

AUTHOR: Caleb Clarke (BE (ENV))

Presenter: Caleb Clarke

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Caleb Clarke

Environmental Engineer

Morphum Environmental Ltd

P.O. Box 99-642 Newmarket

(021) 423371

caleb@morphum.com

Abstract

This paper presents a case study of the Roy Clements Treeway (RCT) Boardwalk project implemented by Metrowater, Auckland City's water and wastewater utility. This project represents an innovative solution to urban drainage management that involves changing land use and community expectations to address infrastructure issues.

The Roy Clements Treeway is located alongside the Meola Creek in Mount Albert, Auckland. A highly trafficked public walkway provides a pedestrian link through the Treeway. The stream often floods the Treeway with contaminated waters, putting public health and safety at risk. Conversely litter such as rubbish and shopping trolleys enters the Creek from the Treeway. Watercourse Management Planning (WMP) underway for the Meola Stream has developed a solution to address these issues with the RCT boardwalk project.

The project consists of providing a raised boardwalk elevated above the floodplain through the Treeway. This allows transition of land use from a high maintenance park to more natural and lower maintenance re-vegetated riparian zone. This has been undertaken in a manner that integrates access, security and transitional maintenance considerations.

This project provides benefits for community education and urban renewal. The restored riparian zones provide a greenbelt in the urban environment, and represent a key opportunity to enhance the water cycle through targeted restoration. Natural environments located within urban areas also have the opportunity to benefit many by providing an opportunity to experience nature on their doorstep.

The boardwalk project also integrates with community activities including:

- Waicare stream care groups
- Community Planting Days
- An adjacent community driven wetland restoration project
- Education of students from the adjacent Mount Albert Grammar School

This is an opportunity to help and harness community involvement, and creates an example process that can be a blueprint for other watercourse management projects with a community focus within Auckland City.

1. Introduction

Meola Creek drains a large catchment area from Mt Eden Road through Balmoral and Sandringham, and discharges at the Meola Reef near the Pasedena area of Auckland's central western suburbs.

Meola Creek runs through the Roy Clements Treeway, an area owned by Mt Albert Grammar School (MAGS) in Alberton Ave, Mt Albert, and managed by Auckland City Council (ACC) as a public walkway. Figure 1 indicates the location of the Meola Catchment and the Roy Clements Treeway,

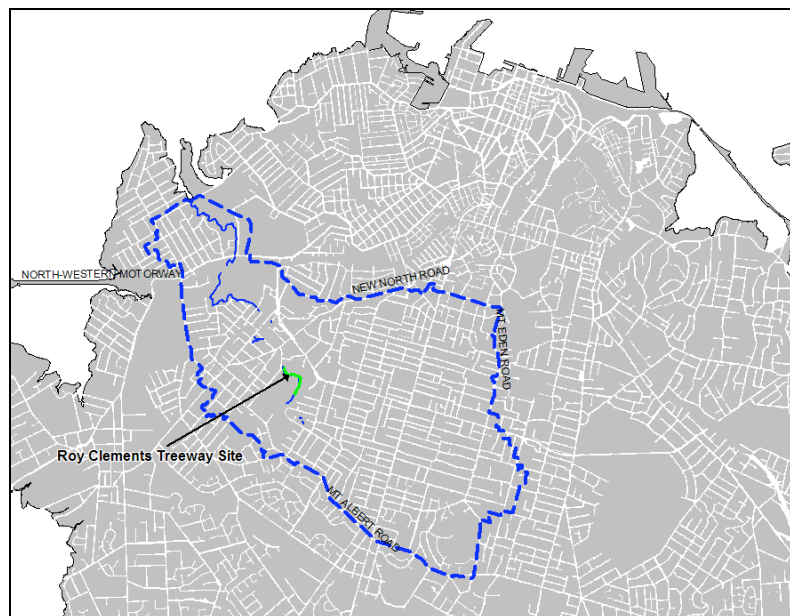


Figure 1 - Roy Clements Treeway location in Meola Catchment, Mt Albert, Auckland

The pedestrian walkway frequently floods impacting on access and public safety. Approximately 10 square kilometres of urban catchment drain to the site, with inflows that include:

- Relatively clean base flow from the adjacent volcanic aquifers
- Stormwater from predominantly residential and some commercial land use including roofs/ roads, pavements and urban gardens, grass and parks, with resultant contaminant inputs that include TSS, heavy metals and hydrocarbons;
- Combined sewer overflows during storm events, including high Nutrient and BOD loadings, bacteria and gross pollutants.

