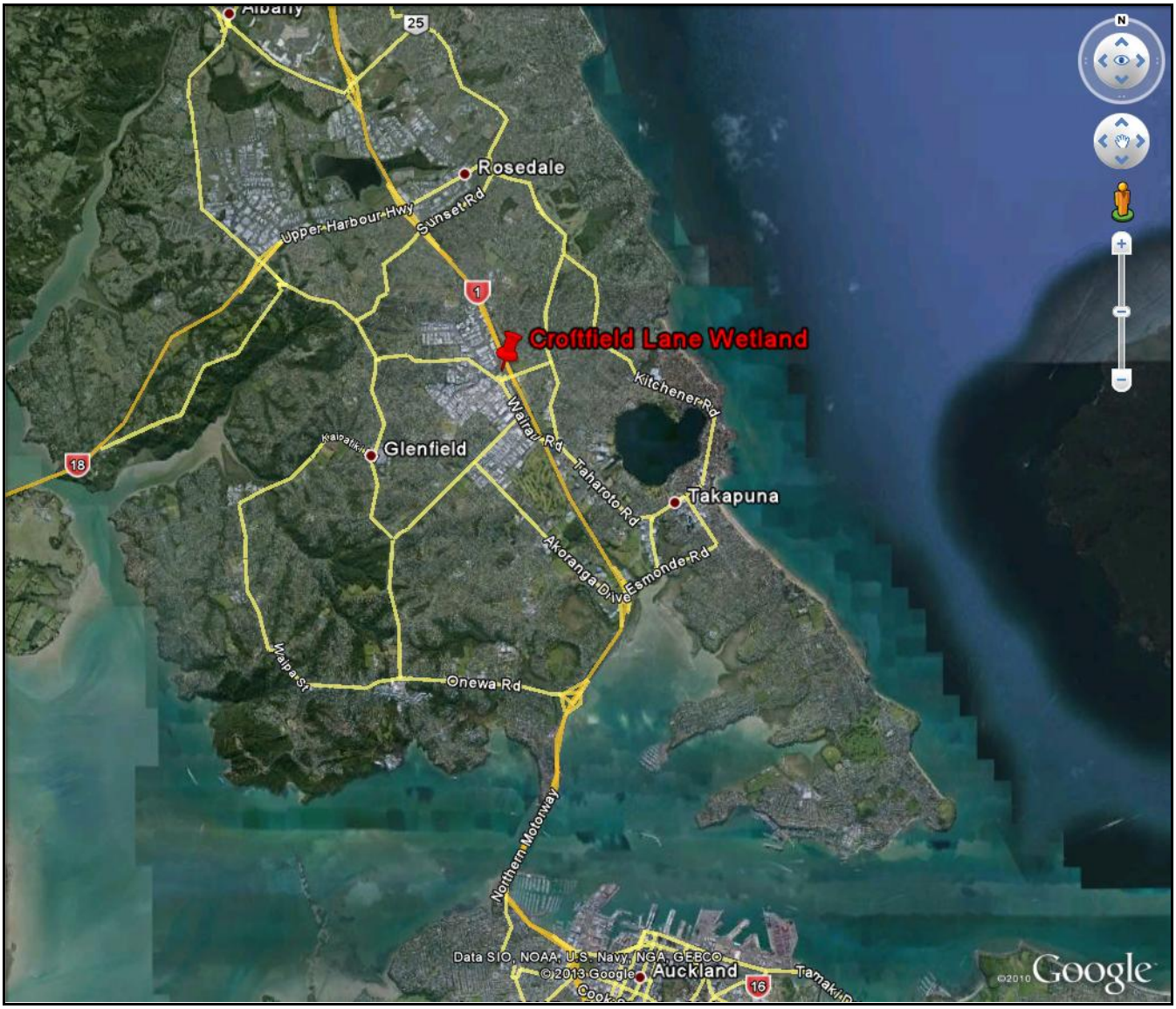
PRESENTER PROFILE

Rowan Carter is a Senior Stormwater Catchment Management Planning Specialist at Auckland Council. He has been involved in storm water management for the last 16 years in various capacities. Over the last 6 year Rowan has had a particular focus on catchment planning and scoping projects, often involving wetland and stream restoration. Many of these projects have required integrated approaches in order to maximise the potential of each project.

1 INTRODUCTION

Successful Integrated Catchment Management Planning includes establishing the connectivity between stormwater issues and the other landuse-driven complexities, such as pedestrian accessibility and ecological connectivity, to ensure that multiple benefit solutions are achieved. This has been the driving philosophy behind the planning and detailed design phases of the Croftfield Lane Wetland Rehabilitation project located in the Wairau Valley on Auckland's North Shore (Figure 1).

Figure 1: Location of the Croftfield Lane Wetland Project on Auckland's North Shore



The Croftfield Lane Wetland Rehabilitation project involves the enhanced reinstatement of a decommissioned storm water treatment wetland, integrated with improvements in pedestrian access, reducing flood risk, enhancing ecology and the re-introduction of amenity. One of the key focuses of the design was to ensure future weed infestations can be resolved without future decommissioning of the wetland.

The wetland was originally constructed in the 1980's to assist in managing the burgeoning issue of heavy metal contamination in storm water runoff from 467ha of commercial storm water catchment (150ha untreated). Located downstream of the Link Drive Wet Pond, the Croftfield Lane Wetland was perfectly positioned to assist in this regard. Heavy particulates would be removed in the wet pond and the wetland would undertake the storm water 'polishing' function.

At the time of construction little thought was placed on aesthetics and in 2002 work was completed on the wetland area, which resulted in improved storm water management function in addition to a viewing platform for customers and employees of the surrounding businesses.

In 2006 routine maintenance in the wetland identified the presence of the invasive Alligator Weed. This weed was found throughout the wetland and caused flooding after

partially blocking the wetland outlet. This resulted in the decommissioning of the wetland area over several seasons, while a rigorous weed management programme was implemented.