This paper presents a case study of the Roy Clements Treeway (RCT) Boardwalk. This project is jointly funded by Metrowater, Auckland City Council and Watercare Services Ltd. Morphum Environmental Ltd has been engaged by Xeno Captain of Metrowater to act as designers and project managers on the project.

Auckland City Council is responsible for the management of Stormwater projects for the City of Auckland. Metrowater is responsible for Auckland City's water and wastewater utility, and manages stormwater on behalf of EUM. Watercare Services Limited owns and operates the Auckland Regional water and wastewater infrastructure.

The Roy Clements Boardwalk project is undergoing construction at the time of writing and offers an example of short term mitigation of some of the major impacts on Auckland's water cycle.

2. Options

The following Options have been considered by various groups in order to address the public health and water quality issues that currently impact on the Roy Clements Treeway.

2.1. Regional Wastewater Solution

It has been identified that removing the main sewer overflow inputs to this system is dependant on regional wastewater infrastructure capacity issues. The proposed concept outlined in the Watercare Three Waters Strategy (Watercare 2008) includes a central interceptor to collect wastewater flows from central Auckland and drain to the south to connect to the existing Mangere Treatment plant via a storage tunnel beneath the Hillsborough ridge.

This or another regional solution is likely to prevent overflows to the Meola Creek. However such a solution is likely to be expensive and take in the order of 6-10 years for planning and implementation. A regional solution is being actioned; however this will not adequately mitigate the short term impacts on the Roy Clements Treeway.

2.2. Sewer Separation

Approximately 40% of the Meola Catchment has a combined sewer system. Sewer separation involves the installation of new infrastructure in order to provide two separate systems for stormwater and wastewater. This reduces the peak wet weather flow and subsequently reduces the frequency of sewage overflows.

Sewer separation is a complex and expensive exercise. Catchments across Auckland have been prioritised based on cost versus benefit in reducing overflows into the Harbour. The Motions catchment is currently undergoing separation, and is likely to consume available budgets for approximately the next three years (Menzies 2008). A decision on the next catchment to be separated is unlikely to be reached for approximately a year.

Therefore, sewer separation is unlikely to provide a short term solution to the impacts on the Roy Clements Treeway

2.3. Flood Mitigation

Flood Mitigation Methods that are existing or are proposed for implementation within the catchment include enhanced Aquifer disposal and pipe capacity upgrades

The treeway flooding is likely to be governed by the downstream culvert beneath Alberton Ave. In addition the grille at Alberton Ave can become blocked and increase the flood levels in the park.

Flood modelling studies are underway for the Meola catchment and capital investment studies are programmed for the near future. These studies may reduce the flooding frequency, however due to the large size of the catchment they are unlikely to eliminate the inundation of the treeway floodplain.

2.4. Treeway Closure

The treeway could be closed to the public, either permanently, or temporarily following storm events. However the treeway provides an important pedestrian link to surrounding suburbs and is a well utilised route for school pupils.

2.5. *Overflow Screening*

Overflow screens could be installed at combined sewer overflows. These would have a high capital cost and become largely redundant with implementation of a regional solution. In addition, overflow screens will not significantly reduce the bacteriological component of the contamination from sewer overflows.

2.6. *Treatment Wetland*

An option of a treatment wetland has been investigated by Watercare Services Ltd and found to be unfeasible (Watercare Services Ltd 2004). Wetlands designed to treat sewage would become highly anaerobic and provide additional public health risk. By contrast, sewage in high-volume stormwater flows is diluted and is largely transported into the harbour where it breaks down relatively rapidly. In addition, the site is not suitable for development of a formal treatment wetland due to the high flows, topographical constraints, and risk of flooding upstream.

2.7. *Raised Boardwalk*

The option of a raised boardwalk provides a short term solution with added long term benefits. In the short term, this solution mitigates the immediate public health and amenity issues from the overflowing creek. In the long term it provides safe pedestrian access during periods of flooding.

It is proposed to construct an elevated boardwalk to avoid pedestrian contact with contaminated stormwater and surface deposited solids. The boardwalk will follow the path of the current walkway from the entrance at Alberton Ave to the Kerr Taylor Reserve. This will serve to minimise public contact with the contamination.

In addition a boardwalk will provide additional benefits that justify the project. Raising the path will integrate with riparian planting with added water quality and ecological habitat benefits. The Boardwalk is currently being installed for completion in November 2008.

3. *Watercourse Management Issues*

The following watercourse management issues are important facets of integration that have been considered for incorporation within the Roy Clements Treeway Boardwalk project.

3.1. *Watercourse Management Planning*

Streams are an important environmental asset in Auckland City. They form an integral part of the stormwater drainage system. However, as development has taken place there has been consequential changes to catchment hydrology, including increased peak flows and reduced or impacted base flows in streams. This development pressure also results in the removal of riparian vegetation, construction of structures in streambeds and flood plains, and in some cases piping or channelisation of streams. This has the following general effects on streams:

- Increasing erosion and deposition of sediments;
- Increasing water temperatures;
- Reducing dissolved oxygen concentration;
- Loss of aquatic habitat;
- creating barriers to fish and;
- General loss of ecological and amenity values.

To better manage waterways it is important to have a plan for the future. A Watercourse Management Plan (WMP) needs to illustrate value, constraints and opportunities within the drainage system. It should, as a fundamental driver, take into account key stakeholder requirements. These stakeholders will include; community, planners and managers (i.e. stormwater, parks, planning).

A WMP is currently being developed by Auckland City for the Meola Creek. The Roy Clements Treeway Boardwalk Project has been identified as a priority project as part of the WMP process and integrates with many of the following WMP objectives:

- Improved management of waterways;
- Improved aesthetics and community value;
- Management of the waterway to meet flooding reduction objectives;
- Improved ecological function of riparian and in-stream system;
- Meet regulatory requirements and levels of service as defined;
- Communication of stream value.

3.2. *Flooding*

Meola Creek often floods the Treeway putting public health and safety at risk. The Treeway section of the Meola Creek has several stormwater inflows that respond rapidly to rainfall giving rise to sudden increases in flow. The treeway is inundated several times a year. The downstream capacity is restricted by a long piped section. The inlet to this pipe is protected by a safety grille installed following the death of a child swept into the stream. The grille is regularly maintained to minimise blockage, as this may increase flooding frequency in the treeway.

At several points along the treeway, overland flow paths enter the park. The low lying walkway is often submerged by standing water and the grass on either side is sodden and muddy.

The treeway boardwalk proposal needs to maintain conveyance capacity in addition to separating the public from the floodplain and wet areas.

3.3. *Wastewater Inputs*

Parts of the Meola Catchment are serviced by combined sewer reticulation. This results in large flows of combined sewage reaching the bottom of the catchment during rainfall. When this exceeds the capacity of the trunk sewer infrastructure, flows spill from several constructed overflows. This was an accepted practise of the day during the 1920's and 1930's. Meola Creek is the receiving environment for these combined sewer overflows, and is therefore frequently contaminated.

As the channel is often overtopped during high flow events, the adjacent walkway and grassed areas that occupy the floodplain are often inundated with contaminated waters. This results in a significant health hazard to school pupils and the general public as the walkway is generally still utilised after such events.

As discussed in Section 2, medium term solutions to the wastewater inputs to the Meola Creek receiving environment are currently being planned for implementation.

3.4. *Water Quality*

In addition to combined sewer inflows, other sources impact on Meola Creek Water quality. These include:

- Heavy Metals, hydrocarbons and suspended sediments in stormwater runoff.