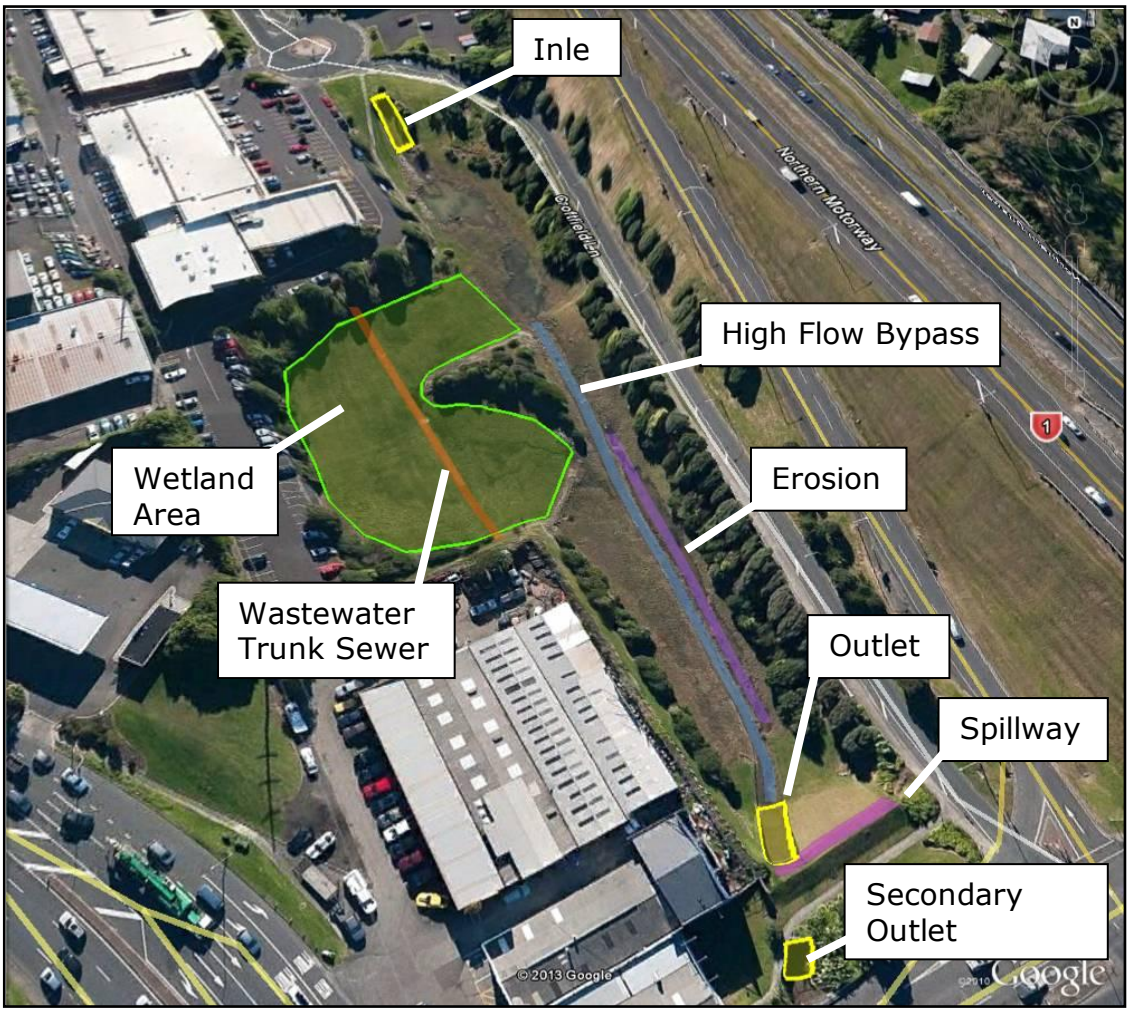
This provided an opportunity to revisit the existing design and consider improving the wetland configuration to incorporate additional benefits, such as access, amenity and improved ease of maintenance.

This paper describes the genesis of the Croftfield Lane Wetland Project, the opportunity-rich thinking behind the project planning and the delivery of what promises to be a very visible 'storm water park' (currently planned for construction in 2014/15).

1.1 EXISTING CONFIGURATION OF WETLAND AREA

Today the footprint of the wetland is approximately 11,000m^2 and the storage capacity is estimated at around 22,700m^3. An inlet to the north discharges flows into an area subject to bank erosion (Figure 2). A bund has been built over the entrance to the wetland to direct all flows down the high-flow bypass to the outlet located under the spillway embankment near Tristram Ave. A secondary outlet is located on the downstream side of the embankment just above the Tristram Ave twin culverts. The purpose of this secondary outlet is to receive overflow from the wetland area in addition to locally-generated surface flow. A wastewater trunk sewer runs through the wetland area and the concrete casing around this pipe is exposed.

Figure 2: Existing configuration of the Croftfield Lane Wetland



2 ISSUES IDENTIFICATION

The genesis of this integrated project originated during the development of the Wairau Stormwater Catchment Management Plan (SWCMP). The stream walk and contaminant management component of the SWCMP process had identified a number of optimisation opportunities within the footprint of the original wetland, including:

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

So, the opportunity for enhancing the wetland was already being considered prior to the Alligator Weed infestation in 2006. The hiatus in wetland functionality and the subsequent community pressure to improve what looked like a 'wasteland' was additional impetus for the project.

The flooding that occurred in 2006 as a result of Alligator Weed choking the wetland outlet identified additional issues (such as weed and flood management) that would need to be resolved in the upgrade. These issues are described in more detail below.

2.1 CONTAMINANTS

The Croftfield Lane Wetland is located in the middle of the Wairau Valley commercial area. It currently acts as a 'dry-pond' and services a total catchment of approximately 467ha. Upstream of the wetland is the Link Drive 'wet pond' which serves to remove heavy particulates in the storm water prior to entering the wetland for storm water 'polishing'. The Link Drive pond has a contributing catchment of approximately 317ha, which infers that storm water draining off 150ha bypasses pre-treatment before entering the wetland. An evaluation of the performance of these treatment systems concludes that, combined they have a 33% treatment removal efficiency.

The contributing catchment has a high level of impervious cover (an estimated 64% imperviousness throughout the catchment which includes a combination of commercial, residential, reserve and motorway land uses) and is subject to stormwater runoff from various business types, ranging from retail and warehousing through to light industrial (e.g. engineering). Many of the access roads in the area are high use roads including a section of State Highway 1 motorway, which are considered a main source of metal and hydrocarbon contaminants. Wind blown litter is an issue in the area and the council waste minimisation team has invested considerable time investigating and resolving litter complaints in the past.

The Wairau Stream is concrete-lined from the Croftfield Lane Wetland through to the discharge point into the Milford estuary. As such there is minimal in-stream invertebrate and fish habitat. For this reason, the impact of these pollutants on the stream is likely to be negligible. However, downstream, the Milford estuary provides a low energy settling zone for pollutants and is home to a myriad of estuarine organisms including shellfish, fin fish and wading birds. The tidal flow of the estuary enters and exits through the mouth at the northern end of the very popular Milford Beach. Prior to amalgamation, North Shore City Councillors received numerous complaints about litter on Milford Beach and around the Milford Marina (within the estuary). At that time a commitment was made to review the existing contaminant management devices in the Wairau catchment and investigate opportunities to improve contaminant removal.

2.2 EOCLOGICAL CONNECTIVITY

In May 2004 a stream walk was undertaken in the Wairau Stream to provide data to support the development of the Wairau Valley Stormwater Catchment Management Plan. This involved an assessment of the engineering and ecological features present along the entire stream length. The assessment found that the Wairau Stream is comprised of 47% concrete lined channel, 29% piped sections and the remaining modified or semi-modified channel. The extensive concrete lining, combined with the large proportion of impervious surfaces within the catchment has created a stream network prone to 'peaky' hydrology and high temperatures. This, in combination with the 19 man-made fish barriers (identified in the stream-walk) has resulted in significant impedance to fish passage. Despite this, several species of native fish have been identified in vegetated, natural stream sections in the upper reaches of the catchment, including banded kokopu and short finned eel. Any improvements in fish habitat along the stream length would provide resting areas for migrating fish and may be influential in increasing fish populations.