- Debris from and stormwater and combined sewer inputs or from members of public using the park. This includes items like litter and shopping trolleys.
- Sunlight from areas lacking in riparian vegetation leading to increased temperature and lower dissolved oxygen.

3.5. Groundwater

The Meola Catchment is largely influenced by the Western Springs Aquifer system. The catchment consists of relatively shallow basaltic lava flows of the Three Kings, Mt Eden and Mt Albert eruptions sitting over a local basement of impervious Miocene Waitemata Group sandstones. These volcanoes have erupted in the last 40,000 years. Meola Creek has become incised along the south-western edge of the Three Kings lava flow. Due to the high porosity and permeability of the basalt deposits, the Meola Creek has become a conduit for water flows from the aquifer. (Russell & Rodgers 1977) The lower end of the treeway is the point where the Three Kings eruption overlapped the earlier Mount Albert lava flow (Viljevac 1998). A diagram of the Western Springs aquifer system is indicated in Figure 2.

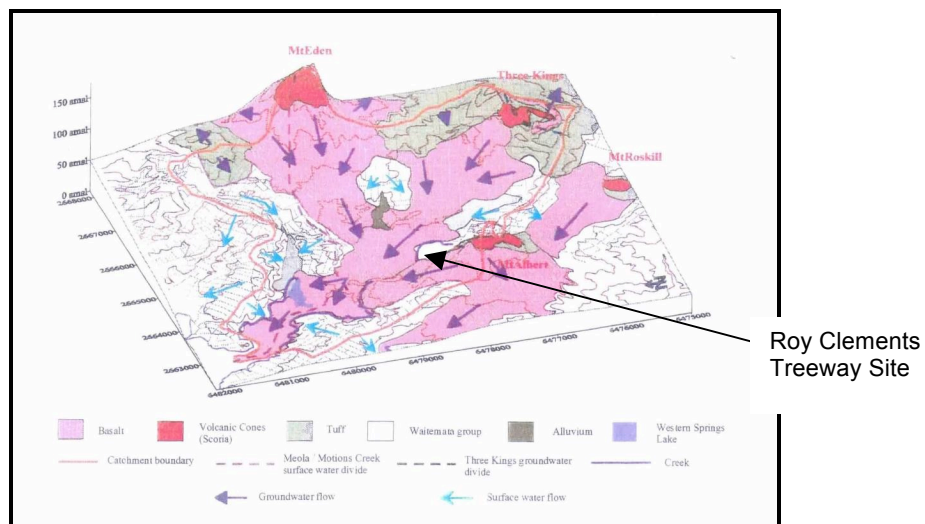


Figure 2 – 3d Hydrogeological Model of the Western Springs Aquifer (Viljevac 1998 Figure 2.12)

The two major springs from the aquifer are those of Chamberlain Park and Western Springs further downstream. However the groundwater level in the aquifer meets the ground surface in the upper Meola Creek area, and therefore the aquifer contributes base flows to the upper section of Meola Creek through the Roy Clements Treeway (Viljevac 1998). In addition, seasonal high groundwater flows lead to several springs from above the eastern bank of the stream along the upper portion of the Roy Clements Treeway. A major area of springs feed a wetland alongside the treeway, which is an opportunity for enhancement. There is a possibility of localised confinement of the aquifer, due to historical alluvial deposition, that increases perching and surface flows (Viljevac 1998).

The Aquifer that feeds the Meola Creek at the subject site is an important resource for Auckland. This aquifer served Auckland at Western Springs as its main water supply from 1877 to 1909 (Russell & Rodgers 1977). Increasing impervious surfaces and potential contaminant sources connected to groundwater disposal may have reduced the value of the resource over time; however measured values of chemical constituents from sampling are largely within New Zealand Guidelines for drinking water (Viljevac 1998).

There is potential use of this aquifer for future water supply. Opportunities for groundwater utilisation have been identified in the Watercare Three Waters Strategy. For now, the aquifer represents the cleanest inflows to Meola creek and maintains important environmental base flows.