2.3 AESTHETICS

In 2002 the Croftfield Lane Wetland underwent improvements for several reasons, including improving the aesthetics of the wetland. This area of the Wairau Valley had increasingly become a destination for large retail outlets, which in turn had resulted in significantly more foot traffic. With the exception of the Link Drive pond upstream of the wetland there was (and still is) limited desirable locations for passive recreation or as a local facility for workers in the area to have time outside of the office. The small pedestrian lookout and short foot path constructed in 2002 did little to improve the situation.

The Croftfield Lane Wetland is also very visible from Croftfield Lane access (from Tristram Ave), the motorway and north-bound motorway on-ramp at Tristram Ave. This provides the wetland area with significant public exposure and given the dishevelled state the wetland is currently in, there is significant public pressure placed on council to improve the view.

2.4 ALLIGATOR WEED

In 2006 the Auckland Regional Council Biosecurity Team requested that the wetland be decommissioned in response to an extensive Alligator Weed *(Alternanthera philoxeroides)* infestation. A rigorous weed management plan was implemented in an effort to eradicate the weed, which was later thought to be introduced to the wetland via plant material in soil transported to the wetland for landscaping purposes.

Alligator weed is a summer growing perennial plant that is generally found on stationary and slow moving water bodies, creeks, channels, riverbanks and associated areas. This weed normally grows from a small piece of stem and can grow as a free-floating raft or with its roots attached to the soil. It has speared shaped glossy green leaves and a ball shaped white flower (see Figure 3). Alligator weed grows extremely vigorously (the author has witnessed 30cm growth in 4 weeks) and infestations can quickly take over wetlands and adjacent land.

Alligator Weed is native to South America, but is now found throughout tropical and warm temperate regions, including the US, China, India, South-East Asia and New Zealand (Ensbey & van Oosterhout, 2012). Weed outbreaks can be incredibly difficult to control due to the weed's ability to live in both aquatic and terrestrial habitats as well as

both freshwater and brackish conditions. Areas that are frequently inundated e.g. wetlands are perfect habitat for Alligator Weed infestation.

Alligator Weed (*Alternanthera philoxeroides*) is a species currently listed on the 2006 National Pest Plant Accord (Ministry for the Environment, 2006). In Auckland this weed has been identified as one of the 'Surveillance Pest Plants' capable of having "*significant impacts on the biosecurity values of the Auckland Region*"(Auckland Regional Council, 2007). It is a major problem weed in the Waikato and Northland, particularly in rural areas.

Alligator Weed has also been identified as a significant threat to ecology, recreation and the economy in other parts of the world. If left uncontrolled, the cost of Alligator Weed infestations in Australia is calculated in the hundreds of millions of dollars. For this reason Alligator Weed has been placed on the Australian list of Weeds of National Significance (Ensbey & van Oosterhout, 2012).

Figure 3: Alligator Weed *(Alternanthera philoxeroides)*

The 2006 infestation in the Croftfield Lane Wetland resulted in both the wetland area and high flow channel being choked with weed rafts (See Figure 4). A 2-5yr ARI (Average Return Interval) rainfall event on 25 April 2006 uprooted and transported large weed rafts downstream where they promptly blocked the outlet (see Figure 5). The ponding resulting from the reduction in conveyance through the culvert exceeded the detention capacity of the wetland area and caused flooding in adjacent property.

The three current management strategies in New Zealand for eradicating or controlling Alligator Weed are:

1. Physical – Deep digging and removal
2. Chemical – Spraying herbicides

3. Biological –Alligator Weed beetle (*Agasicles hygrophila*) or Alligator Weed moth (*Arcola malloi*)

Figure 4: Photo of the lower Croftfield Lane Wetland at the height of the Alligator Weed infestation (taken from Croftfield Lane looking towards Wairau Rd)

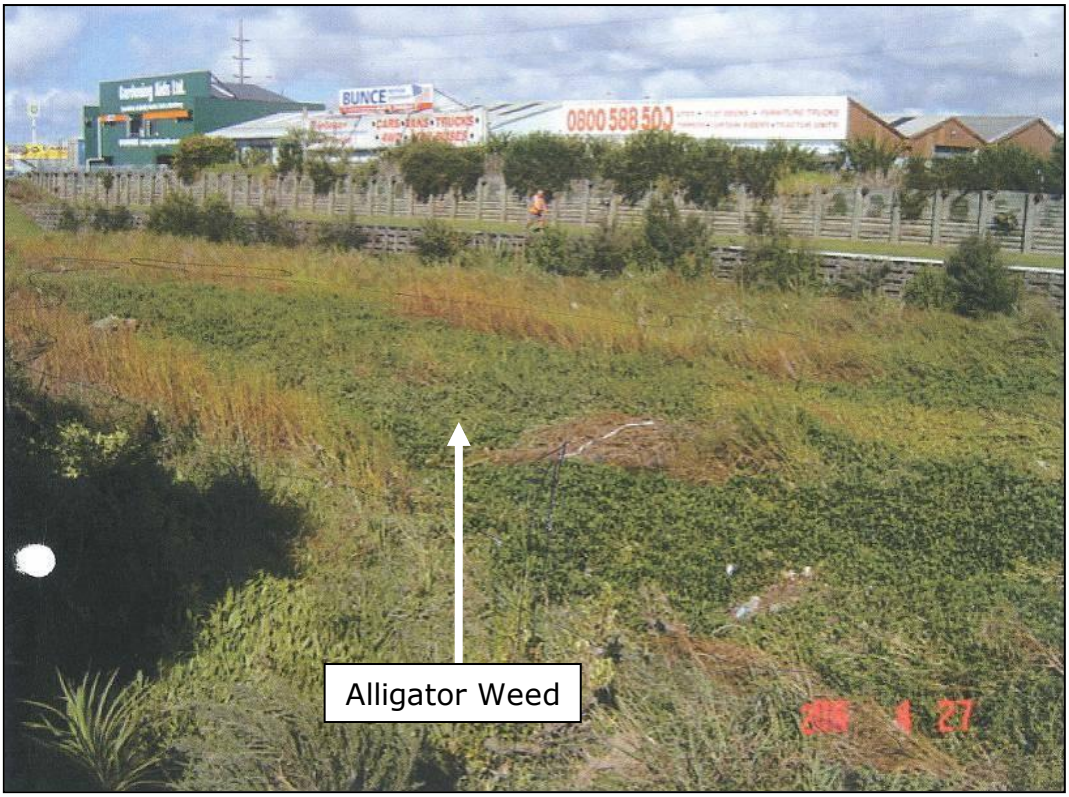


Figure 5: These are two photographs at the outlet of the wetland post-April 2006 flood. The photo on the left shows the height of the Alligator Weed blockage immediately after the April 2006 storm. The photo on the right was taken once the debris had been cleared – note the arrow indicating debris had accumulated up to approximately 4m in height

All three of the management approaches above have merit, however there are a number of issues with each of these strategies. For example, the depth of the root

network can extend greater than 1m below the ground surface, making it difficult to expose for treatment. Secondly, the plant stem fragments easily at node junctions, resulting in downstream dispersion and re-growth. Herbicides are only able to penetrate the soil a short distance, thereby bypassing root systems. Lastly, existing biological controls are not effective in terrestrial environments and are therefore limited to aquatic habitats (Ensbey & van Oosterhout, 2012).

Using the 3 methods of control listed above in combination often provides the best result, however completely eliminating Alligator Weed from an area is very unlikely. For this reason, council decided to design the wetland in segments that could be isolated and 'locked down' for maintenance in the event of a weed infestation. This way single or multiple wetland segments are able to be decommissioned while allowing the wetland to continue functioning in the remaining wetland cells.

2.5 FLOODING

The Croftfield Lane Wetland (and Link Drive Pond) can provide limited peak flow attenuation due to the limited live storage capacity. The attenuation for these systems is most pronounced in the more frequent storm events (i.e. <5yr ARI). Attenuation efficiencies for both devices are 14.5%, 2.5%, 1.4% and 0.3% for the 2, 5, 10 and 100yr ARI storm events respectively (AR Civil, 2010). Based on the local rainfall data we know that the storm event that occurred late April 2006 was of 2-5yr ARI storm intensity. This resulted in a commercial property adjacent to the wetland (and upstream of the spillway) being flooded. Figure 6 shows the flooded property and the flood level after the storm. This gave an indication that the spillway configuration was in need of alteration.

Figure 6: Photo showing the flood level from the April 2006 storm (dotted line). Note the flood level is marginally higher than the entrance level of this Wairau Rd commercial building.

Survey of the spillway and surrounding area found that the wetland spillway adjacent to Tristram Ave is higher than other areas around the periphery of the wetland. The car parks west of the pond and the roads east of the pond (Croftfield Lane and the northern motorway on-ramp) will be inundated before the spillway operates. Property to the west of the wetland is also at risk of flooding.

3 DESIGN OBJECTIVES

The key design objectives were derived from the storm water management issues in the catchment as outlined above.

- Provide for improved sediment, heavy metal and hydrocarbon removal
- Provide for gross pollutant removal
- Reduce flood risk to adjacent property in frequent storm events
- Weed management friendly
- Integrate visual amenity and accessibility
- Improve habitat

A decision was made to use a 'landscape-led' approach for the development of the concept design. This was largely due to the visibility of the wetland and therefore opportunity to create an interesting space in what is otherwise a commercial landscape. In addition we believed that we could achieve all of the design objectives through this approach.

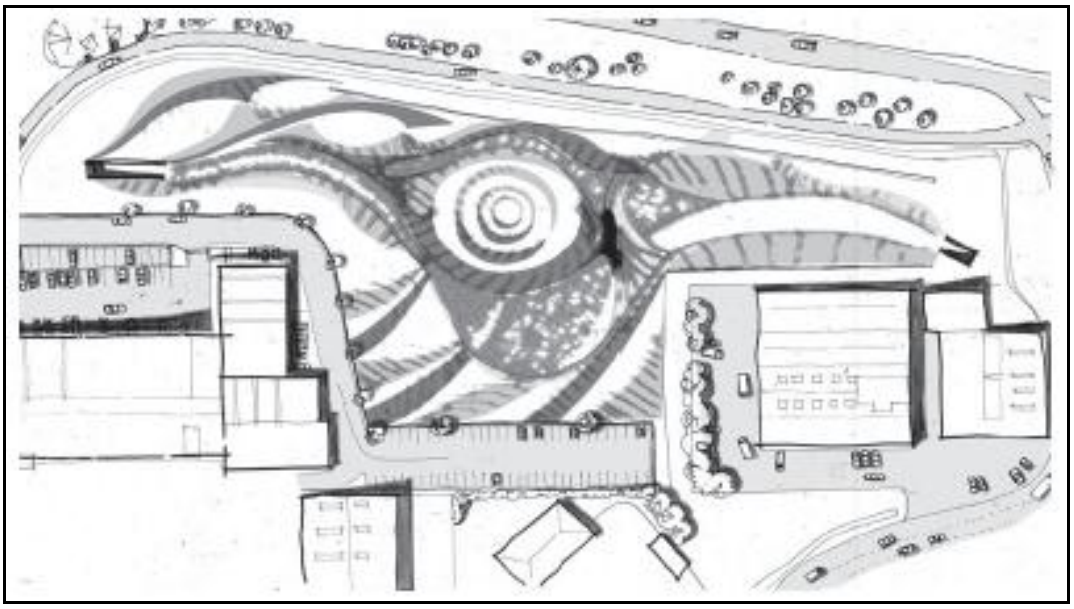
4 LANDSCAPE-LED CONCEPT DESIGN

Three concepts were developed to explore the interaction between materials (landform, planting, and infrastructure) and the systems and processes of stormwater treatment and riparian environments (Boffa Miskell Ltd, 2008). Each of the three concepts were based on a primary focus as outlined below.

4.1 LANDFORM

Landform articulates water flow as high outside bends and long point bars to form a sweeping landscape (Figure 7). Additionally, movement of water (e.g. waves, ripples, and drop splashes) are expressed as landform on a landscape scale.

Figure 7: 'Landform' concept option



4.2 PLANTING

Planting is utilised to stabilise wetland shelves and banks, screen buildings and roadways, shelter public spaces, and capture litter (Figure 8). Planting within wetland areas treats stormwater through filtration, absorption, and breakdown of contaminants.

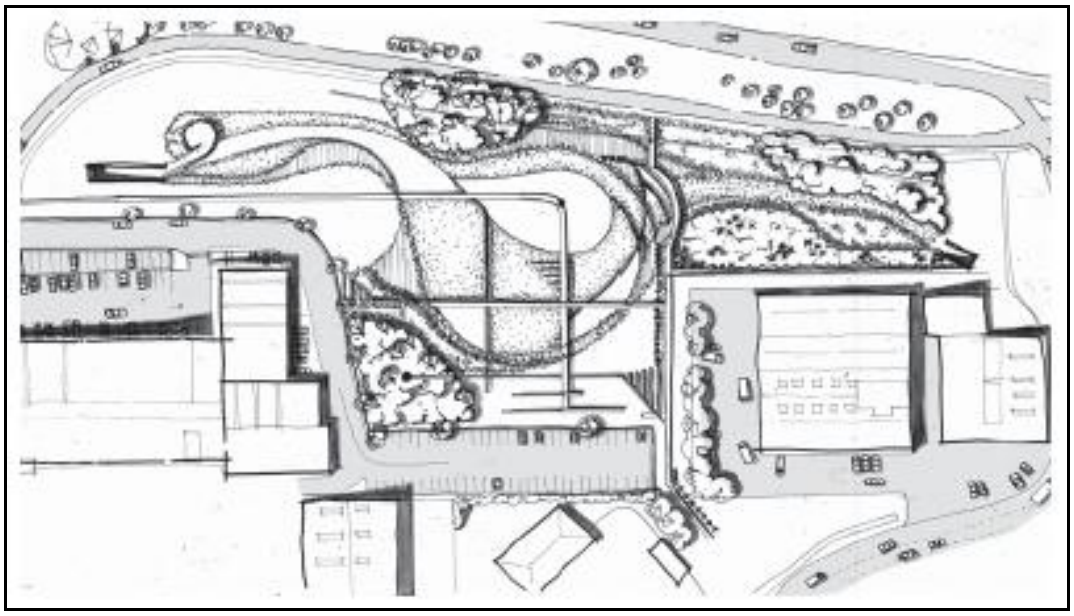
Plant communities in this concept are from the ecological district, specific to North Shore environments, a diversity of sedge/rush wetlands, flax/cabbage wetlands, and swamp forest. Biodiversity is also an objective for riparian edge, upper bank planting, and specimen trees.