3.6. 3 Waters Integration

Watercare Services Limited have produced a major strategy document for the Auckland regional water utility infrastructure entitled the Three Waters Draft Strategic Plan. This plan promotes an integrative approach to management of the water cycle. All three waters have interactions that relate to the Roy Clements Treeway site. These interactions provide three waters opportunities as outlined in Table 1.

Table 1 – 3 Waters Integration

Water Sector	Objective	Opportunity
Water Supply	Utilise alternative water supplies including stormwater and groundwater	Increase appreciation of surface water systems and groundwater resources including storage possibilities. This will have wider benefits for societal valuation of water resources
Wastewater	Reduce risk to public health	Separate public and animals from contaminated water with high health risk.
	Implement short term options that integrate with long term proposals	Preference for short term treatment of this risk that has wider benefit in achieving community and environmental outcomes.
Stormwater Quality	Reduce local contaminant inputs	Provide planting to filter overland flows
	Improve dissolved oxygen	Improve shading by increasing riparian planting
	Improve visual impacts	Screen debris and contamination by planting vegetation. Exclude by making it more difficult to dump refuse i.e. shopping trolleys in the stream
Stormwater Quantity	Mitigation of flooding effects	Prioritising land use within the floodplain that has a lower inherent risk of damage and cost.
	Increase groundwater disposal	Minimise the impacts of groundwater disposal by having regard for groundwater flows and springs with potential to inundate low areas

3.7. Access

Streams often represent an important green belt within urban areas. The Roy Clements Treeway provides an important pedestrian and cycle link between adjoining suburbs including apartment complexes and the adjacent St Lukes retail centre.

The treeway is well utilised for recreation including running and dog walking. This access needs to be maintained during the works and considered as part of the finished boardwalk layout.

3.8. Park Maintenance

The Roy Clements Treeway is maintained by the Art, Community and Recreation division of Auckland City Council. The existing maintenance activities include tree pruning, weed removal, grass mowing and Graffiti Removal.

The construction of a boardwalk will impact on these activities by reducing access for heavy vehicles. In order to minimise these effects, the Treeway Boardwalk needs to be conducted in conjunction with a shift in land use to lower maintenance native plantings.

4. Boardwalk Proposal

The project consists of providing a raised boardwalk elevated above the floodplain through the Treeway. This allows transition of land use from a high maintenance park to more natural and lower maintenance re-vegetated riparian zone. This has been undertaken in a manner that integrates access, security and transitional maintenance considerations.

4.1. Structural Design

The 1.8m wide boardwalk is to be raised 900mm from ground level. As the boardwalk will be less than 1m above ground level, no building consents are required; however it has been designed for 4kPa/4.5kN loads

The boardwalk will be approximately 600m in length and will follow similar lines to the footpath currently in place. The close proximity to streams and existing trees means that the boardwalk cannot be wider than 1.8m.

4.2. Access

Temporary access along the Treeway is required. Despite temporary limitation, the access has been kept open during the works.

Permanent access for pedestrians has been improved by the project. Access is maintained during wet weather, and interaction with mud and contamination has been prevented.

While the boardwalk is wider than the existing concrete footpath, it is not wide enough to provide rapid transit for mixed use. Cyclists may have to slow to avoid pedestrians and some cyclists will need to walk due to the proximity to a 900mm drop.

The maintenance of the tree way may require trimming of specimen trees, weed removal and debris removal. The existing open tree way allows passage of heavy vehicles during dry weather. The current mowing regime on the watercourse side of the boardwalk alignment would not be required with proposed future riparian planting. In addition fallen branches can be left in situ and provide terrestrial habitat.

Several ramps have been provided that allow light vehicles to cross or travel along the boardwalk to facilitate some maintenance activities. Therefore, the reduced access for parks maintenance is not considered to create unmanageable problems.

4.3. Public Health

The boardwalk on the eastern bank will effectively separate pedestrians from floodwaters and ground that is contaminated with sewage effluent.

The western bank of the channel is currently open to the school fields. Pupils regularly enter the channel via this bank, to retrieve balls and to cross to the opposite side. This brings them into contact with contaminated water, often damages riparian vegetation and can cause erosion. The school principal has requested that as part of this project, a fence is installed around the Mt Albert Grammar School sports fields. The fence will follow the edge of the school field and is proposed to be set back between 2m and 12m from the channel edge. This will allow the establishment of a sizable riparian strip along the creek.