Figure 8: 'Planting' concept design

4.3 INFRASTRUCTURE

Infrastructure becomes sculpture as forms follow function with clean structures, lines, and materials (Figure 9). Structures captures instream litter, directs water flows, divides the wetland into maintenance cells, and provides visual and physical access for the public to view stormwater treatment processes.

Figure 9: 'Infrastructure' concept option



5 OPTIONS COMPARISON

Each of the three landscape-lead concept designs were assessed against the pre-determined design objectives (see Table 1). Overall, the 'Infrastructure' design option showed preference over the other two options. The project team felt that gross pollutant removal would be easier to achieve through the use of the 'Infrastructure' design option and the wetland segregation concept proposed provides for enhanced settlement and removal of fine pollutants. This segmented wetland would also assist in managing future weed outbreaks as discrete sections of the wetland could be decommissioned and treated without compromising the functionality of the other wetland sections. Wetland segmentation would also provide an opportunity to improve pedestrian access across the wetland via walkways constructed between the wetland cells. The maintenance cost for the Landform concept would be excessive due to the extensive lawn area. It was also determined that the densely vegetated 'Planting' concept would be difficult to maintain and would therefore be more susceptible to weed infestation. The higher cost of constructing the 'Infrastructure' option was considered worthwhile due to the perceived benefits.

Table 1: Options comparison for the Croftfield Lane Wetland rehabilitation

Objectives	Landform	Planting	Infrastructure
Fine Pollutants			
Gross Pollutants			
Flood Risk			
Weed Management		[Negative?]	
Amenity			
Ecology			
Maintenance $	$$$	$$	$
Construction $	$$	$$	$$$

	Nil - Minor Benefit
	Minor Benefit
	Moderate Benefit
	Significant Benefit

6 CONSULTATION ON CONCEPT OPTIONS

Aside from the comparisons made between each option above, there is also a need to consider the 'fit' of each option within the landscape. As mentioned, the Wairau Creek is almost entirely concrete lined or piped. The presence of banded Kokopu and short finned eel in isolated upstream reaches does not alter the fact that this stream network overall has very low ecological value. The stream flows through a commercial district lacking interesting landscape and while both the Landform and Planting options showed merit, the Infrastructure concept was favoured by council engineers as it ticked all the objective boxes and possessed the most relevant design characteristics in this commercial Wairau Valley landscape.

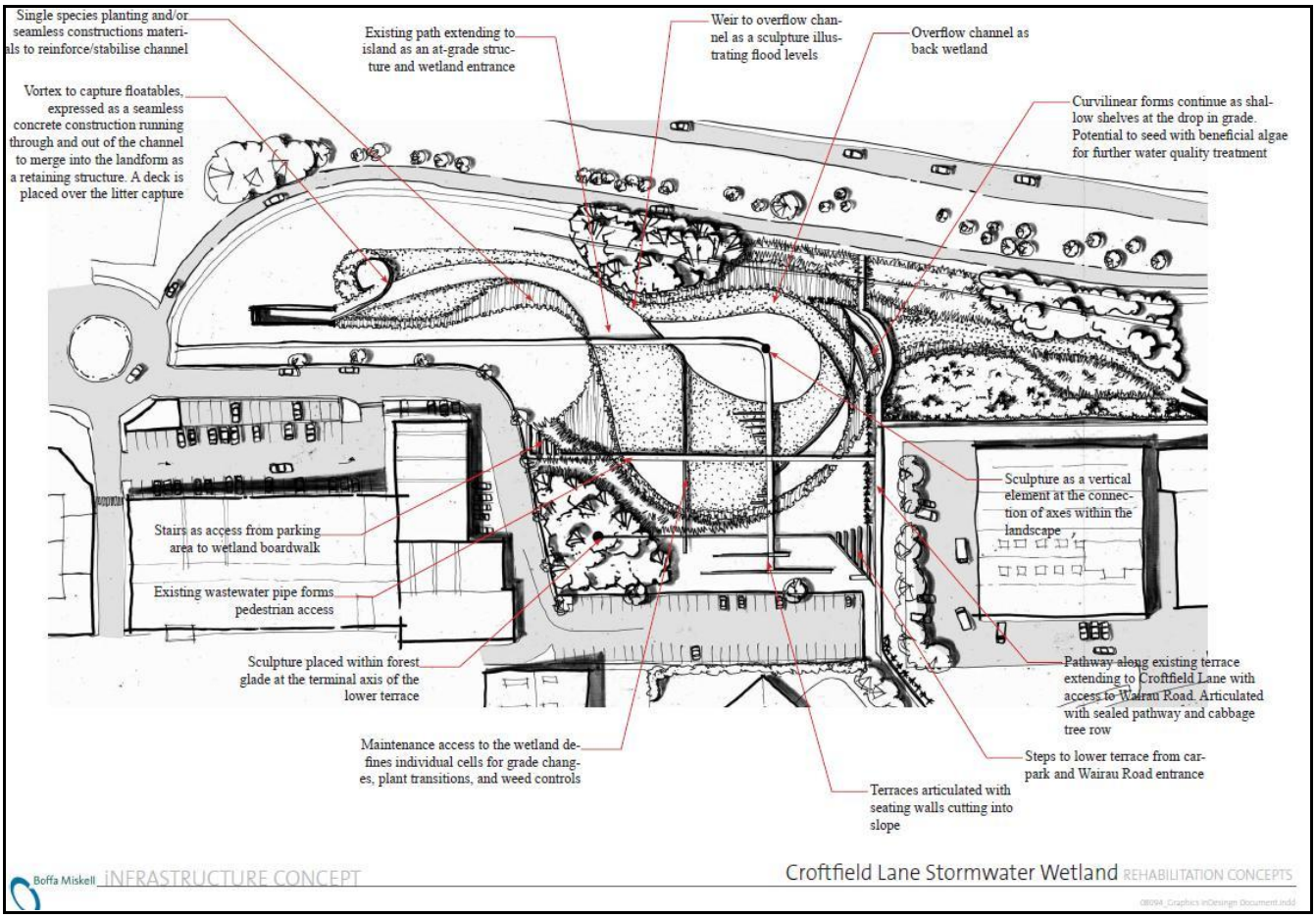
The three concepts above were tabled at a Community Board meeting as part of an update on the management of Alligator Weed in the wetland. Board members showed strong preference for the Infrastructure option, which led us into the engineering feasibility phase of the project.

7 DESIGN DEVELOPMENT

7.1 ENGINEERING FEASIBILITY

The first task in the engineering feasibility exercise was to assess the landscape design option (Figure 10) in terms of practicality, effectiveness of design regarding storm water objectives and constructability.

Figure 10: Developed landscape design



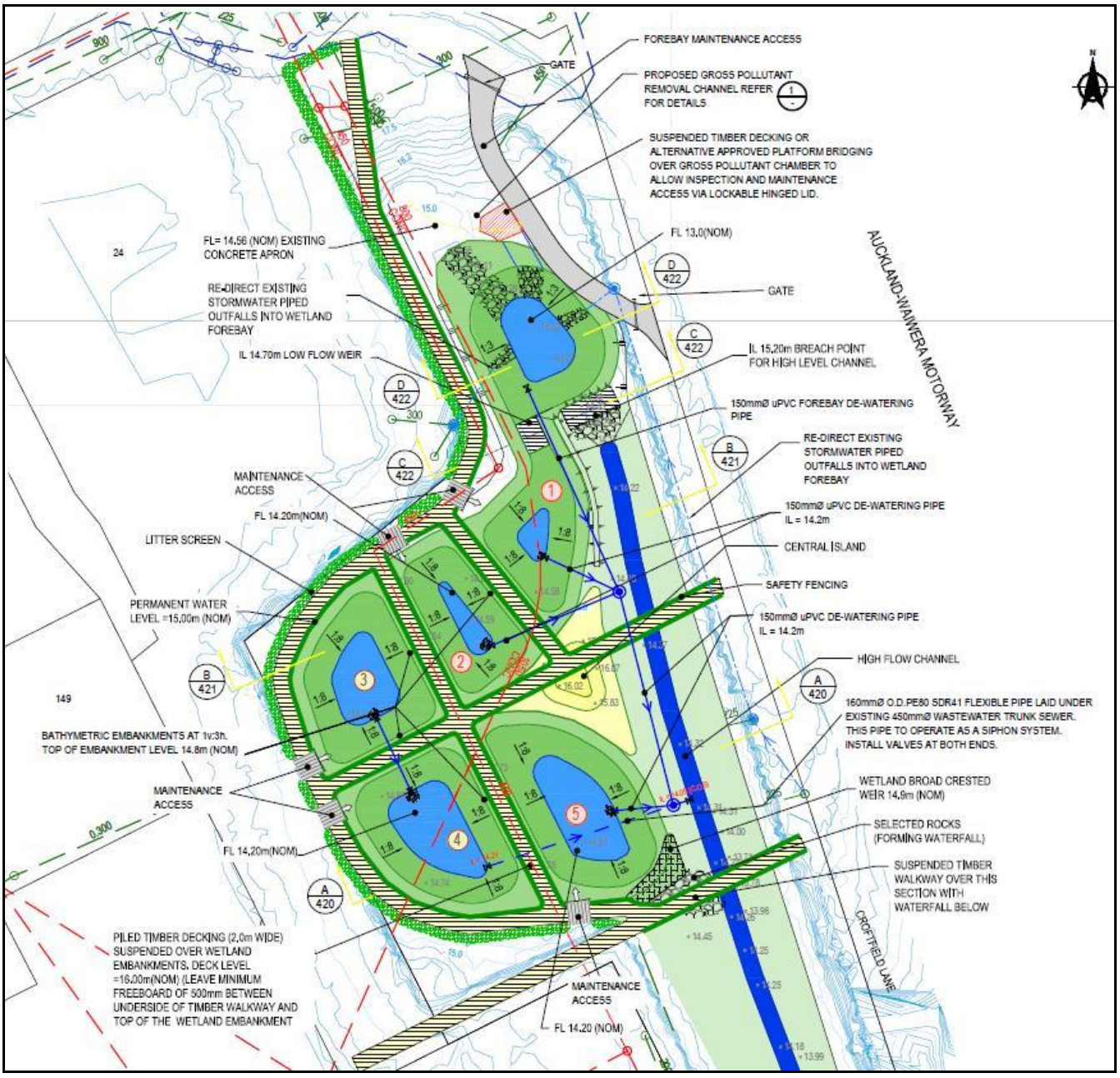
The engineer then built on the foundation of the landscape design option in an effort to rationalise the functionality of the systems and optimise the storm water quality performance, without significantly compromising the landscape design theme.

The main modifications initially made to the landscape design included:

- Reducing the size and increasing the depth of the fore-bay, being more in accordance with Technical Publication 10. (Auckland Regional Council, 2003) and accepted practice;
- Enlarging the internal cells of the wetland to provide greater storm water treatment area;
- Straightening the high flow by-pass slightly to provide more efficient conveyance of large storm flows.

Additional design alterations were made as the concept matured. All decisions in this process were agreed by consensus within the project team, which included council staff and both the consultant landscape designer and the engineer. This was an iterative design process that led to a series of developing concepts and culminated in the latest engineers design for the project (Figure 11). What is evident in this design (more-so than in the earlier designs) is the drainage system that provides for wetland cells to be isolated for maintenance purposes. The purpose of this design element is to enable council staff to undertake weed control in individual wetland cells while retaining normal water levels and wetland function in the remaining treatment cells.

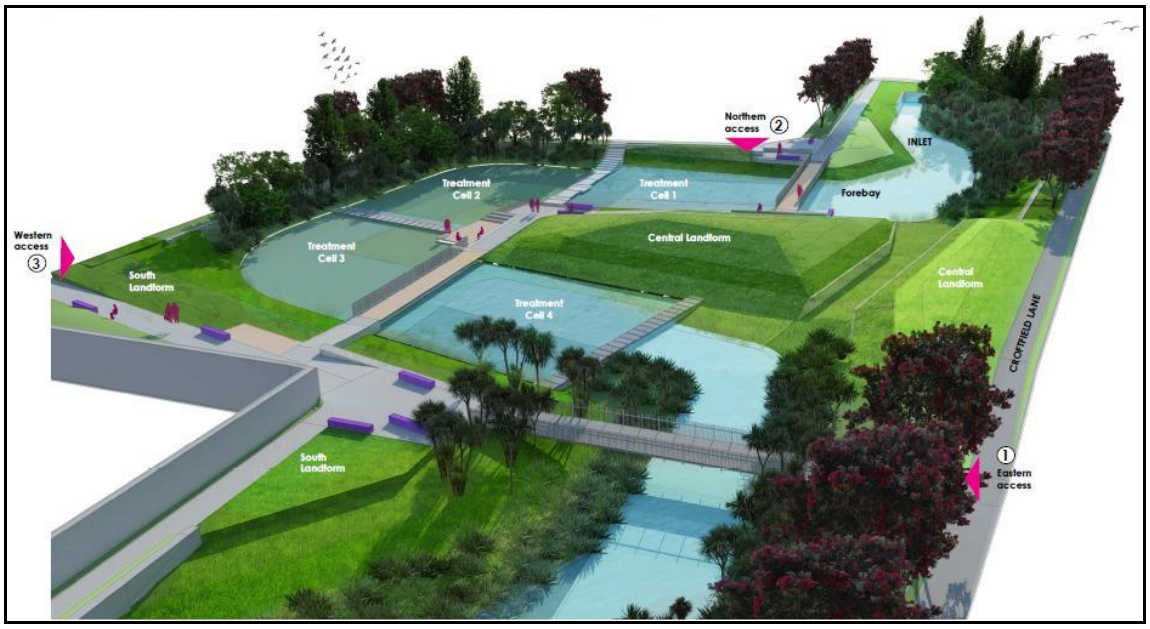
Figure 11: Detailed design showing maintenance access-ways into each wetland cell, maintenance access to the fore-bay and siphon drainage design