4.4. Floodplain Hydraulics

Works within the floodplain have the potential to create a minor obstruction to flows. The free flow of water within the floodplain will include lateral flow as the water spills from the main channel and drains back in, and the longitudinal flow travelling downstream. The factors that contribute towards impedance of free flow of water are the velocity of the flow perpendicular to the obstruction, and the proportion of the cross sectional area that is blocked by the obstruction. The Boardwalk is estimated to obstruct between 2-3 % of the total cross section area for a 100 year ARI event.

This level of obstruction of the floodplain is negligible, and the effect is likely to be no more than minor. Therefore the proposed Boardwalk is not considered to impede the free flow of water as per section 18.2.4 of the Auckland City Council Stormwater Bylaw.

4.5. Tree Protection

Works on trees need to be undertaken in accordance with the concept plan for the school special purpose zone. A tree consent was obtained from ACC, with works conducted in accordance with this consent.

4.6. Wetland Outlet

There is a small wetland located adjacent to the upper section of the Roy Clements Treeway. It is approximately 140m from the boundary of Kerr-Taylor Reserve. It drains via a 300mm culvert located beneath the existing path and discharges at the base of the bluestone channel lining wall (see Photo 5 in Appendix 5). This wetland is fed by clean artesian water from the adjacent basalt aquifer and the culvert has significant base flow. The culvert inlet is intermittently blocked and the water level in the wetland area artificially elevated in an informal manner.

As part of the project this culvert has been daylighted and a rock cascading weir provided to improve the function and aesthetic quality of this wetland. Aquifer fed spring water now spills beneath the walkway and cascades into the creek to provide amenity value. A viewing platform and educational resource is located here to provide information on the interaction of the groundwater and surface water systems and the wetland habitat.

4.7. Crime Prevention through Environmental design CPTED

An assessment has been undertaken as part of the project to maximise opportunities for Crime Prevention Through Environmental Design (CPTED). CPTED emphasises the connection between the functional objectives of space utilisation and behaviour management. This involves consideration of the future boardwalk and its impacts on feelings of safety, and ability to facilitate crime.

There are several ways to offset the potential effects of movement prediction and entrapment:

- Provide clear sightlines into/out of the space
- Provide clear sightlines along the route
- Provide multiple entry/exit points preferably to public areas
- Facilitate surveillance e.g. by clearing vegetation to enable views from neighbouring apartments, incorporating facilities or activities to generate or encourage use.

CPTED elements have been incorporated into the design including:

- Planting of low growing species adjacent to the boardwalk to minimise possibility of ambush and maintain existing sight lines.
- Provision of connections to existing formal and informal access points for the reserve.
- Provision of viewing platforms to allow people to step aside and avoid confrontation, for instance with boisterous school children.

4.8. *Ecological Restoration*

A major driver for the project is the opportunity that an alternative management of the Meola Creek riparian zone represents for ecological restoration. As part of the project, an ecological restoration plan was developed. This included the following considerations:

- The need for an intensive long-term exotic pest plant control programme.
- That plants identified in the Regional Pest Management Strategy be prioritised for removal.
- That pest plants are prioritised according to their impact on native ecosystem processes.
- Encouraging community ownership of the reserve, including working days and events.
- Planting low lying vegetation to create open-sided, welcoming pathways.
- Habitat and food requirements for native birds, invertebrates and reptiles.
- The area has the potential to become a socially and ecologically significant reserve, linking other streams and bush remnants in the area.

This Plan sets out a series of weed control and planting measures that will be undertaken over the following six years to facilitate transition to a stable ecosystem that will require limited maintenance inputs.