Decommissioning the whole wetland area to manage an isolated Alligator Weed outbreak would be a costly task. The expense of re-instating plants, the time required to rehabilitate the wetland ecology and the community backlash from closing a public amenity such as this to undertake maintenance is something that can be avoided through this design. Furthermore, the wetland can continue to remove contaminants while any maintenance work takes place.

A landscape design impression of the matured concept (see Figure 12) was generated. The central landform was retained, pedestrian gathering nodes accentuated with seating furniture, the access-ways refined and the configuration of the wetland modified in accordance with the engineers input. The use of the wastewater trunk sewer as a walkway was also retained.

Figure 12: Landscape designer's wetland concept



8 ADDITIONAL OPPORTUNITIES

8.1 ART

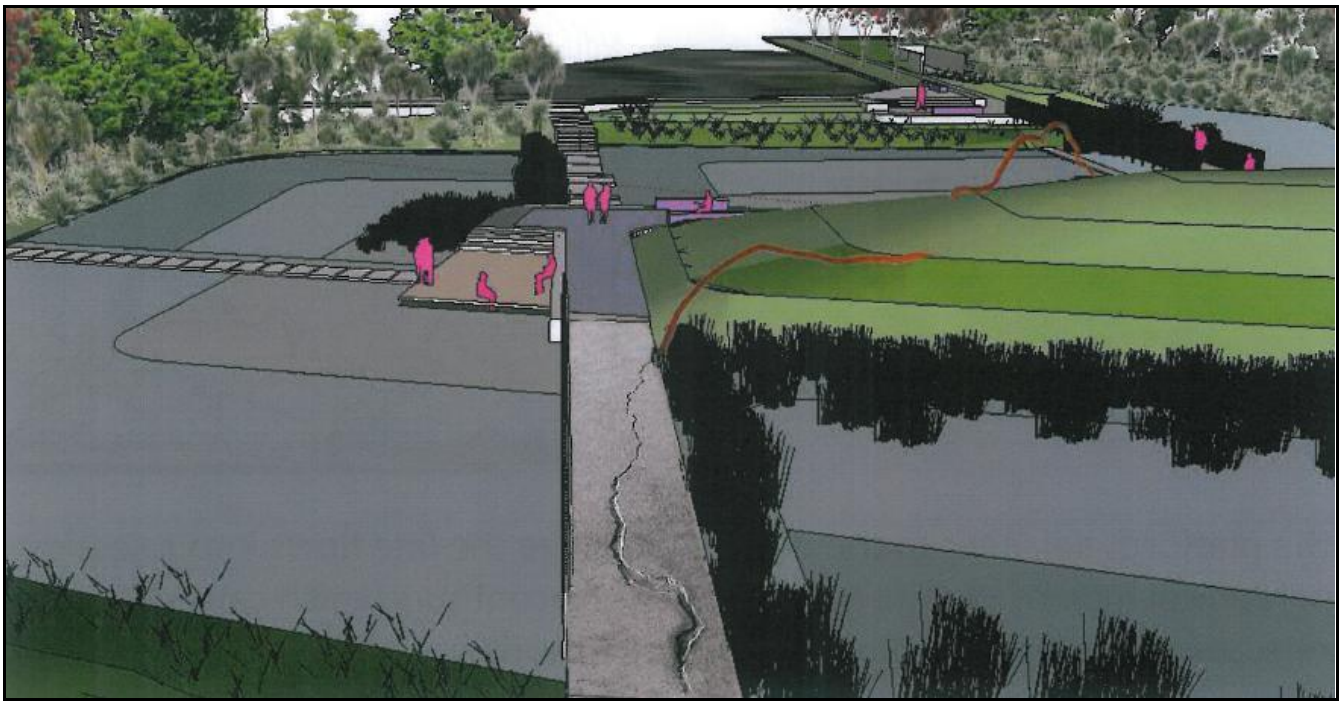
The landscape-led design naturally identified opportunities to incorporate art into the design of the wetland rehabilitation. Auckland Council Art coordinators assisted in selection of an artist who worked closely with the landscape design team to develop the finished design. Several artistic themes were considered before deciding on the theme: 'A transitional space'. The concept would depict:

- A transition between natural and man-made
- A space of continuous movement and change
- An ephemeral space
- A social space

This concept would be represented by a line running from the inlet to the outlet of the wetland along the pathway. This line is representative of movement to and from location through space (Figure 13).

When seeking involvement of artists in a project it is important that they are engaged early in the process. This way they can become fully conversant with the project, the desired objectives and better understand the context of the wetland in the surrounding environment. This can take some time to develop and explore.

Figure 13: Artists impression of how the transitional space concept could be incorporated into the wetland concept design



8.2 OFF-ROAD CYCLE LINK

Over the last decade we have seen a proliferation of commuter and recreational cycleway links in Auckland. Routes adjacent to motorways have been one of the focal points e.g. along the southern edge of the North-Western motorway. Auckland Transport has a proposal to create a south – north cycleway along the western edge of State Highway 1 (SH1), north of Akoranga Drive off-ramp.