4.9. *Community Integration*

The plight of urban streams is largely tied into the value that a community places on natural systems including the water cycle and functioning ecosystems. There are several initiatives and activities relating to the Roy Clements Treeway section of the Meola Creek that provide special opportunities to integrate with community motivation and cohesion. These include:

- **The St Lukes Ecological Protection Society (STEPS)** – This group is focussed on improving the health of the Meola Creek and are heavily involved in positive actions. They are watchdogs against negative environmental activities and advocates of more sensitive development in the catchment. They are developing a restoration plan for the

aquifer fed wetland at the South end of the boardwalk. STEPS are also leaders and core supporters of initiatives including community planting in the area.

- **Waicare Stream Care Program** – This is a regional program that is focussed on protecting waterways, educating community and sharing information with other Territorial Authorities.
- **Adjacent Education institutions** – There are several education institutions nearby to the project site. The boardwalk and its associated ecological restoration can provide an ongoing educational resource.

4.10. Education

The interactions due to community integration will initiate the education benefits from this project. Monitoring will be able to develop ongoing subject material to feed further education from the ecological restoration associated with the boardwalk construction project.

Long term education benefits will be enhanced by signage to communicate the values of the aquatic and terrestrial environments of the Roy Clements Treeway and the Meola Creek. Signage will be erected following project completion at the three viewing platforms associated with the project. The following themes are proposed for educational message delivery:

1. Role of streams in the water cycle from the ridges to the sea and the associated aquatic habitat linkages
2. Function of riparian ecosystems including the transition of vegetation with soil moisture conditions and the ecosystem services provided by the key land/water interface on stream banks.
3. Value of Auckland’s groundwater resource including the possibilities for stormwater disposal, harvesting for use, and the benefits to streams from spring fed base flows.

The signage is currently under development in conjunction with key stakeholders.

4.11. Boardwalk Project Summary

Table 2 below indicates the various elements of the design leading to positive outcomes and fulfilling objectives.

Table 2 – Boardwalk Project Summary

Objective	Element	Outcome
Increase aesthetics and community value	Boardwalk	Naturalised aesthetic in conjunction, Education signs and natural habitat resource with enhanced community involvement through planting days.
Improve ecological function of riparian and in-stream system	Ecological Restoration	Stable, maintainable ecosystem, creating linkages and providing water quality improvement and habitat for the aquatic and terrestrial environments.
Respect groundwater resource	Wetland Outlet	Day lighting of aquifer springs and associated education resources
Manage impacts of wet weather overflows from the	Boardwalk	Separating public from contamination resulting in reduced health risk

Objective	Element	Outcome
wastewater network		
Manage the waterway to reduce flooding	Boardwalk	Not obstructing walkway and reducing flood risk by raising walkway
Allow for ongoing park maintenance	Access Ramps and ecological restoration	Minimised loss of access and reduction of the need to enter the park for vegetation maintenance
Public Safety	Boardwalk extensions for CPTED improvements	Greater feeling of Safety communicated

5. Conclusions

The Roy Clements boardwalk project is an opportunity to take immediate action to address large scale infrastructure problems. It also provides simultaneous benefits in improvement of the urban environment and water cycle. Importantly the boardwalk project facilitates and harnesses community involvement, and may be used as a blueprint for other watercourse management projects with a community focus within Auckland City.

The boardwalk design has been approached in order to integrate various, potentially competing objectives. It is an embodiment of key principles of watercourse management and ecological restoration. It minimises the local impacts of flooding and sewer overflows, allows for increased groundwater flows and draws attention to groundwater/ surface water interactions.

The changes caused by the boardwalk construction are not without cost. The project generates a reduction in accessible open space and channels pedestrian and cycle traffic. The access for large vehicles to the area is cut off. Elements of design have been targeted at addressing these changes to the existing land use. In balance the naturalised environment due to the combined boardwalk and ecological restoration is seen as a net improvement.

The project offers a valuable opportunity to bring different parts of the community together and create a sense of shared ownership and pride in local community assets. Through planting days, and associated local restoration projects, the boardwalk project is part of a wider direction within the community to actively engage in environmental enhancement. The restored environment adjacent to schools will provide a resource for nature awareness and education that can be made more accessible by interpretive signage. The boardwalk will provide a unique opportunity for many urban inhabitants to experience nature on their doorstep.

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