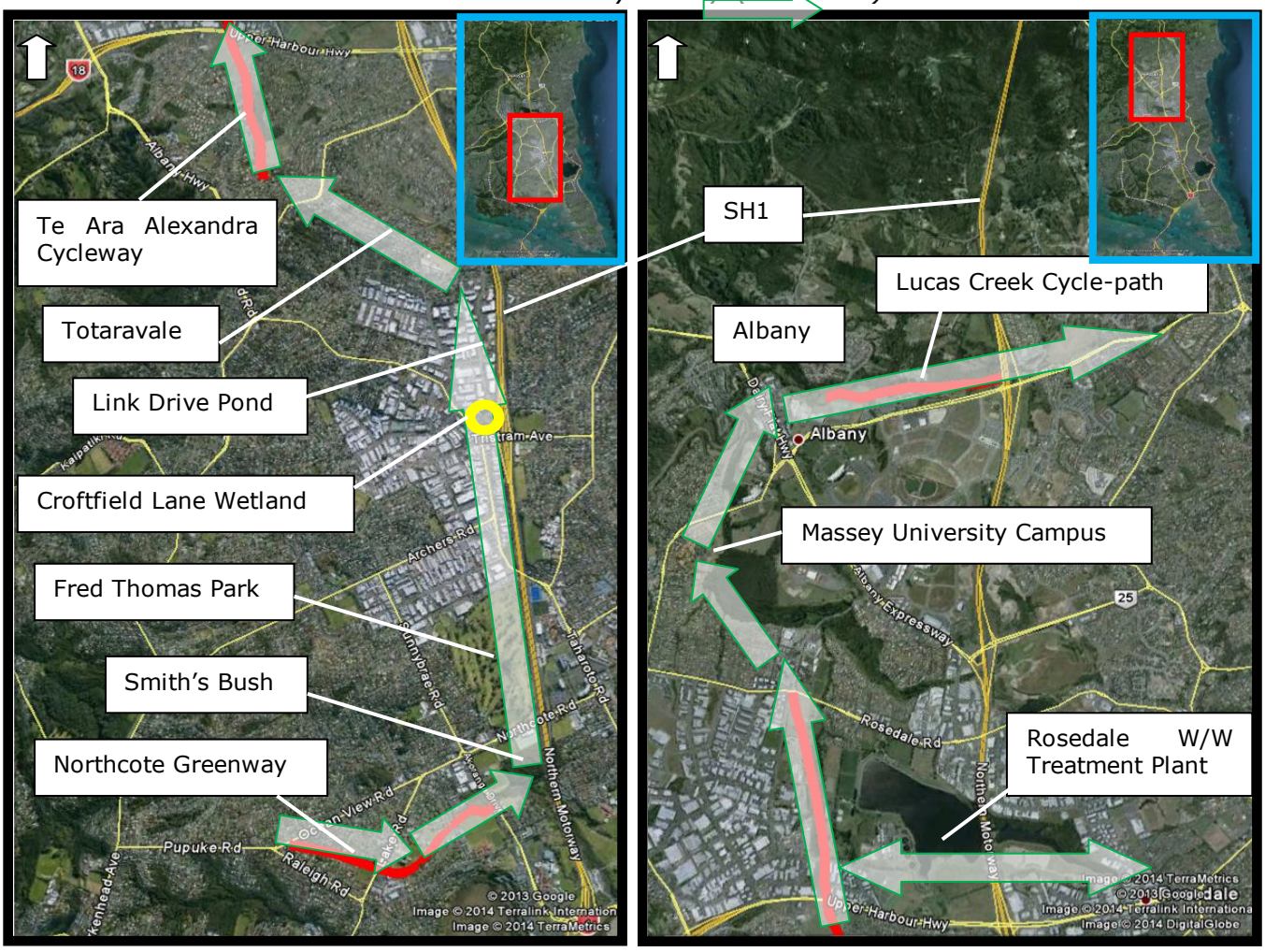
Cycleways located within the carriageway subject cyclists to safety issues, noise and air pollution and provide little in the way of a riding experience. Off-road cycleways on the other hand can enhance the riders experience while meeting the objectives of a commuter route.

The development of the Croftfield Lane wetland provides one of many nodes of interest along the western edge of SH1 that the proposed cycleway could link together outside of the carriageway. Other sites along this path include Smiths Bush, Fred Thomas Park, Link Drive Pond, Totaravale, Wairau Park Commercial Area and a number of schools (Figure 14).

Such a cycleway route would also provide an opportunity to connect with existing cycle-ways, such as the Te Ara Alexandra Cycleway along the Alexandra Stream, the Lucas Creek cycleway network along Oteha Valley Rd and proposed networks in Northcote (Northcote Greenway) and within the Rosedale Wastewater Treatment Plant area. Given some funding and effective planning the Croftfield Lane Wetland has the potential to be one of the highlights along a cycleway linking Northcote and Takapuna with the Wairau Valley, through to Albany and beyond to Long Bay; some 25km of on-road/off-road continuous cycleway.

Opening up sections of naturalised stream through the lower Wairau Valley primarily for mitigating existing and predicted flooding may also act to accentuate the amenity through this area, and coincidentally be situated in alignment with the proposed south-north cycleway route.

Figure 14: Location of the Croftfield Lane Wetland in reference to a potential North-South Off-road Cycleway ( )



Modifying existing roads within the Wairau Valley into cycle-friendly green boulevards could also assist in alleviating these areas of problematic flooding issues (e.g. Link Drive). A green/blue cycleway network could be designed to convey flood flows away from commercial property.

9 CONCLUSIONS

Having ample space in the developed urban environment for storm water treatment devices, flood attenuation structures and recreational facilities is now a fallacy. The luxury of easily selecting a site for storm water intervention that will only achieve stormwater objectives is long gone. Green space in these urban environments is also often sparse and as a result the community is more reluctant to give up these green spaces for a storm water function.

Achieving multiple benefits in our storm water projects is now becoming a necessity not a nice to have. This means that stormwater engineers have to be collaborative workers, good communicators and creative in their thinking.

The role of landscape design in storm water management is strengthening as people become more aware of the desire for aesthetics in design and the role the landscape has in managing primary storm water flow. A great example of landscape-led stormwater design in residential development is in the Kirimoko Park Eco-subdivision in Wanaka where the design approach aimed to minimise earthworks and develop urban and

landscape elements around existing natural features while achieving the desired stormwater, landscape and amenity objectives (Lauenstein et al, 2010). There is no reason why this shouldn't be the default approach when creating public storm water assets, as was applied in the Croftfield Lane Wetland Project.

One of our greatest challenges is finding a way to better incorporate 'social benefits' into the cost benefit assessment. Amenity and other social benefits are often seen as intangible factors, qualitative and not quantitative measurements that can be difficult to represent and compare numerically. In many cases this means they are left out of the equation and opportunities to include such aspects in the design are missed.

The Croftfield Lane Wetland rehabilitation is one such project that attempts to bring these amenity benefits into being. Improved access and visual experience for the public will see the Croftfield Lane Wetland become a green destination in what is otherwise a fully paved commercial district. In combination with the enhanced storm water function the Croftfield Lane Wetland has a good chance of becoming one of the most treasured community and environmental assets in the area - a diamond in the rough!

ACKNOWLEDGEMENTS

I would like to acknowledge Jan Heijs and Barry Carter for their guidance and encouragement to approach storm water project planning with an innovative, open mind. I also wish to make note of our colleagues in the Auckland Council Sports Parks & Recreation, particularly the positive way in which they are adopting the multi-benefit approach the Stormwater Unit is taking with these types of projects. I also appreciate Mohammed Sahim Razak's input regarding the management of Alligator Weed. Thanks also to Brian Horspool for an open mind regarding walking & cycling routes and the Auckland Council Art Coordinators for their artistic influence.

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